THE APPLICATION OF COST-BENEFIT ANALYSIS TO PLANT BREEDING: AN EXAMINATION OF NEW POTATO VARIETIES BRED AT THE SCOTTISH PLANT BREEDING STATION

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The work presented in this thesis is the result of my own investigations and has neither been accepted nor is being submitted for any other degree.

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CHAPTER ONE

Introduction: origination and background to this present study

1.1 Antecedents of this present study

This present study was made possible by a new category of studentship, introduced in 1969 by the Science Research Council (SRC) on the lines suggested by the 'Swann Report on Manpower for Scientific Growth', to provide broader-based subjects of study for Ph.D theses. The studentship was broadly defined as a "study of the economics of plant breeding". The SRC stated at the outset:

> "It is certain that plant breeding is a highly economical process in the sense that the cost is small in relation to the economic gains that result from success. But neither costs nor profits are easily estimated so that there are few (perhaps no) really good examples of such assessment on record." (SRC, 1969)

Three objectives of assessment were outlined: to assess the economic value of new potato varieties in relation to those they displaced; to define breeding objectives in economic terms, and to apply the ideas of cost-benefit analysis (CBA) to plant breeding problems. It was recognised that the development of the study would depend upon the problems associated with assessment.

1.2 The general background to the need for economic assessment in agricultural research and development (R & D)

The antecedents of this present study are best understood against a background of opinion which gathered strength in the 1960s, of unease and concern about the return to investment in agricultural R & D. This was a reflection of a more general disquiet associated with public spending in science, and what society had been getting in return.

This probably had a large part to do with issues of economic growth; particularly, with fears that productivity in Britain was low relative to that of other countries (see Postan, 1972, for example).[1] Views were sometimes expressed that the cost of R & D was too high in relation to the economic return to society, that perhaps the wrong kind of research was being conducted, and that part of the reason was that researchers were unaccountable to public direction and interest. A statement of this view is given in a report of the Central Advisory Council for Science and Technology (1968).

A need for increased accountability was accepted in the 'Rothschild Report' (1971): this argued for changes in the management and control of public funds for R & D, and led to the implementation of the 'customer-contractor principle'. This is defined in H.M. Government's white paper on public-supported R & D as:

> "... (government) Departments, as customers, define their requirements; contractors advise on the feasibility of meeting them and undertake the work; and the arrangements between them must be such as to ensure that the objectives remain attainable within reasonable cost." (1972, p.4)

As a result, a large proportion of what would have been the Agricultural Research Council's (ARC) budget was given to the Ministry of Agriculture, Food and Fisheries (MAFF), and the Department of Agriculture and Fisheries for Scotland (DAFS), to enable them to direct the nature of R & D (which the ARC would continue to administer).[2]

A concern about the management of R & D has been expressed specifically with regard to potatoes in a report published by the

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[1] In addition, a greater awareness of environmental issues might have encouraged a belief amongst observers that uncontrolled increases in scientific knowledge (and economic growth) would not necessarily lead to increased social welfare (for example, there are the notorious predictions of Meadows et al., 1972 and associated debates).

[2] The role of the ARC and DAFS in relation to R & D at the Scottish Plant Breeding Station is noted in Section 4.1
The contractor principle is perhaps an extension of a post-war belief, noted by Russel (1966), that scientists should get on with the business of research and leave evaluation and extension of R & D results to trained advisory officers. The contractor principle goes further by directing what kind of R & D should be done by the scientist.

Economic Development Committee for Agriculture (EDCA, 1971). In a review of potato R & D the EDCA expressed concern at the methods by which R & D agencies selected fields of investigation, particularly, it was alleged, their apparent disregard of economic factors.[1]

However, the pressures for more explicit techniques of assessment of R & D work have not all come from outside research establishments. The tasks of a director of research have probably become more difficult to manage in recent times, as fields of scientific investigation have become more specialised and complex. Directors have themselves indicated that new procedures for R & D project selection and costing, which are concise and clear-cut in economic terms, are required (see for instance, Simmon's account of the historical development of potato plant breeding, and the prospects for economic appraisal, 1969).

However, prior to the undertaking of ex ante estimates of costs and benefits of specific, it seems necessary to conduct ex post studies. It is then possible, for example, to link existing benefits to past expenditure, which at a later stage in the development of project selection techniques might be used as indicative of future trends of benefit from proposed R & D. The place of retrospective studies of investment as a first step in improving project selection procedures is discussed in Byatt and Cohen (1969).

1.3 The aims of this present study

This present study seeks to assess the socio-economic worth to

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[1] The EDCA report was primarily concerned with the needs of processing. It is a recent feature of the potato industry that modern business interests have become more important with the development of processing and pre-packing trades. This seems to have resulted in a new commercialism which demands increased attention to product needs and costs. Not only has this brought about pressures upon researchers to consider economic factors, but also pressures for change in marketing and quality generally (below, Chapter 12).

society of funds invested in potato plant breeding R & D at the Scottish Plant Breeding Station (SPBS). Preliminary work indicated that in order to keep the study within manageable proportions it was necessary to restrict the main part of assessment to two varieties, Pentland Crown and Pentland Dell.

Thus, this study is a retrospective one. However, whilst the absence of systematic techniques of costing and project selection is a reason for applying the ideas of CBA to assess the socio-economic effects of investment in R & D, it also means that there will probably be difficulties. Data is unlikely to be in a form which is suitable for analysis (should it exist at all), and investment effects might be complex and not evident. This has been demonstrated in previous applications of CBA ideas to case studies of investment in R & D; and has been noted by Prest and Turvey in their classic review of CBA (1965).[1]

This means that a retrospective study is unlikely to define plant breeding in economic terms in a way which is precise, since CBA identification and measurements of investment effects will probably only be (perhaps rough) approximations of the truth. Preliminary analysis for this present study strongly suggested this, but also indicated that it was possible to derive an economic value for social benefit which for a wide range of assumptions, would be meaningful. By so doing, socio-economic factors important to investment selection might be identified.

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1 "... in reading (CBA work on R & D), one is struck by two things: one is the uncertainty and unreliability of cost estimates for particular research programmes and the second is the extraordinarily complex nature of the benefits resulting therefrom. Anyone living in the United Kingdom is very familiar with the belated discoveries by government departments that particular programmes of development have cost far more than anticipated. And although there are some examples of quantitative assessments of benefits - among which Griliches' paper is absolutely outstanding (see below, Section 3.6) - one cannot help feeling that the multiplicity of benefits and their diffusion among recipients will normally be such as to prevent precise quantification." (p.727)

1.4 The commercial success of Pentland Crown and Pentland Dell, and the varieties which were displaced

The commercial success of Pentland Crown and Pentland Dell resulted in a break in the pattern of potato maincrop varietal usage which had persisted for over 50 years.[1&2] During this time the leading maincrop varieties had been Majestic, first marketed in 1911, and King Edward VII, marketed under its present name in 1902. In 1964 varieties introduced to the potato industry 50 years previously had been planted on more than 80% of the British maincrop acreage.

Pentland Crown and Pentland Dell were first recorded in 1965 in the Potato Marketing Board's (PMB) acreage statistics at around 2% of the national maincrop. In 1972, Pentland Crown was grown on approximately 30%, and Pentland Dell 11% of the maincrop acreage planted in England and Wales, and 18% and 16% respectively, of plantings in Scotland. Annual plantings are shown as proportions of national acreages in figures 1.1 and 1.2. If the curves for the Pentland varieties are compared to those of other varieties, then it is to be seen that Majestic is the variety which has been most associated with falling acreages whilst the acreages of the newer varieties expanded.

In the case of England and Wales, figure 1.1, Majestic's proportionate share of the maincrop acreage, around 55% in the mid-1960s, fell in inverse proportion to the shares of Pentland Crown and Pentland

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1 'Maincrop' refers to the main part of potato production, for an explanation see the glossary, Appendix 1. Because this study has inter-disciplinary features an attempt had been made to minimize the use of technical vocabulary: but where this is unavoidable, the reader may be referred to the glossary, the terms there defined are marked in the text with an asterisk. Other appendices contain guides to symbols, conventions and abbreviations (Appendix 2) and metric conversions (Appendix 3).

2 This phenomenon appears to apply to other countries: for example, there are the long-lasting successes of Bintje (introduced in 1910) in the Netherlands, and Russet Burbank (pre-1890) in North America.

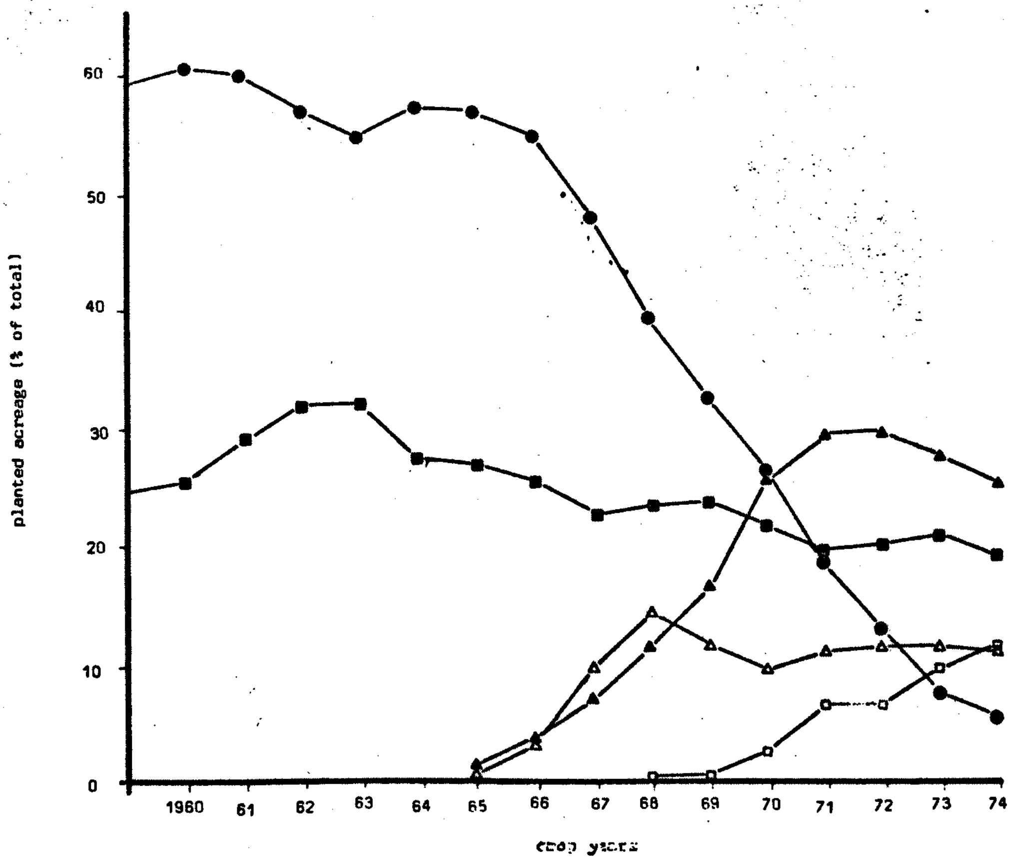

Figure 1.1 Shares of the potato maincrop acreage in England and Wales held annually 1960 to 1974 by leading varieties

Annotation: Majestic ●, Pentland Crown ▲, Pentland Dell △
King Edward VII ■, Maris Piper □

Sources: Table X.3 : and Appendix 4

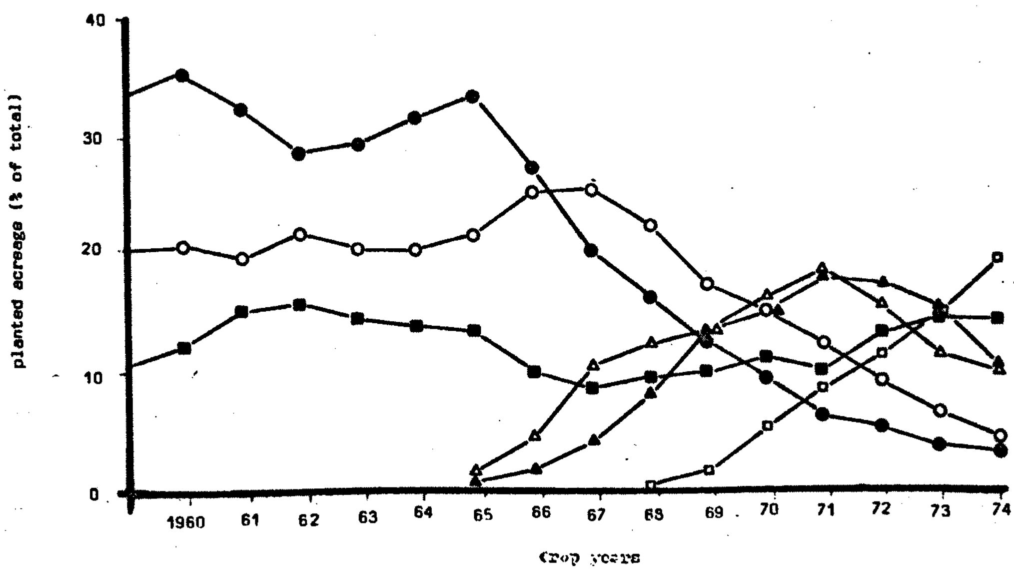

Figure 1.2 Shares of the potato maincrop acreage in Scotland, held annually 1960 to 1974 by leading varieties.

Annotation: Majestic ●, Pentland Crown ▲, Pentland Dell △
King Edward VII ■, Redskin ○, Maris Piper □

Dell, until only about 12% of the national maincrop had been planted with Majestic in the early-1970s. In Scotland, figure 1.2, the varietal national acreage pattern is more complex. Even so, it is obvious from the figure that as Pentland Crown and Pentland Dell expanded, Majestic's proportionate share declined: from about 30% in the mid-1960s to around 5% during the early 1970s.

The other important maincrop variety, King Edward VII, was not obviously affected (some observers, however, have suggested that plantings of this variety had been affected, see Section 12.7). In Scotland, figure 1.2, Redskin (introduced to the market in 1934) appears to have been affected by expanding plantings of Pentland Crown and Pentland Dell. Redskin's proportionate share of the Scottish maincrop declined from about 25% in the mid-1960s to less than 10% in the early 1970s.

In addition to those varieties represented in the figures there are others, less important, but likely to have been affected to some extent. The most important to Scottish markets was Kerr's Pink (first marketed under its present name, 1917): this variety had a proportionate share of the Scottish maincrop of around 15% in the mid-1960s, which declined to about 6% in the early-1970s. It is possible that its plantings were adversely affected by the increased popularity of the Pentland varieties. However, Kerr's Pink was declining prior to the introduction of the new varieties, and it is possible therefore, that other varieties would have been substituted for it anyway.[1]

Written communications with the regional offices of the PMB and the Agricultural Development and Advisory Service (ADAS), suggested that

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[1] It is likely that Redskin had been substituted for Kerr's Pink in the early 1960s, since the latter's acreage declined as the former's increased. Acreage statistics are given in Appendix 4. Varietal descriptions and notes on commercial importance are given in PMB (1965).

some minor varieties having local significance might well have been replaced by Pentland Crown and Pentland Dell, most notably the varieties, Arran Consul (1925) and Doctor Macintosh (1944). Both varieties had held a low but fairly stable proportionate share of the English maincrop since the late 1950s, but declined at the time of the Pentland varieties' expansion, and went altogether from PMB statistics after 1972. Arran Peak similarly declined but went from the acreage statistics earlier after 1970.

Nevertheless, these effects were small. In national terms it is clear from the figures, that this study must concentrate upon the success of Pentland Crown and Pentland Dell in terms of a comparison with Majestic, since it is this variety which would probably have been grown generally up to 1972 if the new varieties had not existed.[1] A full outline of this study's approach is given below, Section 3.9.

Before this, however, it is convenient for exposition to establish a basis upon which the approach adopted might be understood. The application of CBA has sometimes encountered criticism and therefore it is important to understand the logic and assumptions underlying CBA. Thus, there follows in the next chapter a consideration of the general reasoning and purpose of CBA, and afterwards, in the succeeding chapter, an account of the approaches used in other CBA work in the subject area of agricultural R & D.

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1 This is less certain after 1972, however, when it is more likely that Maris Piper would have been generally substituted for Majestic: this possibility is discussed below (Section 9.9).

CHAPTER TWO

The general ideas by which CBA is legitimised[1]

2.1 The general acceptance of the use of CBA

During the 1960s, CBA was increasingly advocated for use in Britain for investment appraisal in areas of the economy where government had an important interest. Thus, CBA was applied where government funding had taken place, such as transport (see Coburn et al, 1960: Commission on the Third London Airport, 1970), and education (see Blaug, 1965: Morris and Ziderman, 1971). The application of CBA to plant breeding is consistent with this trend.

These subject areas (and others in which government has had an important interest) have been generally difficult to assess economically and some of them, like potato R & D (Section 1.2), have probably been without systematic economic appraisal. The advocacy of CBA possibly reflected an increased ability on the part of economists to identify and measure the socio-economic effects of investment: or more probably, it reflected a desire to account for and justify an expanded public investment in activities for which there was little or no financial return.

In more recent times the optimism originally associated with CBA in the early 1960s has declined. A good example of such optimism was

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1 The place of CBA in relation to theories of public expenditure is considered in Millward (1971). A critical view of CBA in relation to administration and decision making is Self (1975). The most comprehensive survey of CBA work is perhaps Prest and Turvey (op cit). Other general work includes Mishan (1971b), Pearce (1971) and Peters (1965).

noted by Prest and Turvey, the originator of which was later to recant.[1] The cause of recent coolness is probably associated with exaggerated claims for what CBA can do, and its use by competing agencies to give increasingly optimistic estimates of investment success.

Certainly CBA is not a universal panacea for the assessment of the socio-economic effects of public investment. It is merely a systematic aid to decision making: it is not free from assumptions and much might depend upon the judgement of the analyst as to what can be reasonably identified and measured. However, this does not weaken the case for using CBA where alternative means of assessment might be absent or insufficient to reach a decision. Indeed, the case for using it, to quote Prest and Turvey, is "strengthened, not weakened, if its limitations are openly recognised and indeed emphasised" (op cit: p.731).

2.2 The origins of and general idea of CBA

CBA's intellectual origins probably begin with Dupuit's illustration of the distinction between a private firm's and public utility (1844), and Pigou's investigation of externalities (costs and benefits external to the investing firm) (1920). The terminology of 'costs and benefits' appears to have first been used in investment appraisal by

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1 "We have begun to grope our way towards a practical concept of economic planning which may prove in a few year's time to be as revolutionary in its way as was the Keynesian revolution in economics thirty years ago ... It is the revolutionary concept of social costs and benefits ... This leads to the revolutionary concept that we can actually add up the social costs and benefits in money terms, by asking what value people would themselves put on them. We can then express them as a rate of return on capital as an ordinary capitalist would, and so determine out investment rationally, from the point of view of the community as a whole, just as the capitalist can now do from his private point of view." Self (196), quoted in Prest and Turvey op cit, p.728. Later Self was to describe the use of some standard CBA ideas as a "confidence trick" (1970).

by the United States Army Corps of Engineers, in the first half of the twentieth century; when government officials initially responsible for evaluating river navigation improvements, were obliged by government direction to consider benefits external to individual institutions.

The general idea of CBA is to identify and then express as many as possible of the factors which are considered relevant to an investment decision, in terms of the common denominator of money. Once this is done it then becomes possible to add the effects (usually termed net benefit), and compare the estimate to the cost of investment. If the comparison is such that the return to investment compares well to returns in alternative investments, then the investment project in question can be accepted. Returns to investment are generally presented in terms of a rate of return, that is, expressed as a percentage of investment cost. The higher a rate of return then the greater per unit of investment cost will be the profitability of any given investment project. The social significance of profitability is based upon the general observation of the economy by economists and their conclusion that market values reflect consumer preferences.

2.3 The social significance of rate of return analysis

The importance of consumer preferences is summed up in the notion of 'consumer sovereignty': this operates in a market economy or price system where economic resources are directed towards the production of different commodities in accordance with the strength of consumers' demand for them. Consumer sovereignty works most effectively under the assumptions of a perfectly competitive market.*

In a perfectly competitive market the value of an investment's output (its benefits) may be measured in the price which ultimate consumers are prepared to pay. Similarly, the costs of output are reflected through the markets for factors of production, in a way which relates them to the consumer valuation of the outputs which would have become available if resources had been used in other ways. In this way, the real costs of resources are interpreted as the loss to consumers of alternative investment outputs (that is, in terms of opportunity cost).

Given a situation where consumer tastes and production technology are stable, the forces of competition will in the long-term bring about equilibrium in the markets, where rates of return to investment will tend to be similar throughout the economy. If rates of return are anywhere above average, funds will be attracted there until profits decline, and equilibrium is again restored. The importance of the rate of return to investment allocation may now be clear. It serves to indicate where investment might be increased: more generally, comparatively high rates of return imply that an economic activity could be expanded to the benefit of society, made up of consumers.

Indeed, using the framework of perfect competition, and from certain axioms about the nature of consumers preference orderings and the technical relationships between inputs and outputs, a consistent line of deductive reasoning leads to some impressive conclusions about the behaviour of the economy. It suggests that an economic system might allocate its resources in such a way that any change in production, distribution or consumption, that would possibly make one person better off, would only be brought about by making someone else worse off. This is known as a 'Paretian optimum', and a review of its conditions, and place in economic theory is given in Blaug, (1968).

Of course, in the real world competition is less than perfect. For example, consumers might not be as sovereign as the foregoing comments about valuation of outputs suggest, since producers might work together to impose trading conditions conducive only to their own interests. However, it appears to be generally believed amongst economists, that competition is strong enough in western economies for the rate of return kind of investment appraisal to perform a social function. That is, it is realised that a Paretian type economic system is strictly only a normative model of how an economy should behave if economic efficiency is a major goal of government policy, the usefulness of which is to direct public investment towards a more socially desired outcome.

CBA accommodates this aim by taking market values and adjusting them so that they might be closer to those which would have prevailed in a perfect market situation. In addition, it goes further in what an ordinary rate of return might measure, by allowing investment effects which otherwise would not have a market value to be given surrogate prices, and if not measurable, at least allows them to be identified.

It is clear then, that CBA goes beyond the simpler approach applied to investment appraisal under commercial conditions. Where estimates of profitability, although expressed as rates of return to investment cost, have to be based upon unadjusted market values and, usually, only the costs and benefits that directly enter transactions between seller and buyer, so that effects without direct market value are omitted.

2.4 The adjustment of market values for inclusion in CBA

The unlikely fulfilment of Paretian conditions in a world of imperfect competition led economists on to investigate the possibility of a 'second-best' theorem (first formalised by Lipsey and Lancaster, 1957), and associated arguments concerned with shadow prices designed to compensate for distortions in market values brought about by non-competitive influences. As a result principles for measurement and correction of values became generally accepted in CBA practice.[1]

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[1] A full examination of distorting influences, and their relevance to CBA is given in Millward (op cit: pp.305-310).

A most obvious and palpable influence is that of government taxation and subsidy policies. How this is allowed for depends upon the kind of approach being used to measure costs and benefits. For instance, where tax elements are included in market price, and if tax is related to usage, then consumer's utility is adequately reflected and there need be no adjustment. However, if an analyst is not measuring costs and benefits in terms of consumer prices, but is instead considering the value of economic resources (market prices paid by producers), then because he is concerned with the productivity of resources in alternative locales (the opportunity costs), tax must be omitted as not reflecting production opportunities elsewhere.

A more difficult example of distortion is that caused by the investment itself. This is an 'indivisability effect', where market values are significantly changed by the investment effects. The important feature to note about this is that given effects have not been marginal but indivisible, there is a need to measure the intra-marginal units of output. This is understood in terms of 'consumer surplus', and it is helpful to exposition later (Chapter 3) if this is explained.

Consumer surplus is a concept built upon the notion that consumers enjoy utility over and above that which can be measured by the price they pay for a product or service. Theoretical reasoning suggests that consumer surplus can be approximated figuratively, by an area above and to the left of price, and below the demand curve.* Thus, in Figure 2.1, where a product's price is P_1, and output sold, Q_1, given a demand curve DD, consumer surplus approximates to Area A.

The usefulness of the concept for CBA may be realised where investment has brought about a change in output with a significant effect upon price. Suppose, in Figure 2.1, that output has been

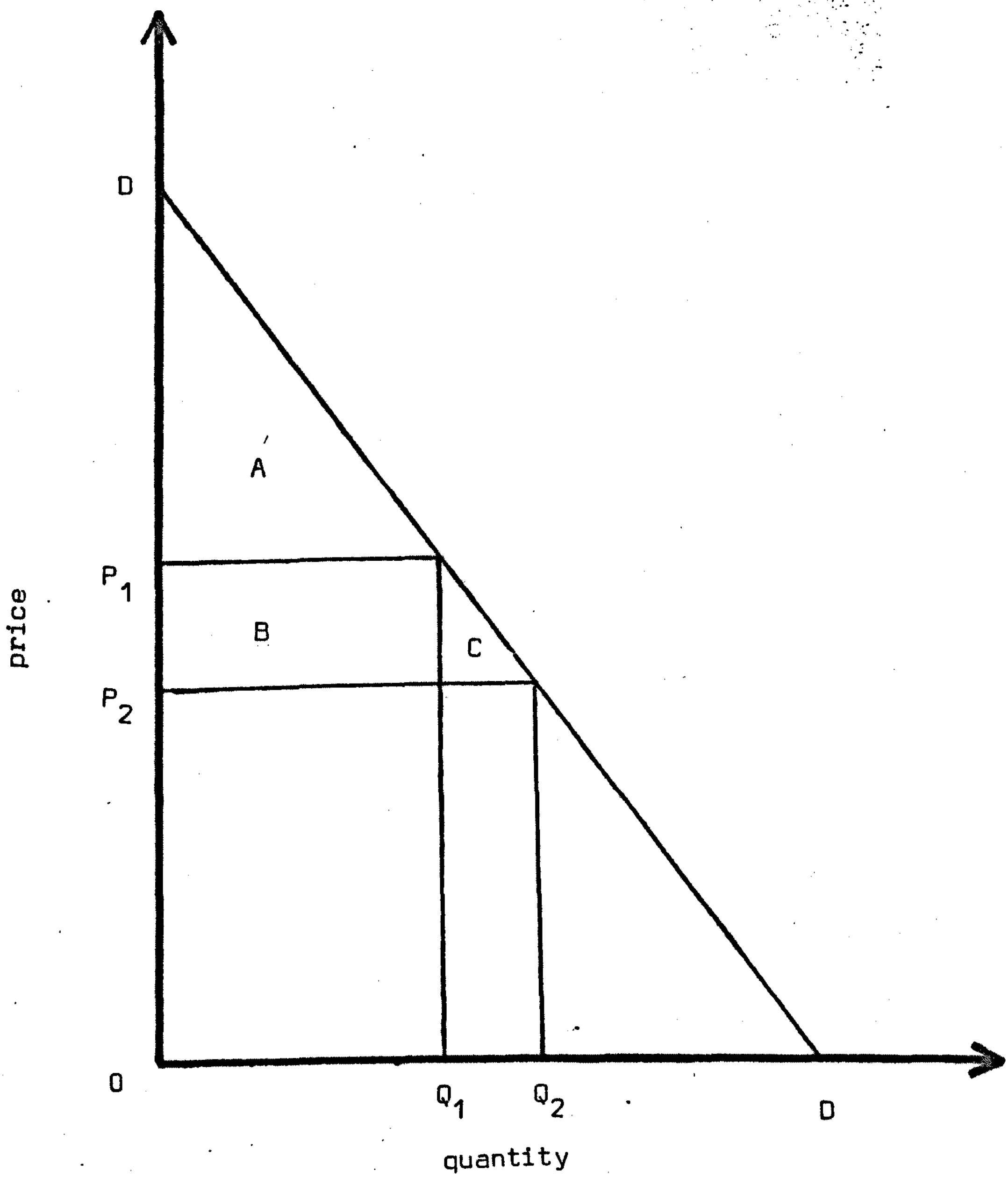

Figure 2.1 The concept of consumer surplus

changed after investment, from Q_1 to Q_2 and price fallen, from P_1 to P_2. The gain in consumer surplus will be areas BC. Area B is surplus brought about by the price fall on the original output, area C is surplus on the extra output sold at the new price.

Benefit may be approximated by $(P_1-P_2)Q_1$, that is, area B; plus $((P_1-P_2)(Q_2-Q_1))/2$, which is area C. The size of the denominator depends upon the slope of the demand curve. The steeper the curve, then the less likely will demand be stimulated by a lower price, and less extra output sold, so that area C will be relatively small.

Care must be taken to ensure that area B represents real benefit, in the sense that it represents the full extent of a cost change, which is meaningful in terms of production opportunities. It might be that investment has brought about a price change by improving the competitive condition of the industry concerned, so that price had fallen from a position where producers were earning excess profits. In this instance, area B, is simply transferred from producer to consumer, and does not represent an increase in total welfare. An example of this type is given by Marglin, where irrigation investment removes the opportunity for farmers to make excess profits from limited water supplies.[1]

A full theoretical exposition of consumer surplus is given in Hicks (1946), and of aspects of economic surplus in general in CBA applications, in Mishan (1971b). CBA is generally couched in terms of partial equilibrium analysis, that is, investment effects are identified and measured on the assumption that the wider economic environment remains essentially unchanged. When investment is being considered over a long period this assumption might look weak. However, the assumption is very important to consumer surplus.

[1] Marglin's description of the use of CBA in water-resource design, is an informative introduction to the use of consumer surplus in investment appraisal, see (1962 ab).

It is possible for example, that if investment is to change prices significantly, then consumers' budgetary decisions, through income effects, might change across a range of products and services, and the position of the demand curve may become uncertain. This might also occur if investment has somehow changed the quality of the product or service being offered. These possibilities raise questions that ideally should be answered in a general equilibrium context, for which there appears to be no usuable body of theory.

In this context, observers have sometimes been critical of consumer surplus, Little (1957, p.180) described it as a "useless toy". Even so, the concept has found general use for a range of CBA studies. A general survey of consumer surplus work has been made by Currie <u>et al</u>, (1971).

2.5 The inclusion of values into CBA not directly reflected in market values

Investment effects not directly reflected in market values include those known as 'externalities' and sometimes as 'secondary costs and benefits'. In a strict sense these refer to investment effects upon the utilities and resource costs of those individuals and groups not directly involved in the buying and selling of the investment's output.[1] These are sometimes difficult to measure and express in a common denominator. Broadly there are two categories of costs and benefits, generally termed 'commensurables and non-commensurables'.

The former can usually, with a little ingenuity on the part of the

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[1] There is much confusion in the literature about definition of terminology: for example, 'secondary costs and benefits' are sometimes those investment effects in terms not of economic efficiency but of other social objectives (see Maass, 1962): sometimes they might refer to effects which have been induced by investment rather than directly produced by it (cf. Millward, op cit).

analyst, be quantified: the aim is frequently one of constructing a surrogate demand curve, by inferring from people's actions (or answers from questionnaires) how they would react in paying for a good or service offered to them. This approach has sometimes led to controversy, perhaps because analysts have been optimistic in what, to their minds, is quantifiable: there might be associated dangers of establishing precedent (see Guardian, 1972).

Non-commensurables (sometimes termed 'intangibles') are those effects of investment which cannot be assessed quantitatively, but only written into a CBA study as a description. Often, these items are the ones to cause most argument after publication of CBA results, particularly since they often involve quality of environmental considerations of lasting effect. It quite often appears that because quantification tends to be large and dominant in studies, non-commensurables seem unimportant. This need not be so. Neither is it easy to determine whether the favourable benefits, shown to exist in the arithmetic, might be traded off against adverse effects upon non-commensurables.

2.6 The relevance of CBA to a subject area associated with agriculture

It was noted that generally economists considered competition strong enough in the economy for market values to be meaningful in terms of consumer preference, and therefore of significance to social allocative efficiency (Section 2.3). What is less certain, however, is the specific application of CBA in a subject area associated with agriculture, for the degree of government intervention has been great in this sector of the economy; so much so, that the effects of distortions in competitive forces might be too uncertain to make allowances for with any degree of precision.[1]

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[1] A brief account of government agricultural policy is given in Appendix 5. The validity of intervention is considered in James (1971: pp. 19-27).

For example, Bowers has argued that government policy has resulted in an 'artificial' encouragement of a high usage of high cost inputs in agriculture, which in the long term, has raised prices to levels well above those which would have prevailed in competitive conditions: see his example with regard to the substitution of machinery for labour (1972). Certainly, subsidies and favourable financial arrangements are likely to have an important stimulatory effect upon farmers' adoption of different kinds of technology: but the effect is not always one of inflating prices. The fertiliser subsidy probably led to a great expansion of the usage of chemical feeds, which allowed fertiliser prices to fall as the market expanded (Metcalf and Cowling, 1967). Thus, it seems likely that distortions resulting from government intervention might have made for a large and uncertain bias in market values.

It might seem that the sum total of government intervention and support had been precisely tailored to reflect benefits accruing from agriculture to society as a whole. In other words, agricultural markets had been manipulated in such a way to make market values reflect collective social utility. Additionally, it might be argued that intervention had acted to change facets of the industry's behaviour so that agricultural markets would act more like perfectly competitive markets.[1]

It seems doubtful, however, if governments or their agencies

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1 Two major problems likely to exist under free conditions but which would not exist in a perfect market, are those of depressed agricultural incomes associated with rising productivity in the face of inelastic demand (Section 3.7) and the cobweb price-output interaction pattern (Section 10.3). The nature of agriculture is such that two conditions necessary for a perfect market, perfect mobility of resources and market intelligence, do not fully apply. See Metcalf (1969) for notes on these problems, and Phelps Brown and Wiseman (1970) for a statement of the conditions necessary for a perfect market.

consider policy in the degree of detail that would probably be required.[1] For instance, Josling has suggested that there is great uncertainty about the economic effects of farm support measures, either in terms of cost, consumer or farm income effects, and that it is likely that agricultural programmes survive for years without careful scrutiny (1972).

Prest and Turvey have suggested that the non-fulfilment of conditions necessary to the achievement of a (movement towards) Paretian optimality are relevant to CBA only in as far as it makes market values "obviously biased" measures of investment effects (op cit : pp.704-705). It is the bias which is "immediate, palpable and considerable" which should be considered by the analyst. Small and remote divergences in market values from what exist under perfectly competitive conditions, are likely to lead to bias in CBA measurements which fall within a margin of probable error. Large and "unknowable" divergences, on the other hand, are, in Prest and Turvey's view, necessarily irrelevant to action (ibid).[2]

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[1] Also, it is difficult to equate government actions, or consequences of that action, with 'social' interest, rather than say, 'sectional' interest.

[2] This is pragmatic advice and is a feature of CBA work. When theory makes application difficult it is usually the approach of the analyst to adopt a simpler method of measurement so that CBA is made practical. For instance, issues associated with 'second-best' theories can be very complex, and suggestive of very sophisticated corrections of market values; Prest and Turvey have referred to some of this work as "dubious sophisticates", and of little use, since it is unlikely to be understood by decision makers generally (ibid).
The question of how market values should be adjusted is a controversial one. For example, much of the scepticism associated with marginal cost pricing could, as at least one observer has pointed out (Millward op cit), be similarly linked with CBA applications. Economic literature has given prominence to the question of whether or not there is in practice, a meaningful correspondence between price and marginal cost. It is an issue which has been at the centre of the debate concerning the appropriateness of marginal cost pricing for public industries (see Farrell, 1958).

The kind of examples of government intervention in agriculture given above, seem to fit the 'large and unknowable' category, and therefore, might be ignored. However, it raises problems for comparability when rates of return to investment in agriculturally related fields come to be compared to those for investment elsewhere in the economy.

Of course, this is not just a problem consequent upon differences in the non-fulfilment of efficiency conditions alone. Different CBAs might use different assumptions for measurement, and omit different considerations. Also, the quality of data might vary greatly in different parts of the economy. It seems, therefore, that comparisons of rates of return are safer kept for use in investment selection within a single economic sector if one is to be sure that like is being compared with like. If this is done, then there seems to be no strong reason for not using CBA in an agriculturally related subject area.

Nevertheless, whether small differences in rates of return can be considered meaningful, in the sense that they allow a 'fine tuning' of investment projects, is still questionable as data quality is unlikely to be such as to enable precise quantification. A cautious view is best: that a rate of return analysis is useful in that the estimation of average returns to a given economic activity probably indicates whether the return is falling or rising in relation to the average rate of return to investment in an economic sector generally. If it is rising then, ceteris paribus, investment should be increased in that activity.

Whilst then, CBA might be usefully applied to investment appraisal in subject areas associated with agriculture, application needs further qualification, since there are two fundamental assumptions necessary to rate of return CBA which might not be acceptable to a public decision maker.

2.7 Assumptions necessary to the application of rate of return CBA

There are two assumptions implicit in the use of rate of return CBA for public decision making. These are that individual consumer decisions are meaningful for social investment selection, and secondly, that a surplus of benefit over cost indicates that an investment is beneficial. On the first point, it might be argued that consumers do not act in a rational manner, or even that they are independent of the very technology they are meant to direct.[1]

It was noted above (Section 2.3), however, that generally economists considered competition to be sufficiently strong (and hence, consumers generally sovereign enough) to mean that a rate of return analysis is useful for resource allocation. Even so, in a specific instance, consumers might not be well informed about the product they buy or be in a powerful position to demand from producers the kind of output which might best serve their interests.

A surplus of benefit over cost assumes that if, according to Paretian optimality, no one is to be left worse off, then beficiaries compensate the losers. Of course, the Paretian condition is too restrictive in practice, since it is difficult to envisage an economic change without someone being left worse off. Thus, a compromise is generally accepted, that for investment to be worthwhile, benefits should be such that beneficiaries could (though need not actually) compensate losers. This is known as the 'Hicks-Kaldor' criterion for assessing investment worth (see Herberger, 1971).

There are inter-personal comparisons here if the Hicks-Kaldor

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[1] Galbraith has argued in general terms, that consumers might be manipulated to behave in the interest of a given technology (or corporation); see his description of the 'dependence effect' (1958: pp.148-154).

criterion is used for investment selection: acceptance involves discrimination against the losers, if compensation is not actually paid out (which is likely).[1] However, the cost to the losers is one reckoned by the parties involved themselves.

Nevertheless, there is a further cause of bias towards one group of individuals against another: this is inherent in taking money values as a common standard for measurement of investment effects. Assuming that the utility of money rises as income falls, then ceteris paribus, measurements will tend to be biased in favour of the richer members of the community: the more money an individual or group has, the more likely will he or they tend to value investment effects. If the distribution of income is considered imperfect, and if this bias is thought to be strong, then an investment might seem to improve the welfare position of the advantaged at the expense of the disadvantaged, even though a surplus of benefit is evident from a CBA.

The emphasis given to consumer decisions and implied acceptance of status quo income distribution in CBA applications is common to much of conventional economics, and has often provided a basis for criticism of economic science generally.[2] With regard more specifically to CBA,

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1 Of course, ideally economics as a science should not make inter-personal comparisons, since this brings elements of value judgement into the analysis. Welfare economics is that branch of economics which has investigated the nature of policy recommendations that the economist is entitled to make (Baumol, 1952), and has been at the heart of questions as to how to decide objectively how an economic activity might be deemed worthwhile. It seems, however, that it has only succeeded in establishing that no welfare significance can objectively be ascribed to the results of analysis of economic activity, such as CBA (see Millward op cit)

2 Some have argued that the aim of Paretian-type optimality conflicts with 'liberal' values in that what should be democratic decisions are removed to the market place (see Peacock and Rowley, 1971). Some economists, including Galbraith (1974), have been critical of conventional techniques of analysis: they have suggested that economic thinking has restricted itself to an efficiency (market or neoclassical) paradigm, which has resulted in a neglect of issues such as income distribution (see, for example, Sachs, 1970). Hunt and Schwartz present a critical review of contemporary economic theory, and note that the use of CBA to measure the socio-economic effects of investment represent the "high-water mark of neo-classical economics" (1972 : p.30).

it is the author's view that these issues are not important enough to discourage the use of the analysis, if they are made explicit and understood in the full perspective of the nature of the investment subject area, and nature of public policy aims relevant to the investment decision.

Thus, the application of CBA might usefully be complemented with a background analysis to determine how the market behaviour in a subject area differs from the perfect competition model, so that the strength of consumer sovereignty might be tested for its sufficiency. Also, the CBA itself might usefully be extended to consider costs and benefits subject to social objectives and priorities other than efficiency. So that for example, if income distribution is important to social investment, then the effects of investment in terms of incidence might be considered separately.

2.8 The inclusion of costs and benefits in relation to goals other then efficiency in CBA

Of course, the aims of economic policy, and hence investment, are many and sometimes complex, but broadly, besides the one of economic efficiency, they are full employment (a full use of labour resources), economic growth (the maximisation of outputs and incomes), equity (or distribution of outputs and incomes), balance of payments, strategy (conservation of resources) and environment.[1]

Non-efficiency costs and benefits can be included in a CBA by listing the agencies, persons, industries, regions affected by investment:

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[1] Kohler has discussed how policy might work with these considerations in mind and in relation to efficiency conditions (1966). Some observers have stressed a need for CBA to consider non-economic aims (see Lichfield in Lawrence, 1966); this implies the use of interdisciplinary teams for CBA, since analysts' assessments of specialised opinion might require specialised expertise, say, where costs and benefits are being reckoned in terms of number and quality of flora.

selection being made upon the basis of significance in terms of magnitude and policy concern of importance to the decision maker. Relationships between affected agencies may be traced in a network or given in a form of a balance sheet.

This might usefully complement a rate of return analysis, which, of course, only considers effects of investment in so far as they have consequences for resource costs and utility overall (these are often termed 'real effects' of investment). If decision makers are concerned to know something of the incidence of investment effects, then a balance sheet might record financial effects as agencies actually feel them (financial as opposed to real effects, are usually termed 'pecuniary' in the literature).[1]

For example, a lowering of production costs might result in savings which are not passed on to consumers, but simply added to the profits of producers. The change in costs is a real benefit in as much as the costs in question reflect production opportunities elsewhere, and would be included in a rate of return analysis. However, if a social decision maker is concerned solely to reduce prices to final consumers then there is no benefit on these grounds. The incidence of cost and benefit is not of direct relevance to efficiency considerations.[2]

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1 Some studies seem designed more to establish a (maximum) financial value to an investment's output or services, rather than properly investigate consequences for consumer utility or resource cost. These studies are 'social' only in the sense that they sometimes include third party effects in the rate of return arithmetic.

Two recent studies associated with British agriculture, one concerned with the benefit of the prevention of foot and mouth disease (Power and Harris, 1973), the other with the prevention of swine fever (Ellis, 1972); appear to fall into this category. Ellis stated explicitly that since the "problem was mainly a question of additional benefits" he did not feel "justified to reflect social costs and benefits" (p.4). A distinction is sometimes made between the two types of CBA, and termed "conventional" and "social" CBA, see for example, Russel (1973, p.57).

2 The possibility that production cost savings might not be fully passed on has been generally assumed away in CBA studies in agricultural R & D by an assumption of perfectly competitive conditions; where, of course, competition forces cost savings to be passed on in lower prices. Examples of broader CBA studies are given as case-studies in IMTA (1969).

A major problem is how the costs and benefits of efficiency are to be compared with those subject to other goals. Some studies have sought to include non-efficiency costs and benefits into the rate of return, by adjusting market values to reflect 'social utilities' or government priorities.

Weisbrod has suggested that the estimates used in the rate of return might be adjusted by weights in the instance of income distribution considerations, derived by inference from the study of past government policies and their impact upon incomes (1972). However, there is a presumption in this that past government policies have been the correct ones.

Generally, there is no obvious indication from past practices and policy of what might constitute 'social utility'.[1] Nor is there in the literature a generally acceptable basis for measuring costs and benefits to society in terms of non-efficiency objectives, which is comparable to the rationale which legitimises the derivation of the efficiency rate of return.

Besides, the logic of including both consumer and social utility together in a rate of return is uncertain. The relationship between consumer valuations, determined by individual self-interest and conditions as they exist, and social valuations, determined in part, by collective priorities and normative considerations, is unclear and the difference ought to be obvious to the decision maker when he considers the effects of an investment. It seems clearer to separate costs and benefits identified and measured on the basis of different socio-economic goals, and leave questions of trade-off to the decision maker.

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[1] It is sometimes suggested that this is the fault of government, since public decision makers are unwilling to denote 'ethics that count'. This rests upon a belief that governments are able to lay down a social 'objective function' since they are placed to know what a society's value system should be. For a discussion of this possibility see Kaldor (1971).

2.9 The usefulness of CBA

This chapter has shown the general idea behind CBA. It is an approach based upon the market conception of how resources are allocated, and seeks to identify and measure costs and benefits on a broad basis. The application of its ideas to plant breeding is consistent with the use of CBA in other subject areas where previously economic appraisal has sometimes been absent.

It was indicated above that a rate of return analysis has a useful role to play for choosing between different investments, and although state intervention has probably affected market values to an uncertain extent, this usefulness extends to the agricultural sector.

Nevertheless, rate of return CBA must not be considered a universal panacea, its dependence upon individual consumer valuations, and a given distribution of income must be openly recognised. The efficiency results of CBA can be complemented with an explicit consideration of investment effects in terms of other socio-economic policy objectives.

These points are general ones, to see the nature of previous work in the application of CBA ideas to appraise investment in agricultural R & D, it is necessary to be more specific. This is done in the following chapter.

CHAPTER THREE

The application of CBA to assess the effects of investment in agricultural R & D

3.1 Introduction

By looking at previous attempts to apply CBA to problem areas similar to the one considered by this study, it is hoped to establish a model of approach suitable for assessing the costs and benefits of new potato varieties.

Many of the problems associated with CBA measurement in the field of agricultural R & D investment are similar; it is for this reason, and for the sake of brevity, that this chapter concentrates upon CBA studies carried out in this subject-area.[1] CBA studies more generally are surveyed in Prest and Turvey (op cit), and more recently, in Kendall (1971) and Layard (1972).

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[1] CBA techniques do not present the economist with his only means for measuring the effects of technical change or innovation. Studies of these subjects have a long history in economic literature. This is seen by a list of work comprehensively surveyed by Kennedy and Thirlwell (1972). These studies are generally ones which attempt to explain, in production function terms, the contribution to technical progress of various factors. Usually, technical progress is studied in aggregate; that is, in terms of a whole economic sector, and do not go into much detail.

Some such work by Griliches (1963ab; 1964) suggests that agricultural productivity might be explained almost wholly by non-R & D factors, particularly those of education and increasing returns to scale. This is surprising, given that rate of return CBA has suggested that R & D might make a large contribution (see Section 9.11). It is perhaps a reminder that overall, the contribution of such factors (which sometimes seem in specific instances to be unrelated to output changes, for example, education), might be vital to widespread adoption of innovation practices.

Although it should be noted that the value of production function techniques has been strongly questioned. The difficulties involved in measurement are notorious, and associated assumptions, probably at least as questionable as some of those associated with CBA (see Kennedy and Thirlwell, op cit).

3.2 The with and without reference option by which to measure costs and benefits.

The pioneering attempts at the quantification of a return to investment in agricultural R & D, which led in time to CBA studies of specific investment programmes, were done in the United States of America (USA) by Schultz (1953). On seeking to establish what present agricultural output would cost if produced at previous input levels (that is, if modern production methods had not existed, he provided a principle for measurement subsequently used in CBA work.

This is sometimes termed the 'with and without' approach (see Lichfield, 1966: p.341). The assumption is that the true value of an investment is not what it yields (effects) absolutely, but the difference between the yield (effects) with the investment, and the yield (effects) without. A major difficulty associated with this principle in measurement, is that analysts might never be sure what a 'without' situation would have been like. For instance, how other factors might have combined to affect output.[1]

Another problem is that the with and without reference option might be too narrow a basis upon which to assess investment, since the approach implies that the investment in question is the best one for achieving change over the present situation. The importance of this depends upon the nature of the investment selection problem facing the decision maker.

For instance, the value of a new high yielding plant variety might be yield advantage over existing varieties. However, social decision makers may wish to seek the best use of investment funds in agriculture generally, and therefore consider potential alternative investments to

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[1] This is, of course, a variant of an enduring problem encountered in social science generally. The difficulty associated with the need to abstract, meaningfully, variables from a complicated situation in the real world, so that measurement might adequately reflect the results of an activity in question, and its nature be understood.

to assume that it is similar to work by Peterson and Griliches, since the wheat study is a product from the same school, the University of Chicago, from which the hybrid corn and poultry studies were produced.

Only one study associated with agricultural R & D has been published in Britain which has used CBA measurement principles. This is a study by Grossfield and Heath (1966) of the development of a potato harvester. This, and the American studies, are of the rate of return CBA type, and are retrospective analyses of successfully adopted practices.

The problems associated with R & D cost measurement in agricultural R & D studies have, in principle, proved less important than those to do with benefit. R & D costs were taken from the records of expenditure of firms and organizations: then simply discounted (or accumulated) and summed to derive a total indicative of an overall investment cost, against which could be expressed net benefit as a rate of return. What studies attempted to measure as net benefit can be shown diagrammatically in terms of consumer surplus.

Figure 3.1 depicts a single market situation consistent with partial equilibrium assumptions, for an output of a commodity subject to a cost reducing and output increasing innovation. The original supply curve, S_O, has shifted vertically by the amount of the cost fall, and to the right equivalent to the increase in output potentiall; so that after the innovation the new supply curve is S_n.

The demand curve, DD, remains unchanged. So the old price, P_O, becomes changed, at P_n, where a new output, Q_n, is being sold, larger than the original output, Q_O. This figure assumes, of course, that the market (and any associated middle markets and industries) is perfectly competitive, so that cost and output advantages accruing from innovation are passed on to consumers in lower prices. So that to plant breeding which also result in increased yields, such as fertilisers.[1]

Nevertheless, given that resources available for CBA studies are often limited, and the terms of reference narrowly defined by sponsors (whose view of alternatives might be circumscribed), the problem is beside the point, even if decision makers' field of interest is wide-ranging, since practicalities restrict socio-economic assessment to the narrower reference option. All the studies of investment in agricultural R & D have used the with and without principle; however, the possibility of investment alternatives should not be ignored when the significance of CBA results are considered.

3.3 Previous applications of CBA to R & D, and models of approach used to measure R & D effects

Griliches' study of hybrid corn (1958) is probably universally acclaimed as the classic CBA study in the field of investment in agricultural R & D (possibly in R & D generally). It represented the first study of a specific agricultural innovation on CBA principles of measurement. Other work has followed, associated with North American agriculture: Peterson has extended Griliches principles in work associated with poultry R & D (Peterson, 1967). More recently, Schmitz and Seckler have examined the introduction of a mechanized tomato harvester (1970), and Ardito-Barletta wheat R & D in Mexico (1972). Details of this latter study are unfortunately unobtainable at the time of writing, and so will not be described. It is reasonable

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1 An acceptance of the one alternative as opposed to the other, implicit in a CBA approach, might render the study's findings to criticism of the kind associated with work of the Commission on the Third London Airport (op cit). Although this CBA sought only to determine the costs and benefits of siting an airport in alternative sites, some observers argued that the alternative of not having an airport was the real social question, and that because this had been decided, the study was merely a cost effectiveness exercise* (see for example, Peters, 1974). The problem is essentially one of which level of public decision making is CBA appropriate.

changes in resource use are fully reflected in prices, and that prices are meaningful in terms of consumer utility.

Remembering all which has been written in chapter two, the gain of the innovation to society may be approximated by area shown in figure 3.1, under the demand and between the two supply curves, B+C+D+E. Since the net gain in surpluses is A+B+C+(-A+E+D), the size (and distribution) of surplus depends upon the relative positions of the supply and demand curves. For example, if the original supply curve was horizontal, $P_oS^1{}_o$, and shifted to a new position, $P_nS^1{}_n$, then the gain would approximate to area A+B+C.

The concept associated with the degree of slope of the demand and supply curves is that known as 'elasticity'. This is the degree of responsiveness of one economic variable to another: a move along demand and supply curves is a response of demand or supply to changes in price (known as 'price elasticity' of demand or supply); a shift of the curves however, is a response to changes in non-price variables, say for example, income (known as 'income elasticity'). Where demand or supply is described as price 'inelastic', changes in price bring about a less than proportionate change in demand or supply: when described as 'elastic', then changes in price will bring about a more than proportionate change.

In figure 3.1, the supply curves, S_o and S_n, are depicted as fairly price elastic, and approximately correspond to those used in Peterson's poulty study: thus, the benefit he attempted to measure was area A+B+C+E. The other example of supply curves, $P_oS^1{}_o$ and $P_nS^1{}_n$, illustrate price elasticity of supply which is perfectly elastic. This was one of the assumptions associated with supply, used by Griliches (1958; op cit). He attempted to measure area A+B+C.

The Schmitz and Seckler study used this basic framework of consumer

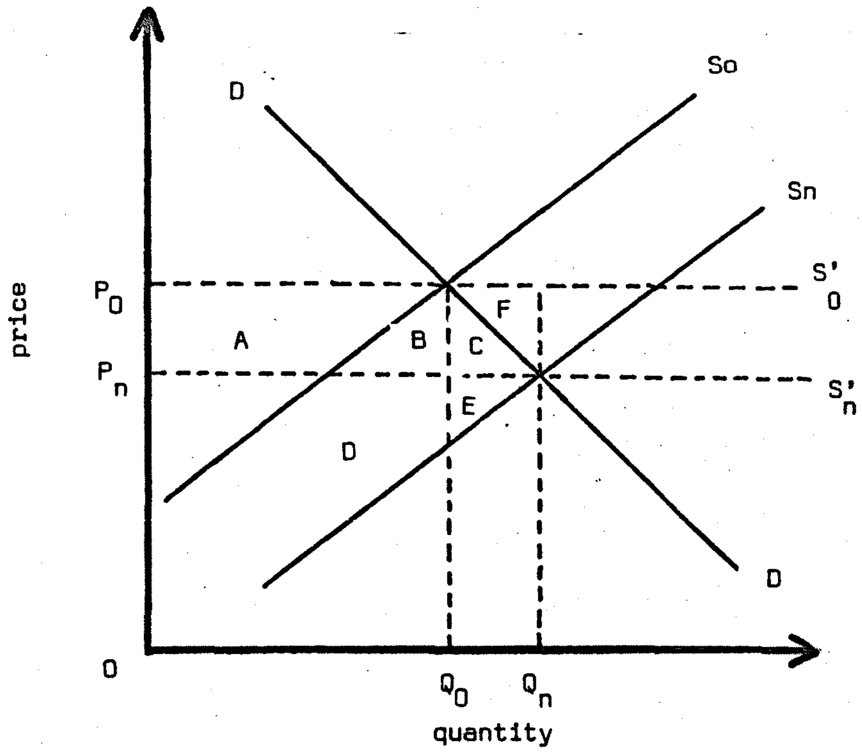

Figure 3.1 Benefit illustrated in terms of consumer surplus

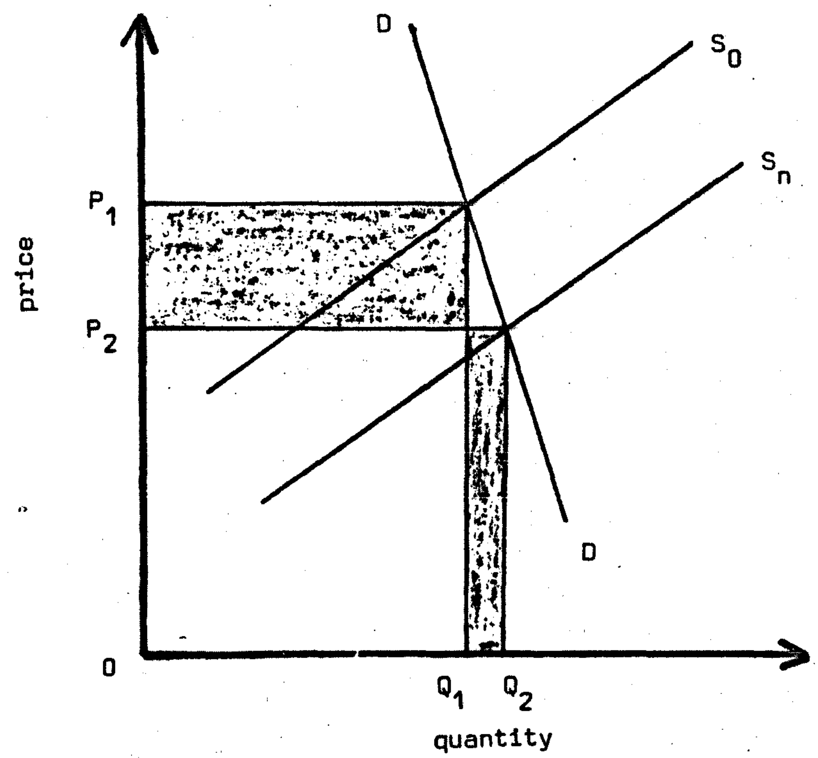

Figure 3.2 Output increasing innovation and its effect upon farmers income

surplus, but attempted to measure area A+B+C+F. In this instance, if the supply curves for tomatoes had been similar to Griliches', then benefit might have been overestimated; but if they had been closer to Peterson's, then benefit might have been under-valued.

The Schultz, and Grossfield and Heath studies, did not explicitly mention consumer surplus, but because their approaches were essentially to measure resource cost, under competitive conditions, it may be suggested that they were attempting to measure benefit approximately equivalent to area A+B in figure 3.1. In other words, the studies did not take into consideration the possibility that additional consumer surplus might have been generated from the sale of extra output, that is, on demand created by lower prices. This will tend to under-value benefit, but not significantly, if demand is price inelastic.

Since the Grossfield and Heath study is one carried out in a British environment, and examines an innovation associated with the potato industry, it is of interest to this study to examine it in more detail. Also the Griliches hybrid corn study needs further consideration, since its approach and results have received prominence in economic literature associated with CBA: it could be said to represent the classic instance of the CBA approach, as it has been applied to agricultural R & D.

3.4 The Grossfield and Heath Study

The Grossfield and Heath study attempted to estimate the costs and benefits of R & D on a new type of potato harvester, undertaken and sponsored jointly by the state-funded National Research and Development Corporation (NRDC) and the National Institute of Agricultural Engineering (NIAE). After a period of development, starting in 1950 with the evaluation of a prize-winning potato harvester, the NRDC in 1956 took over a patent on a trailer-operated experimental model developed by the

NIAE. The NRDC then granted a licence to a large engineering firm, which successfully brought the harvester up to marketable standards, and after 1960, successful sales.

The NRDC received royalties from the firm, but Grossfield and Heath felt that these were small and unrelated to the market value of the services provided by the R & D. For their analysis, and despite the semi-monopolistic position of the engineering firm, the authors assumed that the harvester market was competitive and so cost savings would be passed on to consumers of potatoes.

The benefits of the harvester were assumed as the difference between the costs of liftin potatoes by hand, and of using the NIAE harvester, experienced by those farmers who bought the machine. It was thought by the authors that medium sized growing units (20 to 50 acres) would be the ones to benefit most, and it was estimated that the average savings per harvester per annum for this size of growing unit would be around £80 to £90.

The value of benefits was estimated for only 7 years, this was because the contribution of the NRDC was essentially one of providing funds at a critical stage for the NIAE, and providing licensing expertise and enterprise in exploiting the invention. Whilst eventually a new harvester would probably have been produced, it is unlikely that the engineering firm would have taken up the NIAE model without the NRDC, thus the NRDC prevented a delay in benefit.

The Grossfield and Heath study showed that a 'social' value could be assigned to the output of R & D in the context of the British potato industry. However, from work for this present study it seems that the harvester study might have adopted an approach too narrow for the results to truly reflect social benefit. It is likely that a closer study of production practices and marketing would have indicated the probability of large additional costs associated with the substitution of machiner for labour and a consequent lowering of quality (see Section 7.9 for a note on the mechanisation of the potato harvesting with respect to tuber damage).

Also the study omitted consideration of reduced unemployment opportunities for labour displaced. Grossfield and Heath used the average wage rate paid to labour to estimate savings: however, if alternative employment opportunities were limited in the early-1960s, then it might be that the alternative productive potential of labour was less than the average wage rate. In addition, it is not clear what kind of labour would have been affected by mechanisation: if it was casual labour, particularly family, including child labour,[1] then costs saved would have been less than that indicated by average wage rates.

The possibility that displaced labour resulting from mechanisation might result in costs which should be put against the benefit of saved labour costs, was recognised explicitly in the Schmitz and Seckler study (op cit). This consciously made use of the Hicks-Kaldor criterion (above, Section 2.7) to trade off the net benefit in terms of resource cost, against the disutility associated with displacement.

3.5 The Schmitz and Seckler mechanised tomato harvester study

Schmitz and Seckler derived a "gross social rate of return" which was the measurement of net benefit in terms purely of resource costs saved, and a "net social rate of return", which besides resource costs included the personal costs to displaced labour. In other words, costs saved per ton of tomatoes were summed, and then compared with

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[1] One of the motivations for designing a mechanical harvester was to remove a need to employ Scottish school children in 'tatty-howking'.

wages lost as a result of displacement (assuming different conditions of alternative employment).

However, this approach seems inconsistent: since on the one hand, the opportunity cost of labour (its resource cost) is being reckoned upon the assumption of full employment, whilst on the other, disutility is summed, which is associated with under- or full unemployment; their trade off is questionable. A correct approach would be to estimate labour costs together, but on different assumptions to see how the overall rate of return varied. Thus, to the total of labour costs saved should have been added costs associated with displacement (disutility of differences in labour income before and after the innovation, plus that of additional factors associated with psychological losses and, perhaps, family removal to other areas).[1] The difference this would make upon the overall result for the study would depend upon the size of effects upon other, non-labour, production costs: unfortunately, Schmitz and Seckler did not give a breakdown of resource cost savings.

3.5 The Griliches' study of hybrid corn[2]

The Griliches' study bears some similarity to this present study. It was a study of plant breeding, which attempted to estimate a rate of return to investment made over a major part of the first half of this century. However, the R & D concerned was that which produced the novel hybrid corn varieties in the USA: a number of R & D organisations were involved, and the cost of research on the idea of hybrid corn was not considered.

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[1] There might have been increases in utility associated with improved work conditions for labour remaining in harvesting employment.

[2] More is stated about the Griliches' approach in Appendix 6, with regard specifically to its application to the SPBS innovation.

There were two elements in costs; the flow of annual R & D expenses over a period, 1910-55, and extra production costs involved in producing hybrid seed as opposed to the open pollinated varieties. Research expenses were based upon a mail inquiry to State agricultural experimental stations, information from the United States Department of Agriculture (USDA), and an arbitrary doubling of state expended funds to account for private R & D costs.[1] These costs were then accumulated forward to 1955 at 5% and 10% compound interest (the reverse of the procedure of discounting present value from the inception of the research) to arrive at an expression of the capital value of R & D investment, on which it is possible to compute a rate of return.

The second element of costs was subtracted on an annual basis from gross benefits. It was derived from a knowledge of the total extent of corn acreage, the proportion of it planted with new varieties, and data on seeding rates. It was assumed that the annual cost of the resources used for the production of new seed was equivalent, given competitive conditions, to the price of the seed. The difference between prices for old and new seed would thus be an indication of extra resources and their cost in producing hybrid seed.

Two sets of assumptions were used to produce two estimates for benefit, that is, supply of corn was in one instance assumed perfectly elastic, the other, inelastic. However, the difference was small (about 7% of benefits), and for simplicity this study will consider only the former assumption.

Although the annual value of corn was known there was no direct information about the effect of the new varieties on corn prices. This could be inferred however, from the productivity of the new seed, which

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1 R & D records were generally insufficient to link hybrid corn R & D with its cost, and Griliches stated that "(cost) figures should be taken with several grains of salt, the dosage increasing as one goes back into the past" (op cit).

could be approximated by multiplying the proportion of corn acreage planted with new varieties by the observed crop yield advantage of these new varieties over older varieties. If this in turn is multiplied by the value of the total output of corn, an estimate is derived for A+B+C+F, figure 3.1.

The area F needed to be omitted, but to do this, Griliches required to know the price elasticity of demand for corn. This was obtained from the USDA, which Griliches took and multiplied by the extra output of the new varieties, to approximate to the area C+F, then halved to derive C. It was then possible for Griliches to estimate annual returns, and consequently to accumulate net benefit forward to 1955, in the same way as for research costs. An estimate was made for future net benefit, and the two were added together and used to compute a rate of return to R & D costs.

In the same study as hybrid corn, Griliches investigated in a similar way, a rate of return to investment in R & D associated with hybrid-sorghum. The results, when compared to those of the hybrid corn analysis, indicated the importance of total national crop output to size of the rate of return. Although sorghum research costs were much smaller than those for hybrid corn, the annual returns were much smaller as well, principally because of the relatively small planted acreage of sorghum.

Like Grossfield and Heath in their CBA, Griliches applied the assumptions of a perfectly competitive market to derive a meaningful rate of return, without qualification.[1] A closer study of American

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[1] This is to say, he assumed that competitive conditions were sufficiently strong to guarantee that production cost savings would be realised and passed on to consumers of corn (and that freed resources would be alternatively employed). It was recognised that the corn price required a downward adjustment to allow for the effects of market support in inflating price above the level where it would reflect more than the resource costs of producing corn (see Appendix 6, for a note on the price adjustment).

agriculture might have uncovered relationships which throw doubt upon the size of Griliches' rate of return.

For instance, Griliches assumed that a 10% increase in yield per acre, brought about by the new hybrid varieties' yield advantage, would lead to a pro rata reduction in the selling price for corn. However, it seems unlikely that yield is related proportionally to costs, since some cost items remain fixed with changes in yield, and others vary uncertainly (this is certainly so with the potato crop in Britain, Chapter 6).

In the instance of American corn production, the dominant factor influencing prices has been a strong tendency to over-production. The US government has provided subsidy facilities to encourage farmers to plant less corn. This suggests that resources have been slow to leave corn production, so that although costs per ton per acre would probably have fallen as a result of higher yields, costs per ton of corn sold for human consumption might not have done so, to any great extent. And thus, the Griliches' rate of return might be greatly exaggerated, in that the cost savings envisaged might not have been fully realised.

However, if hybrid corn had contributed to surplus trading conditions, it is probable that market prices would have been kept down to levels which otherwise would not have been reached. This would have meant a financial benefit to consumers, perhaps of some size and distributional importance.

This is not of itself a factor of relevance to a rate of return, since it is not a real effect involving production changes or additions to surpluses, because essentially the effect is only a transfer of income from growers to consumers.[1] However, there are three features of a

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[1] The transfer of income from growers to consumers, of course, involves a transfer of surplus from producer to consumer surplus. However, total surplus is unchanged by the transfer, and a CBA rate of return would be unchanged.

situation with lower prices, which might bring about changes in real welfare, from an efficiency standpoint. These are the possibility that lower prices result in a larger output being sold; that a transfer of income affects investment and need for state (or state inspired) intervention to maintain agricultural incomes.

If lower prices generate an additional demand, then additional consumer surplus will be derived from the extra output involved. For instance, in figure 3.1, assuming price to have fallen from P_o to P_n at the new supply curve, S_n^1, more output, $Q_o + Q_n$, will have been sold; the resulting extra consumer surplus is denoted by the area C. The size of extra output sold as observed (Section 3.3), will depend upon the kind of demand elasticities present, and these are likely to be inelastic.

This is to be expected because the cause of surplus trading conditions where agricultural productivity is rising, is associated with inelastic demand: or more strictly, the industry's problem of adjusting output to allow for increased supply potential when demand is fairly stable, and unlikely to respond to changes in prices brought about by reduced costs. The effects of surplus trading conditions upon investment and the need for state intervention are usefully described in relation to this problem.

3.7 The general problem of increased productivity in agriculture: the broad effects of investment in agricultural R & D

Consider first the effects of rising productivity upon the incomes of farmers where demand is inelastic.

Taking the same assumptions as for figure 3.1, that is, those associated with a perfectly competitive situation; and given an output increasing innovation which shifts the supply curve from S_o to S_n, the effect upon farmers' incomes can be shown diagrammatically, in figure

3.2. At the old supply curve, output, Q_1, is sold for price, P_1, and farmers' market receipts approximate to area $P_1.Q_1$.

At the new supply curve, additional market supplies brought about by the innovation's higher output forces prices down, to P_2, although more output is being sold, at Q_2. The shaded area to the right of P_1P_2 approximates to farm receipts lost as a result of the lower price: that shaded area above Q_1Q_2, to receipts gained from the sale of the increased output. The extent to which these off-set each other depends upon the slope of the demand curve, DD; that is, the price elasticity of demand. For agricultural products generally, demand is inelastic, which means that demand will increase less proportionally than the fall in price. Thus, the rise in income from extra sales will not compensate for that lost as a result of the price fall.

Under the conditions of a perfectly competitive economy, however, farmers will be no worse off than before. Since the forces of competition ensure that in market equilibrium, all producers are earning 'normal profits' (just enough to make production worthwhile). What will have happened is that the loss of income to the farming industry will have been brought about by marginal producers leaving the industry (not necessarily the ones on the least fertile land, but producers for whom alternative occupations offer higher returns).

Whilst agriculture might in fact, be a highly competitive industry (it is generally made up of small competing units trading in fairly homogeneous commodities), one condition necessary for perfect competition is generally absent. This is the requirement that resources be perfectly mobile. Agricultural resources are sometimes specialised, often to particular crop, and generally remote from (non-agricultural) alternative employments.

Thus, given the impact rising productivity will tend to have upon agricultural incomes and the difficulty the industry might have in adjusting to changing conditions in supply, it is likely that in uncontrolled conditions, increased output potential is likely to produce a chronic situation of surplus trading and depressed rural incomes. In America, Heady long ago, pointed to the 'general welfare effects' of innovation in agriculture, particularly as they might affect the general prosperity of rural areas (1949).

This general effect might affect the efficient employment of resources over the long term, if the transfer of income from growers to consumers (noted in the previous Section) means that farmers have less to invest, and are more likely to be given to false economies, neglect soil fertility and structural improvements. This possibility has attracted the interest of the state in agriculture and agricultural innovation, to an extent where resources have been employed to support markets and encourage structural change (the third possibility for resources, noted previously).[1]

The interest of the state is based upon general considerations, however, not only the efficient use of resources within agriculture, but the implications of a depressed agriculture for the rest of the economy. Since the level of agricultural incomes might be important to the balance in the relationship between country-side and urban areas, which affects migration patterns, general employment and social investment (and therefore, many of the non-efficiency goals of economic policy noted in Section 2.8).

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[1] Strictly, the consequences of transfers of income, and of funds that the state would use to finance market support operations and grower subsidies, are far-reaching. If the transfer of agricultural investment funds to consumers does not result in alternative investment with at least equivalent returns (that is, consumers do not save an extra amount equivalent to that received in lower prices), then there is a cost, in terms of resources. However, this in practice is difficult to identify.

These considerations, associated with the problem of agricultural output adjustment to changes in condition of supply, seem to suggest serious limitations to the use of the Griliches' rate of return as evidence for a very large social benefit from investment in hybrid corn (and hence, similar plant breeding). The reality of the situation suggests that significant cost savings might not have been realised. Also, the possibility of wider consequences for resource use, and affects for non-efficiency social goals, were not considered.

The main fault of Griliches narrow approach is associated with an assumption of comparative equilibrium (full market adjustment is assumed to have occurred), without sufficient reference to what would likely have been the true situation of disequilibrium, which would surely have led to important qualifications of the CBA results. This is not to suggest that Griliches (and perhaps other analysts in CBA associated with agricultural R & D) was unaware of broader issues: his purpose may have been to try (the novel) ideas of CBA, and not cloud exposition with complications and qualifications.

The general impression left by the three studies referred to in the text above, Sections 3.4 to 3.6, is that relevant (to social decision making) investment effects might be ignored if the subject area of the CBA is not examined closely. However, there might be practical difficulties in doing this if there is only a single analyst and limited study funds. In which case, all that can be practically done, is to relate the investment effects, as derived under perfectly competitive assumptions (with of course, appropriate adjustment of market values), to a generally observed investment effect and test the sensitivity of the rate of return to the broader issue.

This, the Schmitz and Seckler study attempted to do by considering the effects of mechanisation upon labour (Section 3.5). They were aware of and observed in their study, the general effects of technological change upon labour attitudes (notably the history of the 'Luddites') and importance of the cotton harvester in undermining the livelihood of "numerous agricultural labourers" (op cit: p.570).[1] And therefore, estimated costs associated with labour displacement on a variety of assumptions, to see how it might affect a resource cost rate of return.

However, although aware that mechanisation will require new tomato varieties, they did not investigate the potential effects of these varieties.[2] Nor did they specifically consider mechanisation in relation to the state interest in agriculture. To see how broader issues important to social policy might be included with a rate of return analysis, it is necessary to look outside CBA work in agricultural R & D to a CBA of forestry.

3.8 H.M. Treasury's CBA of forestry

As part of the government's review of forestry policy, a team of inter-departmental economists under the chairmanship of the Treasury, produced a CBA of forestry (1972). The aim was to collect relevant information and fit it into a CBA framework, and where, quantitative material proved to be absent or incomplete, the aim was to take account of an apparent consensus of opinion.

Conceptually, the study was made up of four parts. The first involved the attempt to compare the return to resources used in

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[1] The effect of technological change upon the sharecropper had been examined in a sociological paper, which had attracted wide attention in literature associated with agricultural R & D, by Day (1967).

[2] They state: "we have not entered the discussion as to whether the new tomato grown for mechanised harvesting is of inferior quality than that grown prior to mechanisation". If the new variety is inferior, which is debatable, the costs incurred because of inferior quality are not accounted for" (op cit: pp.572-573).

forestry to the return which could have been expected if the resources had been used in hill farming, the presumed alternative. This involved a consideration of both enterprises in some detail.

Secondly, the study attempted to assess the effects upon interests associated with recreation and amenity, involved in a substitution of forestry for hill farming. The main basis of measurement was to infer from the costs incurred by visitors to an area, what they would be willing to pay for an assumed advantage over hill farming.[1]

Thirdly, the effects of forestry upon water, climate and wild life of a region were considered (as resources and environment of an area). Of these only the effects upon water were reckoned as significant enough for inclusion in the rate of return.

Fourthly, the study considered and examined issues of importance to government policy generally, which might be of relevance to forestry's substitution of hill farming. These included regional employment opportunities, strategic considerations (the possibility of disruption of supply of wood), and the balance of payments. The validity of these as social concerns was examined, and both their resource and financial costs reckoned.[2]

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[1] The 'Clawson' model for measuring recreational benefit was used (Clawson, 1959). The weakness of this approach is perhaps associated with the correctness of using individual assessments for recreational pursuits in an environmental context. The nature of out-door recreation is sometimes only possible where visitors per acre are minimised. Thus, it is likely that this kind of activity will never show a very high return compared to other activities, since only a small number of people can enjoy themselves at any given time. It seems therefore, that if this type of activity is not to be neglected then it must be treated as an intangible. The question of whether forestry or hill-farming might be best for a particular consideration was decided by the economists themselves, on the basis of informal discussions with interested organisations. This has dangers in that dissenting opinion might be dismissed by analysts as irrelevant, or irrational when really it should be assessed under the willingness to pay criterion as a cost, or included as an intangible.

[2] For example, it was stated "... persistent unemployment is considered to be an evil, the removal of which fully merits the expenditure of public funds. It is less clear how much cost society is willing to incur in terms of real resources in order to reduce unemployment, after taking full credit for the net output of those provided with work. ... certainly relevant to calculate the implied 'costs per job' of maintaining employment in agriculture and forestry, in terms both of resources and public expenditure, for comparison with current standards in other fields". (H.M. Treasury, 1972, op cit p.4)

The value of these objectives to society could, the study suggested, be represented by a premium, added to the value of those resources associated with the objectives. Thus, the study used a premium of 20% of the value of wood to indicate the value to the balance of payments of forestry as an import saving activity. The figure was an arbitrary one.[1]

The inclusion of costs and benefits in terms of specific social objectives, into the efficiency rate of return, is a result of the approach of the Treasury study, which sought to consider all the interests affected by forestry as consumers, including the state. This implies that the distinction between individual utility on the one hand, and collective utility (and objectives) on the other, is unnecessary. A rate of return can be derived which reflects the net sum of utility of both individual and collective objectives (or in other words, to represent together, in the efficiency rate of return, both the utility of individual consumers and the utility of government regarding an investment's effects).

This seems unwise for reasons noted above, Section 2.8; in particular, with regard to how it might blurr the importance of investment effects in terms of what a public decision maker might consider as two distinction considerations. Namely, the effects for private individual consumers (the efficiency objective), and those in terms of specific government policies. To include both in rate of return means that a trade-off between the costs and benefits in terms of one to the other has been decided prior to consideration by the decision makers. It was pointed out that there is no basis, as yet, for valuing social

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[1] As all such premiums or notional values are likely to be, see Section 2.8. In fact, it was only with a 20% premium that forestry was able to show a positive rate of return.

utility associated with government aims and policy (ibid).[1]

Nevertheless, the fact that the study attempted to identify and measure investment effects for a broad range of interests and uses of the country-side, represents a broader approach than those used in CBA applications in the subject area of investment in agricultural R & D. These were largely concerned to assess costs and benefits in terms of efficiency only in relation to the consumer of the final agricultural product. The Treasury study approach is a step forward, since the decision maker is supplied with additional information to that simply concerned with resource use and final consumer utility, since he is supplied with intelligence of costs and benefits to third parties, considerations and policies not easily allowed for in market valuations.

This is consistent with the purpose of CBA outlined by Prest and Turvey in their survey:

> "CBA is a practical way of assessing the desirability of projects, where it is important to take a long view (in the sense of looking at repercussions in the further, as well as the nearer, future) and a wide view (in the sense of allowing for side effects of many kinds on many persons, industries, regions, etc.) i.e. it implies the enumeration and evaluation of all the relevant costs and benefits". (op cit: p.683).

The previous work in CBA application to investment effects resulting from agricultural R & D has generally tended to be narrower than this description of what CBA might do implies. As observed it has, perhaps, been more concerned to investigate the idea of CBA, to assume away the possibility of broad effects to facilitate a simpler estimation of resource cost or consumer utility, that relevant to the direct consumers of the final product.

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1 It might be argued that since the influence of the state is so large as to influence market values to a large and uncertain extent, then prices and costs are such that it is impossible anyway to distinguish between private and social utility. If this is so, then the premise that individual consumers are sovereign and determine in a meaningful way the outputs and services they receive, is uncertain. Also, there is no guarantee that the workings and policy of the state and its agencies do influence market values in a way which reflects social utility (Section 2.6).

As indicated in the instance of the Griliches' hybrid corn study above, the effects of a plant breeding innovation are probably wider ranging than what the theoretical model of perfect competition might imply; both the resource cost and distributive effects might be uncertain, and involve an important state interest. For this present study, it is hoped to give more attention to the nature of the agricultural background, to judge if investment effects have been more complex than a simple assumption of competitive conditions would imply.

3.9 The scope and approach adopted for this present study

The approach of this present study is restricted of necessity, by financial constraints and a need to clarify exposition. For these reasons this study will be restricted to Great Britain only. The seed potato industries of Ulster, the Isle of Mann and the Channel Islands are not considered and since Pentland Crown and Pentland Dell are maincrop varieties, the early crop sector of the potato industry enters into consideration at only a few points.

Some parts of the potato industry have not been considered in detail with regard to the resource use of their business; these are the garden and the potato trade generally, and the advisory research service. These were investigated to some extent, but the effect of the new varieties upon them were considered to be such as to not warrant the large share of this study's finances required to uncover the full implications of the displacement of Majestic.

The steps involved in the CBA approach adopted and which hereafter determine the structure of this present study, are broadly three. The first involves the derivation of an investment cost for the R & D which produced Pentland Crown and Pentland Dell. The second is concerned with the derivation of net benefit and the expression of it as a rate of return on investment cost. Thirdly, other effects not included in a rate of return, but important to government policy objectives are considered, and in one instance used to qualify the rate of return results.

The first step takes up two chapters of this study, one to describe the system of R & D at the SPBS, and the other concerned with measurements of R & D costs. The R & D system is described in relation to the identification of the part of the potato research programme relevant to the production of Pentland Crown and Pentland Dell; cost apportionment assumptions are then made upon the information so derived.

The criterion used to estimate net benefit is the one of resource cost, as opposed to one which takes consumer willingness to pay. The former attempts to identify and measure changes in resource cost, as opposed to the latter's use of final prices. This allows for a more detailed examination of cost changes than is possible with the willingness to pay criterion.[1]

Whilst this study was in progress, the Director of the SPBS had published along CBA lines, his own assessment of the social costs and benefits of R & D output produced by the station (Simmons , 1974). The major part of estimated benefits are attributed to the new potato varieties that are the subjects for assessment in this present study. This work and its results with regard to the results of this present study, are assessed below (Section 9.13).

The Director followed a resource cost criterion to estimate the returns to the new potato varieties, by considering, as this present study does, farm costs. However, the study is not detailed, taking

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[1] The willingness to pay criterion is applied to the SPBS innovation, following the Griliches' model of approach in Appendix 6.

production costs from one, rather unreliable source, without qualification. The main problem is associated with the fact that varietal effects are uncertain, and some investigation is required before reasonable cost assumptions can be derived. Some consideration as to the identification of varietal effects and their importance to costs, is given at length prior to measurement.

Once estimates of benefit have been derived, it becomes possible to compare them to investment cost. This is done in conjunction with considerations of how the comparison might best be presented, and the sensitivity of the comparison to changes in key variables and inclusion of other factors associated with resource cost.

The third step is to complement the rate of return results with a consideration of issues which might be important to government. This represents broader assessment of investment effects on the lines of the forestry study, although because potatoes are more specific to a given land use, it might be expected that these considerations will not be as important as they were to the Treasury's study, except in one important respect.

This is how new potato varieties might have been important to the workings of market regulation policies, and in combination with, have had a widespread and general impact upon the potato industry.

It is hoped that what follows will be a modest approach to CBA, which recognises not only the limitations of technique but that of the quality of data; one hopes to be cautious, taking care not to extend the process of identification and economic quantification beyond the point which is credible.

CHAPTER FOUR

The R & D background to the introduction of Pentland Crown and Pentland Dell

4.1 The origins of the SPBS

For strategic reasons, which manifested themselves during the First World War, and because of the depressed conditions in agriculture during the early part of the twentieth century, a need was recognised for improved plant breeding (findings of the 'Selbourne Committee', 1916). In Scotland, the Royal Highland and Agricultural Society responded by raising £22,500 from public subscription to establish a 'Scottish Society for Research into Plant Breeding'; the subscription was backed pound for pound by government finance, to bring founding capital to £45,000. The society was registered in 1921 under the Friendly Society's Acts, and facilities were established at a plant breeding station, Corstorphine. In 1954 a move was made to the station's present site at the Edinburgh Centre of Rural Economy, by Roslin - later called Pentlandfield.

Beginnings were small, the founding staff consisting of two scientists and an annual expenditure of around £3,000. Income was provided by government aid, the society's investments, sale of produce and members' subscriptions. The move to Pentlandfield brought a significant change in source of income, for although the Department of Agriculture and Fisheries for Scotland (DAFS) met four-fifths of the £130,000 capital costs involved, the rest was provided by the society, which liquidated investments derived from the original foundation. So that since that time the costs of the SPBS have been almost wholly supported out of DAFS funds. A full account of the institutional origins and development (including details of organisation and finance) of the SPBS is given in Gallie (1971).

The SPBS is one of eight research institutes grant-aided by the DAFS. This organisation examines and co-ordinates research cost estimates and exercises control over staffing complement; in so doing, it draws upon the ARC's experience for advice on scientific aspects of work. The ARC, which since the Second World War has come to assume increased responsibility for general agricultural research policy and overall administration has exercised scientific control throughout the research service by means of visiting groups. The DAFS has representatives on the ARC (for a brief description of the organisation structure of research service see ARC, 1969: more specifically, for an account of agricultural R & D in Scotland in relation to the SPBS and ARC in the 19502, see SPBS, 1955: pp.12-18).

A twofold system of financial control has been used in the research service: the use of five year forecasts of annual estimates and expenditure, and a six yearly programme of work of each institute and its annual review. Forecasts and annual estimates have been based upon traditional forms of 'input accountancy'; that is, cost estimates are divided into headings of such categories as staff, equipment, maintenance and so on, and not upon elements of programme of work or projects. This has also applied to breakdown of research work within individual institutes; the lack of project costing, even to the type of crop, was noted by an EDCA report as a feature of agricultural R & D in Great Britain (1971 op cit). In fact, this might be common to research establishments generally (Baker & Pound, 1964). The lack of project costing will be important when the R & D costs of the new varieties are considered for measurement.

4.2 Objectives and work of the SPBS

The SPBS was established for the improvement of agricultural plants:

"It is hoped that such improvements may be attained partly by selection and partly by the creation of new varieties possessing in the higher degree those qualities which will make them most profitable under Scottish conditions". (SPBS, 1922: p.2). These aims have remained approximately the same down to recent years (SPBS, 1969: p.3). Explicitly it is seen that the concern is less with social or consumer interests, as with the profitability of Scottish agriculture. Pentland Crown's propensity for a greater usage of own grown seed cannot be said of course, to make it a variety likely to increase the profitability of the important Scottish certified seed industry, so perhaps the objectives of the society and station are not given prominence in practice.

Whilst nearly all the R & D carried out at the SPBS has had as its ultimate purpose, the output of improved plant varieties, a useful distinction may be made between work of a scientific interest, and that directly involved with breeding and testing for new varieties. The relation between the two, which for convenience shall be termed 'research' and 'development', is not always clear. It suffices to note here, however, that in practice perhaps more than half of the work at the SPBS has been of the development kind. A historical review of the whole of the SPBS activities is given in Gallie (1954) and more recently in Simmons (1968).

Plant breeding began with cereals, herbage, root plants and potatoes in 1921. However, very quickly, potato breeding assumed more importance relative to the other R & D and work became based upon two departments, those of potato and forage. The latter has come to be concerned chiefly with barley, oats, brassicas and some grasses. Several named varieties have been marketed but by the end of the 1960s, without any significant impact on national acreage figures.

4.3 The evolution of the potato research programme

The contribution of potato research to Pentland Crown and Pentland Dell is difficult to identify, and so it seems instructive to describe the research environment in some detail. This will make the business of research cost apportionment easier to understand. The approach adopted for this study was to build a record of the potato seedling and varietal contribution to Pentland Crown and Pentland Dell (a family tree), and to use this, in combination with the record of research in papers, annual reports and staff recollections, to associate research programmes and plant breeding material with innovation characteristics noted as important in the potato industry chapters.

This approach is probably more detailed than most which have been used to identify research contributions to innovation. Other work has relied heavily upon the memories and knowledge of senior research personnel; however, at the SPBS, staff changes had made this difficult. The family tree is shown in Figure 4.1 and was constructed from the SPBS records by the author specifically for this study; it will be used for reference throughout this section.

It had been hoped that an innovation map, similar to those used to identify critical events in technology to assess the weight of contribution from basic as well as applied science to innovation (see IITR, 1968; Isensen, 1969), might have been applicable, but ignorance about the early decisions in potato research prevented this. A more general but less detailed account of potato research at SPBS than the one provided in this section is given in MacArthur (1970). An account of the development of potato breeding generally is given in Simmons (1969 op cit).

The foundation stock of the SPBS came from a St. Andrews breeder, Dr. J. H. Wilson, and selection began upon a similar basis to that which

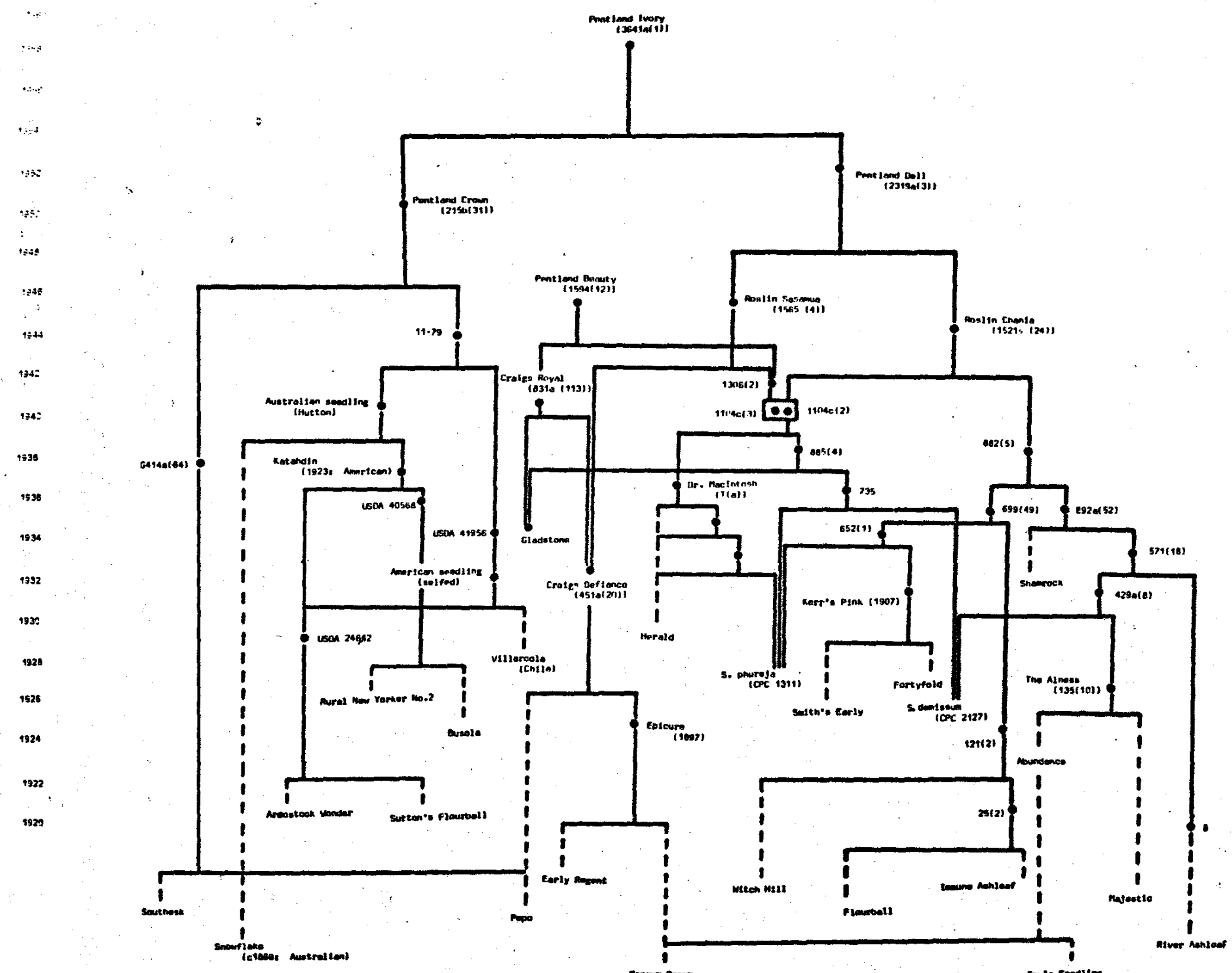

Figure .1 The inter-relationship of plant breeding material in Pentland Crown's and Pentland Dell's genealogy.

Annotation: Point in time at which hybridisation occurred ●

might have been used by horticultural breeders, of visible inspections of varietal characteristics and judgements based on hunch. In fact, it is probably fair to state that this approach remained, with some refinements, the principle behind the R & D that led to the introduction of Pentland Crown and Pentland Dell.

In the years prior to the establishment of the SPBS, private breeders had raised some varieties which were to become very successful, (Majestic and King Edward VII).[1] What seemed to be required of breeders was a (perhaps lucky) flair, or ability to spot say, high yielding varieties, and a knowledge that high yielding seedlings are likely from certain crosses (hybridisations). It was more important to do this well, than know the genetical basis for high yields.

However, inadequate knowledge was a major problem for the potato research programme at the outset. Little was known about varietal background, and existing classifications were suspect, since the effects of disease and of a suspected narrowness of the genetic base of European potatoes were uncertain. The potato had been slow to become a subject for geneticists, probably on account of its relatively complex hybrid structure (due to tetrasomic inheritance). This factor presents particular problems for plant breeding, for it means that individual potato varieties (or seedlings) are extremely heterogeneus and that their progeny contain a wide range of both good and bad characteristics. This makes it difficult to trace varietal characteristics, and also means that large numbers of seedlings must be raised to find an occaional one, with a recombination of genes which generally produce desirable results, though none, very undesirable.

Thus, in the early years of the SPBS, work concentrated upon the collection and classification of varieties and seedlings, isolation of

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indeed, one Donald Mackelvie continued to raise good commercial eties into the 1930s, the 'Arran' series of varieties (Rennie, 1968).

pedigree strains (pure lines), comparative trials and selection. It was not long before disease considerations, which in the first instance had been associated with a need to take stringent precuations to prevent further infection (particularly from viruses), became prominent. This is not to suggest that research rather than development was given priority, but that from the beginning the two went hand-in-hand. In fact, research was carried out directly with practical ends in view (SPBS, 1925): SPBS staff were always on the look out for the possibility that research material might contribute to a new variety (that is, material which might contribute to a new combination of varietal attributes, which might have commercial significance).

A major commercial problem earlier this century was wart disease, Synchytrium endobioticum, a disease that potentially can destroy complete crops and infect soils for a considerable period. Its importance required legislation which ensured that infected areas were scheduled, wherein susceptible varieties were prohibited.

The SPBS gave priority to the investigation of this disease. By 1930 the general basis for varietal immunity had been found to rest upon Mandelian inheritance: that is, where resistance behaves in breeding as a dominant character, and can be easily introduced into breeding stock (for example, the inclusion of one immune parent in a hybridisation, leads to at least 50% of progeny seedlings with immunity). Thus, from about this time all new varieties had wart immunity. For an account of this first success of organised plant breeding (in co-operation with official sanctions) see Cox (1967; pp.87-8).

Wart immunity, and another problem, pollen and ovule sterility (associated with the ability of potato plants to flower and set seed), were the major determinants of the choice of varieties and seedlings in the early years and this is reflected in the early ancestors of both

Pentland Crown and Pentland Dell, as shown in figure 4.1. For instance, varieties such as Pepo, Flourball, Ashleaf and Shamrock had both wart immunity and plenty of pollen.

By the mid-1920s, however, blight (Phytophtura infestans), and viruses had generally become recognised as the most commercially significant of potato diseases (McIntosh, 1925). Blight investigations featured in the SPBS's research programme from the beginning and virus related work began in earnest after 1929, when in response to an application from the society, the Empire Marketing Board made a grant (which led to the establishment of a sub-station). It is with these two diseases that the main part of research at the SPBS was concerned during the period up to Pentland Crown's and Pentland Dell's introduction to the market.

By the end-1930s, selection for hybridisation for commercial screening involved the inclusion of material from both blight and virus investigations. The decade following, however, was a period of stabilisation for the SPBS's activities, but with the relaxation of war-time conditions, saw an expansion which saw a broadening of breeding material (some of the material imported from overseas proved important to the development of Pentland Crown).

An impression of the aims of breeding policy, and associated problems, at the SPBS at this time is given by Black (1953): a list of factors important in determining 'economic type' is given in Appendix 8. It is likely that researchers at this time, thought in terms of a series of potential new varieties. The blight and virus investigations were presided over by the two most senior potato scientists at the SPBS, Black and Cockerham respectively. Their interests seem to have determined the combination of attributes a series of potential varieties might have. Both Pentland Crown and Pentland Dell are the result of attempts to incorporate blight and virus resistance properties in breeding material. Pentland Dell evolved out of the blight investigations and Pentland Crown from those concerned with viruses. These investigations deserve consideration in more detail.

4.4 Blight investigations

Attempts to include blight resistance in potato varieties started properly after the epidemics of 1846-48. It was not until about 1909, however, that blight resistance was positively demonstrated in breeding material (Salaman, 1970). This involved a wild species, Solanum demissum, originally from Mexico.

At about this time, Wilson (at St. Andrews) was using what were probably derivatives of S. demissum to transfer a blight immunity to cultivated stocks (ordinary commerical varieties termed S. tuberosum). This is a long process, because hybridisation must usually be followed by a system of repeated backcrossing to varieties of economic type in order to eliminate undesirable factors and bring together desired ones. In the process, it is quite likely that the original resistance will have become dispersed. So then it is necessary to inter-cross selected plants from purely bred lines in order to recombine the genes. Derivatives of Wilson's material formed the original collection of material for the SPBS and Black's blight investiations began with this: the seedlings and varieties at the bottom of Pentland Dell's pedigree, figure 4.1, were derived from this material.

There were four main breeding systems used by Black for testing blight resistance, and all are represented in Pentland Dell's pedigree. The first (1) is the 'multiple hybrid' system. This includes a pedigree produced by Wilson, with initial crosses made at the beginning of the century. In figure 4.1, it is represented by seedlings and varieties at the bottom of Pentland Dell's family tree, below seedling 121(2).

The variety of S. demissum that Wilson used cannot be identified with certainty, but it is probably CPC2127, one used in more recent experiments. The Wilson derivatives held their resistance until about 1932, but then succumbed to blight attack (the seedling 121(2) was used later to derive 699(49) on account of its pollen propensity, rather than for any blight resistance).

The second system (2) is that of the 'S. demissum - S. tuberosum' one. New work began in 1932 by crossing S. demissum, CPC2127 and selecting in subsequent backcross generations for resistance to the new strain of blight responsible for the breakdown of material produced by system (1). Five generations using S. demissum and three S. tuberosums produced seedling 877a(34), which was widely used as a parent in breeding; but it was on the way to obtaining this seedling that one of the second generation turned up in Pentland Dell's pedigree, 571(18), see figure 4.1.

It was found that progenies bred only from S. demissum and S. tuberosum gave segregation ratios which bore little resemblance to standard Mendelian ratios (due to different chromosome number and irregularities in species' behaviour). In order to overcome this difficulty, S. demissum, which is hexaploid, was crossed with the diploid species, S. phureja to obtain a fertile tetraploid hybrid, 735(38), see figure. This is the third system (3), 'S. phureja - S. demissum - S. tuberosum 'hybrids'. The original cross was made in 1937 from S. phureja, CPC 1311, and S. demissum CPC2127: the result, 735(38) was crossed with S. tuberosum, Gladstone, and the triple hybrids then backcrossed. Repeated backcrosses with S. tuberosum varieties followed, producing plants with normal chromosome behaviour.

This breeding system (3), forms a large part of Pentland Dell's Pedigree, up to and including seedlings 1104a(2) and 1104(3); seedlings which are common to both the Roslin Chania and Roslin Sasamua lines, the parents of Pentland Dell. The last breeding system to be included in the pedigree is (4) '(S. tuberosum X S. phureja) X (S. demissum X S. tuberosum)'. This is a system linking those of (2) and (3) and including seedlings from 571(18) and S. phureja. The only notable inclusion in Pentland Dell's pedigree that appears to have been a contribution from outside blight investigations is that embodied in Craigs Defiance, a variety stemming from the SPBS's virus work, with field immunity from several mild virus strains.

The blight breeding systems were based upon a knowledge that dominant genes might control resistance to specific races (or biotypes) of the fungus. The aim was to produce new varieties having these dominant genes (called R-genes). The first variety of this type was Pentland Ace; it was introduced in 1951, but in 1954 when its plantings had reached nine acres, the variety suffered a severe blight attack.

Perhaps this was to be expected since derivatives of S. demissum had previously had their blight resistance broken down. Black had noted in the early 1950s that the value of R-gene resistance was uncertain (1953, op cit), and as early as 1938 biotypes of blight had been identified (Reddick and Mills, 1938). Gradually it came to be realised amongst potato breeders that R-gene resistance was unreliable in the face of the versatility of blight in evolving new biotypes: no variety was likely to remain immune to blight for long. Research interest began to switch to more promising fields of enquiry, particularly the significance of field resistance (a quality controlled polygenically and not by a dominant gene: varietal resistance manifests itself as an average reaction to disease, so that crops might be less affected with some varieties than others).

However, although after the failure of Pentland Ace, the SPBS began to concentrate attention upon other types of resistance, Pentland Dell was introduced in 1960 with three R-genes (giving immunity to the main blight biotypes). The variety was rapidly taken up by growers and accepted as a variety immune to blight. Reports that blight had been recorded on crops of Pentland Dell in south west England had supposedly been made to research service prior to the general blight immunity breakdown (O'Neill 1968). Given the information that was apparently available about the nature of Pentland Dell's immunity, it is curious that growers were apparently taken by surprise when breakdown came (Hardie and Hampson, 1969). This happened generally in 1967. Thereafter, the variety's share of the national maincrop declined, and later stabilised at a level lower than might have been expected, given its initial rapid rate of adoption, see figures 1.1 and 1.2.

Conversations with SPBS staff suggested that Pentland Dell would never have been marketed without its blight immunity and certainly not upon the basis of its high crop yield potential alone. This almost implies that the variety exists by default. However, the presence of S. demissum in the variety's pedigree is possibly significant, for the fact that it broadened what was a very narrow genetical breeding base. At least one observer has suggested that S. demissum contributed significantly to pushing up varietal crop yield potential above previous levels (Toxopeus, 1952). It is possible that a main reason for the failure to find successful competitors for Majestic and King Edward VII was the limited material available to breeders to increase crop yields.

4.5 Virus investigations

Virus related research was encouraged earlier this century by seed certification schemes (organised by the Board of Agriculture for Scotland,[1] and the Potato Synonym Committee), which enabled growers to propagate pure stocks true to varietal names. This greatly helped researchers to identify deviations from varietal type due to virus

[1] The fore-runner of DAFS.

infection. Also, during the 1920s, international work established the biological nature of virus disease.

From the outset, some work at SPBS was designed to ascertain whether viruses could be controlled by breeding. An important step forward had been achieved in America by the development of seedling USDA 41956, a variety with field-immunity to a mild vuris, called 'X' (Schultz et al, 1934); it was found that the resistance could be transmitted to hybrid progeny (Stevenson et al, 1939). The discovery at SPBS of the mechanism of field immunity from mild viruses, soon followed (Cadman, 1942). It was discovered that a dominant gene was responsible for a hypersensitive necrotic reaction, when plant tissue was invaded by a mild virus (the reaction works to kill plant tissue around the virus so that it becomes isolated and harmless). This kind of field-immunity was transferred to Pentland Dell, through Craigs Defiance (see figure 4.1).

This success led to a search for field immunity from severe mosaic (virus 'Y'). American work concerned with both virus Y and leaf roll had produced Katahdin a variety which exhibited some resistance to virus Y, and by passing it on to progeny showed that resistance was inheritable (Jones & Vincent, 1937). Katahdin appears in Pentland Crown's pedigree, figure 4.1; this is because it was used by Hutton in Australia to study the speed and intensities of necrotic reactions to viruses. It was crossed with Snowflake, an old Australian variety, useful for its pollen propensity (Bald & Pugsley, 1941), hence the presence of this variety in the pedigree.

Hutton's research produced seedlings of a quality which prompted him to forecast commercial varieties with resistance to virus Y within a foreseeable future, a prophecy fulfilled by Pentland Crown. The nature of resistance was found not to be field immunity, but field resistance (Hutton, 1948). It was a seedling from the Snowflake-

Katahdin crosses which was received from Hutton by the SPBS and crossed in the late 1940s to obtain Pentland Crown's parent, seedling 11-79, see figure 4.1. An indication of international co-operation is shown by the fact that Hutton's virus investigations had received valuable virus strains from Britain (from Bawden at the Rothshampsted Experimental Station).

Pentland Crown's other parent, G414a(64), is a product wholly of the SPBS's virus investigations and is responsible for the new variety's degree of resistance to leaf roll. It had been noticed early on that varietal differences in reaction differed in relation to infection from leaf roll virus, however, no type of resistance was known. Varieties which had showed less than average susceptibility were grown in field trials of SPBS where they would be exposed to natural infection. It seems that these continued upon a year-to-year basis without any certainty as to how long they should take. Some degree of resistance was first recognised as inheritable in trials between 1933 and 1935 and three varieties were selected as promising: one of them was Southesk, a grand-parent of Pentland Crown, see figure 4.1.

It is likely that one of the 2164 seedlings raised from Southesk during 1939-40 was G414a(64). This seedling was put through leaf roll trials during the 1940s, then selected as suitable for commerical hybridisation. The other parent of Pentland Crown, seedling 11-79 was being used for virus-aphid research and it was a hunch of Black's which put the two together.

The origin of Pentland Crown's common scab (Steptomyces scabies) resistance is a mystery and cannot be explained in relation to the pedigrees shown in figure 4.1, as the varieties there seem susceptible. Likewise is Pentland Dell's spraing susceptibility. These factors would not have gone unnoticed by the SPBS, however, their importance was probably thought secondary to the main aim of producing commercial varieties with resistance to severe viruses and blight.

4.6 The importance of the blight and virus programmes

The contributions of the blight and virus programmes were necessary to bring about Pentland Crown and Pentland Dell. In a sense the success of these varieties is only a part of the return to research if the purpose was to produce a series of varietal types with resistance to blight and virus. The research would have gone on at the SPBS regardless of whether the new varieties had been introduced or not. Thus, the costs associated with these activities were not caused by the new varieties directly, but by the need to have varieties with resistance to virus and blight, so that the likelihood (or possibility) that varieties such as Pentland Crown and Pentland Dell would one day be facilitated and produced.

The research itself has probably had a contributory effect to knowledge generally. The work in genecology in relation to blight and viruses has, one observer has written, given the SPBS an international reputation, for a contribution of the "widest significance up to the early 1960s" (Russel, op cit: p.360). Two papers which appeared to attract international interest were ones concerned with the classification of blight biotypes (Black, 1952) and the nature of field immunity to virus X (Cadman op cit).

4.7 The development of potential varieties

A period of varietal development can be described as that period from the year of hybridisation to varietal registration and marketing. At the time of Pentland Crown and Pentland Dell this took eight years: one for hybridisation, four for screening at the SPBS and another three, involved with 'merit trials'. The process is pictorially represented in figure 4.2 and in terms of the approximate numbers of seedlings involved at each state in table 4.1.

TABLE 4.1 Approximate development path of Pentland Crown

	Number of individual seedlings at P.C. development stage (a)	Number of plants per seedling (b)	Year of Merit Trial (c)
1951	Hybridisation		
1952	8,000	1	
1953	2,000	3	
1954	400	8	
1955	100	40	
1956	7	1/25th acre	1st
1957	4	1/8th acre	2nd
1958	2	1/2 acre	3rd

Source: SPBS staff recollections and Annual Reports

Promising breeding material was supplied from research investigations, or from elsewhere, for hybridisation: after which seed (balls or potato plums) was harvested and stored for a following (usually the next) year. Early selection was made upon the basis of morphological characters, such as the attractiveness of haulm, stolon length, shape and colour of tubers and freedom from tuber disease. Little reliance was put upon yield at the single plant stage, but tuber size and numbers were regarded as a good indicator (preferably few and large). In the early 1950s single plant selections were planted straight into the open ground.

The attrition rate amongst seedlings was highest at the end of the first year, see table 4.1. In the second year after hybridisation, seedling plant number was increased to three and more accurate assessments were made of morphological characters. Yield indicators were still liable to be misleading. Tests involved checking for tuber diseases such as common scab and the appearance of virus effects from

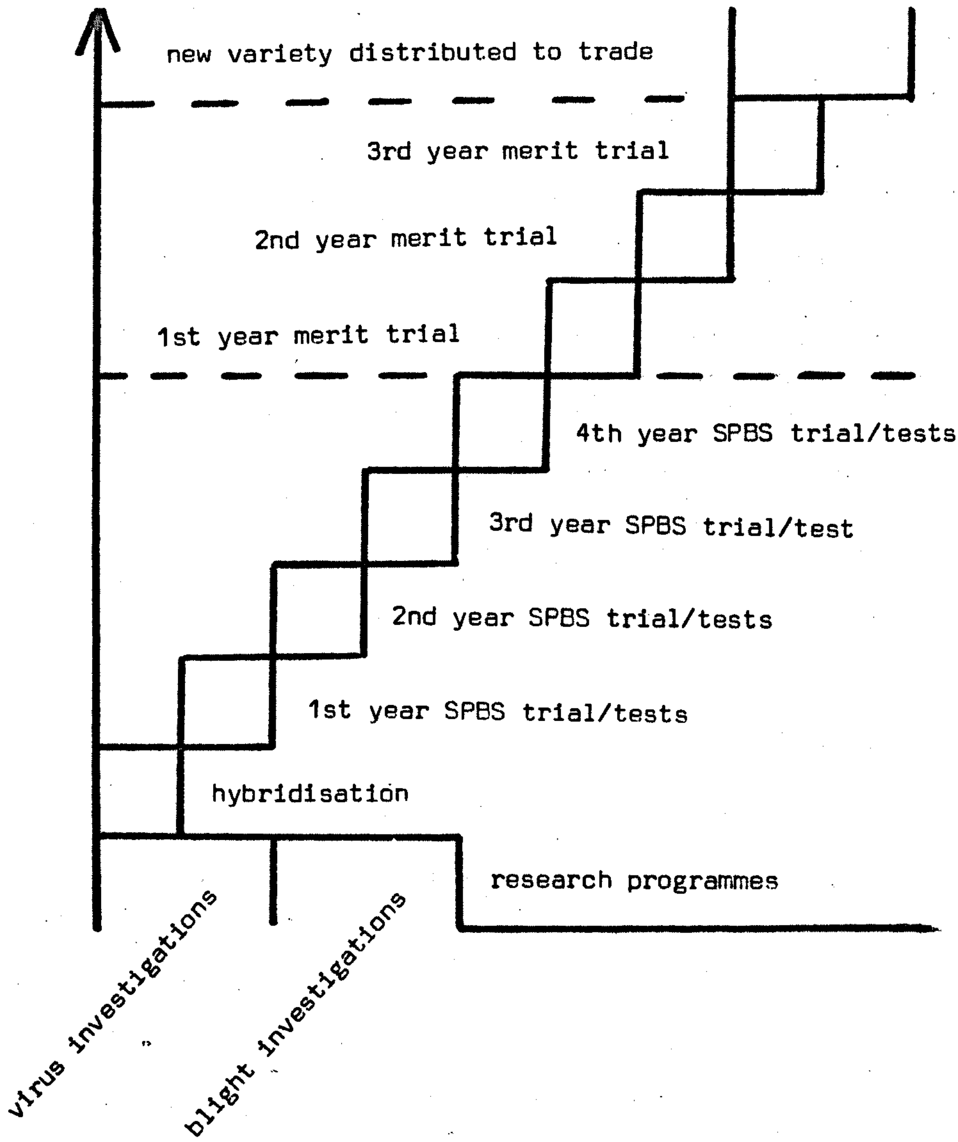

Figure 4.2 The development stages of a potential variety during the 1950s

infection in the previous year, and for specific strains of blight.

The third year involved tests for wart disease and Virus X, yield trials of a limited nature and observations upon the incidence of disease generally. Tubers were also examined for cooking quality (not to be unpleasant: texture, consistency, colour and flavour were considered). By the end of this year, researchers could obtain a reasonably accurate impression of the probable advantages.

The fourth year involved a repeat of the third for environmental factors, prior to submission for use in the 'merit trials'. At the end of this stage, approximately half a dozen seedlings might have been of sufficient standard to go further and be available in enough quantity to provide at least one-twentyfifth of an acre.

Potential varieties were then submitted to the Agricultural Scientific Services Station (the official seed testing at East Craigs, by Edinburgh) for authoritative assessment (these were called during the 1940s and 1950s, the Official Immunity and Merit Trials). The purpose of the trials was to provide an independent assessment of potential varieties; to prevent the marketing of wart susceptible or synonym varieties and to discourage the marketing of mediocre types.

Confirmatory tests and assessments were carried out by other organisations. Final decisions about whether a seedling received a commendation, which signified that a seedling was believed to be of a standard at least equivalent to that of existing varieties were made by a Potato Trials Advisory Committee (which included both scientists and growers). A full description of the merit trials and criteria of assessment appears in Davidson (1964).

4.8 The introduction of new varieties to the potato industry

Upon commendation seedlings were named and registered with the DAFS. Throughout this latter period the SPBS (with help from the society's members) would have been maintaining virus-free stocks, and multiplying the number of plants; so that at the end of the merit trials enough stock existed for marketing and distribution to research organisations (for further tests and trials). Pentland Crown and Pentland Dell were marketed in different ways.

Stocks of Pentland Crown were handed over in the year of naming, 1958, to an agent appointed by the society (J. C. Dougall Limited, Auchterarder). The agent was a certified seed potato merchant (referred to as a raiser* in the industry) and he received half an acre of stock from the SPBS's virus-free nucleus. The agent was permitted to grow the variety for one year before distribution, but then in the second, was required to distribute three-quarters of the stock to other seed potato merchants. The society retained the right to distribute small quantities to research organisations for experimental purposes and with the agent's consent, to some approved raisers of virus-tested stocks (SPBS, 1956).

Pentland Dell was not handed over to an agent but upon registration and naming, in 1960, was given to the DAFS, who distributed stocks to a number of selected certified seed producers (SPBS, 1961). This change in procedure resulted in a faster extension of the variety to ware growers than probably would have been the case with the system used for Pentland Crown.[1] Pentland Dell is first recorded in PMB acreage

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[1] The author heard allegations that Pentland Crown had been deliberately released to the market slowly by raisers to maximise the scarcity value of the variety and keep up certified seed prices (conversations with PMB staff, Edinburgh). These allegations appear to have originated from certified seed merchants in England. Unfortunately, although these allegations were investigated, the raisers who marketed Pentland Crown (and those associated with Pentland Dell) were no longer available to provide information for this study, and so nothing is known, in any reliable detail, of the early circumstances of Pentland Crown (and Pentland Dell). Hay gives some information about raisers generally (1969): where it is suggested that certified seed stock can take between four to eight years to reach the ware grower, after introduction by a plant breeder.

statistics in 1965, the same year that Pentland Crown first appeared there, but the former variety had been introduced two years earlier.

A faster marketing means that growers receive the advantages of new varieties all the sooner (and, therefore, the returns to investment are the greater), but also, that more growers are likely to be involved in the 'learning process' associated with the new variety. If things go wrong under commercial conditions then more growers will be adversely affected. So, ironically, the speedier marketing of Pentland Dell might have meant that its blight immunity breakdown was felt by a maximum of growers.

A more comprehensive, yet rigorous testing of new varieties under actual commercially conditions might have cushioned the learning process for growers.[1] It was a consequence of the potato growing industry's experience with Pentland Dell that led the PMB and Ministry of Agriculture, Fisheries and Food (MAFF) to co-operate together in commercial trials for 'recently introduced varieties'.[2]

Once information is present with regard to varietal behaviour, it has to be published in a form which can be passed on to, and understood by the farming community. The main organisation responsible for doing this, as well as carrying out trials and tests (collating and conducting assessments), is the National Institute of Agricultural Botany (NIAB), and in Scotland, the DAFS; a full account of the NIAB's varietal assessments is given below (Section 7.1).

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[1] There is evidence that the learning process uncovered several faults, in Pentland Crown as well as Pentland Dell. The latter's extreme susecptibility to spraing (Section 7.8) and propensity to trouble from little potato (Section 7.1) were 'grower discoveries' (conversations with NIAB staff). Pentland Crown gave trouble from damage and storage problems, part of it because the new variety had been treated as if it were like Majestic (Section 7.8). A general critique of the extension and advisory part of the agricultural research service is Marcellin (1973); it is described as the weak point in the development and application of innovation.

[2] The reasons for the trials are given in a footnote, Section 7.1: the relationship to the NIAB assessments is also noted.

The information published by the NIAB takes a form of a leaflet, with notes about varieties recommended for commercial use: the information is based upon trials carried out at several centres in Britain, and is up-dated every year, see for example, NIAB (1971). In addition to this source, growers and merchants may obtain information, perhaps of a more local character, from the regional offices of the ADAS (which often have direct links to local experimental centres).

It seems likely, however, that growers generally rely upon their certified seed supplier for the main part of their information about new varieties (see Jones, 1963, for a full account of sources of information available to farmers, and how they are used). One other important source is the PMB, which regularly sends out publications to registered growers, and organises trials and meetings.

4.9 The relation of R & D to costs

There are three features associated with R & D costs, which this chapter has brought to light. The most important is that the new varieties were a product of an existing system. That is, R & D arrangements would have existed anway, whether Pentland Crown and Pentland Dell had been introduced or not. In this sense, the new varieties are unlikely to have contributed significantly to R & D costs; yet the system existed to produce new varieties.

The other two features are the long-time scales involved (from hybridisation it was fourteen and twelve years to the time Pentland Crown and Pentland Dell respectively made an impression upon national acreages), and the contributions of individuals (the flair which put seedlings G414a(64) and 11-79 together: the work of Hutton in Australia). Factors such as these make the application of economic appraisal difficult in fields associated with investment in R & D.

It will be remembered that other work in agricultural R & D has concentrated largely upon methodological problems associated with deriving net benefit. The problems associated with R & D investment costs were ones more of uncertainty than approach. For example, in Griliches' hybrid corn study, his approach was to take R & D as a whole, and the main problem was simply a lack of cost estimates. Thus, he was forced to make allowances and cost approximations which were pure guesses (Section 3.6).

This study, when it comes to uncertainty about R & D costs, is no exception to the rule. It is hoped, however, that the above description of the background to the introduction of the new varieties has been such to enable the reader to see cost estimates in a true sense of proportion. So that in the following chapter, concerned with the derivation of R & D cost, approximations (if only educated guesses) will be understood.

4.10 A summary of this chapter's main points

The traditional method of cost control leaves records in a form which is unsuitable for CBA. The institutional background was considered, and the development of the R & D programme at SPBS linked to the pedigree of Pentland Crown and Pentland Dell. The original aims of the station were specifically Scottish ones, but in time, they seem to have been generalised. The work of the SPBS can be understood as falling into two parts, research and development.

Although breeding was begun from the beginning of the SPBS's life, 50 years ago, the emphasis was upon research, with a view to laying a foundation for a scientific approach to breeding. The problem in the early stages was associated with general ignorance.

It was not long before blight and virus considerations dominated research. Pentland Dell and Pentland Crown represent outcomes from these research activities, respectively. Pentland Dell represents an attempt to develop a variety with (a now redundant) resistance to blight, whilst Pentland Crown is a variety with resistance to the Y and leaf roll viruses. Other characters associated with these varieties, such as spraing susceptibility and common scab resistance, cannot be linked with any conscious effort on the SPBS part (except in terms of recognition in screening procedures).

The work on blight and virus research has given the SPBS an international reputation.

The development side of breeding involves screening and selection of promising seedlings. A seedling required a minimum of 7 years to reach registration and naming. The last three years involved assessment by bodies external to the SPBS, to judge the merits of varieties for commercial use.

At the end of development varieties were released to the seed trade. Pentland Crown and Pentland Dell were marketed in different ways: this affected the speed with which they reached ordinary ware growers for general cultivation. It was impossible to obtain information about this stage of the varieties' history.

In a direct sense, it seems unlikely that the two varieties contributed to R & D costs to an extent which would have changed total costs significantly from what they might have been without the new varieties. However, the R & D system as a whole was established to facilitate the production of new varieties such as Pentland Crown and Pentland Dell.

CHAPTER FIVE

Derivation of estimates for the R & D investment cost

5.1 Records of R & D costs at the SPBS

The record of expenditure at the SPBS for the period from the foundation to the time when the Pentland Crown and Pentland Dell were marketed, was of an input accountancy form (that is, according to expenditure upon items used, rather than activity); a method used commonly throughout the research service at that time. The information is available in the form of statements of expenditure, published in the SPBS's annual reports. A copy of one such statement, representative of the others used for this study, is to be found in Appendix 8.

Totals of expenses taken from this source appear in column (a) table 5.1. Some totals are approximations between those of a previous and subsequent year, because records were missing: however, these are few and are denoted in the table by an asterisk. There are no records for expenditure for potato R & D specifically and so the totals refer to the whole SPBS's programme of work.

Totals cover all expenditure, including capital and administrative costs. They therefore reflect the costly move of the SPBS from Craigs House to Pentlandfield in the early 1950s. The contribution of funds to this operation began in the post-war years of the 1940s and reached their highest point around the mid-1950s. For example, in 1954 capital expenditure amounted to about £0.48m out of the total, £0.075m (SPBS, 1954: pp.10-13). It is hoped that the distorting effect of elements such as these are allowed for, at the end of each cost period (below, Section 5.4) by treating assets then, as receipts. Depreciation, where it can be detected in the accounts, is omitted.

TABLE 5.1

SPBS Expenses: Derivation of Potato R & D costs (£s)

	Total SPBS expenses (a)	Price Index (b)	Adjusted Expenses (c)	Staff Ratio (d)	Total Expenses (e)	Salary Ratio (f)	Potato Expenses (g)
1922	3930	3.8	14934	1.3-1.3	7467		
1923	4611	4.0	18444	-	9622		
1924	3641	4.0	14564	-	7282		
1925	3803	3.9	14832	-	7416		
1926	3321	4.0	13284	-	6642		
1927	3900	4.1	15990	2-1	5330		
1928	3719	4.2	15620	2-1	5207		
1929	1399	4.2	14276	3-3	7138		
1930	5953	4.4	26193	3-4	14967		
1931	5405	4.7	25399	3-4	14514		
1932	5132	4.8	24634	3-4	14077		
1933	4981	5.0	24905	3-4	14231		
1934	5156	4.9	25264	3-3	12632		
1935	5124	4.9	25108	3-3	12554		
1936	5235	4.7	24604	3-3	12302		
1937	5425	4.5	24412	3-3	12206		
1938	6007	4.5	27031	5-3	10137		
1939	7070	4.2	29694	5-3	11135		
1940	6363	4.0	25452	5-3	9544		
1941	6487	3.8	24651	4-3	10565		
1942	7638	3.6	27497	3-3	13748		
1943	6820	3.3	22506	3-3	11253		
1944	6796	3.1	21069	2-2	10534		
1945	6889	2.9	19978	2-2	9989		
1946	8096	2.6	21050	3-4	12029		
1947	11088	2.5	27720	5-4	12320		
1948	15598	2.3	35875	5-4	15944		
1949	18448	2.2	40586	6-4	16034		
1950	23343	2.2	51355	7-5	21398		
1951	31788	2.0	63576	6-5	28898		
1952	38826	1.9	73769	6-4	29508	50	36884
1953	60260	1.8	108468	7-4	39443	45	48811
1954	75526	1.8	135947	8-4	45316	43	58457
1955	70849	1.8	126880	8-4	42293	40	50752
1956	51783	1.7	88031	10-5	29344	39	34332
1957	49859	1.6	79774	11-5	24929	39	31112
1958	61584	1.6	98531	11-5	30792	39	38428
1959	54372	1.6	86995	12-6	28998	39	33928
1960	57184	1.6	91494	12-6	30498	38	32023

Source: (a) (d) SPBS Annual Reports
(b) Appendix 9
(f) SPBS records

It is sometimes suggested in literature concerned with investment appraisal, that only those costs directly associated with the R & D in question should be taken into account (capital outlays and fixed costs excluded). In questions associated with future expenditure, this is so.[1] The concern in this study, however, is a retrospectvie one, the computation of an average rate of return on previous investment.

How the totals shown in table 5.1 reflect the alternative value of R & D resources is uncertain. As Nicholson has observed, too little is known about the opportunity costs of research resources to use estimates which depart from market values in CBA, with any degree of certainty (1969). Thus, there is no correction of estimates in the table for use in this study.

However, it is necessary to take account of time. The estimates shown in column (a) do not allow for the effects of differences in the purchasing value of money over time. Purchasing value of money is not constant, pound for pound, over time.

5.2 The use of a price index to adjust money values to a constant standard for measurement and reference over time

This century, prices in Britain generally, have tended to rise over time, so that the pound in recent years has tended to purchase fewer goods and services than it had done previously. This means that costs and benefits measured in one year might not be comparable to those valued in another.

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[1] This sometimes involves the principle of 'bygones are bygones': that past expenditure is irrelevant to future developments, which is to say, that any investment decision must be made upon the basis of a comparison of future expenditure with future returns. It does not imply that past R & D is irrelevant for its effects upon the future, but that marginal changes in expenditure should lead to returns greater than those obtainable elsewhere from investing the funds in alternative activities.

To allow for this, it is usual in CBA studies to adjust values by weighting them, using a price index. For this present study, it was decided to use a general output price index. This is the Consumer Price Index, compiled annually by H.M. Treasury for national accounting purposes. Details about how it is derived, a copy of the index and table of weights compiled from the index, are contained in Appendix 9.

If there are grounds for believing that changes in relative prices of R & D or agricultural resources might have been ignored or hidden by a general index, then a specialised input index could be used. For example, Peterson used an index based upon the salaries of associate professors in large American universities, to convert values used in his poultry study (1967 op cit).

The MAFF publishes a specialised index, the 'agricultural price indices (all products)', and this indicates that agricultural prices were more generally depressed during the 1920s and 1930s, than prices generally in the economy (as reflected by the consumer price index). This index, however, varied throughout the period relevant to this study, when the bases and methodology were changed at various times. Thus, it was decided to use the general index.

The SPBS expenses shown in column (a), table 5.1, were adjusted to 1971 £s values, shown in column (b). Adjustment was achieved by weighting the values by the percentage changes in the annual value of the pound from 1971 (the latest year for which most data was available for this study). So, for example, if the price index shows that for year preceding 1971, prices were 10% lower, then the adjusted value of the pound is correspondingly more in the year in question, and costs and benefits in that year must be inflated by 10% (multiplied by 1.10).

5.3 Derivation of potato R & D expenses

Since input accounting does not list expenditure by activity, there is no record at the SPBS which proportion of expenses has been due to potato R & D on the one hand and that of forage crop plants on the other. It is necessary to devise a method by which total expenses can be apportioned between the two kinds of activity. Except in the instance of scientists, no reliable record had been kept at the SPBS of what the potato and forage departments had taken in terms of resources.

Staff lists appear in the SPBS's annual reports, and from these it was possible to derive ratios of forage to potato scientists. Since conversations with SPBS staff suggested that the number of staff employed in the two departments was proportional to the resources used by the departments, it seemed that these ratios could be used to apportion total SPBS's expenses.

The staff ratios that were used are shown in column (c) table 5.1; the figures on the right hand side denote potato scientists and on the left, those of forage. The estimated potato R & D expenses are listed in column (d). Only staff records of scientific and experimental grade scientists were used: since at that level personnel were less likely to have been exchanged between departments, than say, scientific assistants.

Records at the SPBS were such, that it would have been possible after 1951 to have used staff salaries rather than number. This might seem a superior method, because size of salary might be an indication of the resources a scientist has at his command. The result of this method is to increase the proportion of expenses taken by the potato department, perhaps because the senior scientists had been there longer than their counterparts in the forage department, see columns (e) and (f), table 5.1. To be consistent, however, this study uses staff number, since little is known about salaries prior to the early 1950s.

5.4 Apportionment of R & D expenses between specific varieties

There is a lack of a formal relationship between research input and varietal output, particularly given the chancy nature of hybridisation. However, as noted in the previous chapter, there has been a systematic organisation of R & D effort aimed to facilitate that 'chance' was biased towards the introduction of new varieties, such as Pentland Crown and Pentland Dell.

It seems then that it is relevant to consider the whole potato R & D costs incurred prior to the introduction of the new varieties. This was the procedure adopted by Griliches; he did not consider the specific costs of any hybrid corn varieties, but instead attempted to estimate the costs of the system of R & D which made those varieties possible.

The inclusion of all potato R & D costs in the CBA arithmetic would take account of 'dry holes', the failures (or dead-ends) to be expected in R & D; for example, the blight immunity breakdown of Pentland Ace (Section 4.4). This might go some way to answering criticism that CBA studies of investment in agricultural R & D only measure the effects of successful innovations (Section 9.15). However, taking all R & D costs might be too conservative a bias against the returns from the SPBS innovation, since it involves a 50 year investment period. A high discount rate would probably make net benefits achieved in the late 1960s and early 1970s seem very small in relation to the costs of R & D investment.

An alternative to the whole of R & D costs approach is that which uses varietal development periods to apportion expenses. This might be said to ignore research costs to the extent that potato costs prior to years of hybridisation are not considered. This need not be unreasonable, since it seems unlikely that research programmes would have been affected, or different, had not individual varieties been bred. This means that only those costs incurred for 1951 to 1960 would be relevant, for this is the period in which the developments of Pentland Crown and Pentland Dell happened. There were of course, other seedlings, which turned into named varieties, undergoing trial and multiplication at that time (see Appendix 8), however, only three of these, Pentland Beauty, Pentland Hawk and Pentland Ivory have achieved commercial success to date in terms of having planted acreage recorded in the PMB statistics: this success was modest, and is described in Section 9.9).

Thus, potato expenses could be divided between these successful varieties, or all named varieties, or estimated number of seedlings undergoing development. The former approach is adopted as the more conservative assumption which means that during the early years of Pentland Crown and Pentland Dell's developments, potato costs are shared with Pentland Beauty, and for the later years, with Pentland Hawk and Pentland Ivory.

The methods of taking all SPBS's potato R & D costs and the development period approach, are not the only possibilities of cost apportionment. Many variations are possible. For example, expenses could be treated on a decade basis, the net returns to which would come from SPBS's varieties (or only Pentland Crown and Pentland Dell) achievements in a following decade to that of R & D costs. Another might be to compute average R & D costs per year, divide the number of R & D years by successful commercial varieties, multiply the two results together to derive an average R & D cost and time period. Then in a similar way, average all benefits and compute a rate of return to the average R & D cost. These methods and ones like them are less specific and thus less pertinent to a study concerned with Pentland Crown and Pentland Dell. Also, given the wide margin of error that probably exists for whichever method is chosen, refinements did not seem worthwhile.

The two methods of considering investment cost, the longer time span one of taking all potato R & D costs to 1960, let this be termed 'whole potato R & D investment cost', and the shorter one which just covers the development period of the new varieties, let this be termed 'development investment cost', are chosen for use in this present study. The appropriate potato expenses for the two methods are shown in tables 5.2 and 5.3 respectively.

For development investment cost, it is seen that total potato expenses are divided between the number of seedlings which later achieved commercial success, column (c), to derive estimates of cost shares for Pentland Crown and Pentland Dell, column (d). The item 'funds' at the beginning and end of the cost periods, refers to the assets of the SPBS at the times shown. These are taken to represent the purchase price of the initial investment outlay at the beginning and re-sale value at the end (these totals will of course differ when discounting is used).

5.5 The use of discount rates to adjust the values of costs and benefits to reflect a decision maker's time preference in foregoing current expenditure to obtain future benefit

(a) The concepts of discounting and present value

The potato expenses shown in tables 5.2 and 5.3 require adjustment to reflect a 'present value' (as net benefit will have to be discounted): this involves a discounting procedure widely used in investment appraisal generally.[1] Discounting is based upon the assumption that

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[1] A history of developments which led to the general adoption of discounting in investment appraisal generally is given in Shaw (1968). The use of associated present value techniques has only in recent times found general acceptance. It is likely that encouragement from bodies such as the National Economic Development Council has been important to a wider understanding of discounting (NEDC, 1965). It is feasible to allow for inflation effects simply by an upward adjustment of discount rates instead of using price index. However, this would imply that inflation rates were constant, which is unlikely: also it might act to confuse what the discount rates are meant to measure.

TABLE 5.2

Potato Research Costs 1921-1960 (£s)

Fds at	Potato expenses	Discount factor 5%	Discount factor 10%	Discounted expenses 5%	Discounted expenses 10%
1921	81747	0	0	81747	81747
1922	7467	0	0	7467	7467
1923	9222	0.952	0.909	8779	8183
1924	7282	0.907	0.826	6605	6015
1925	7416	0.864	0.751	6407	5569
1926	6642	0.823	0.683	5466	4536
1927	5330	0.784	0.621	4179	3310
1928	5207	0.746	0.564	3884	2937
1929	7138	0.711	0.513	5075	3662
1930	14967	0.677	0.467	10133	7005
1931	14515	0.645	0.424	9362	6154
1932	14077	0.614	0.386	8643	5434
1933	14231	0.585	0.350	8325	4981
1934	12632	0.557	0.319	7036	4030
1935	12554	0.530	0.290	6654	3641
1936	12303	0.505	0.263	6213	3235
1937	12206	0.481	0.239	5871	2661
1938	10137	0.458	0.218	4643	2210
1939	11135	0.436	0.198	4855	2205
1940	9544	0.416	0.180	3970	1718
1941	10565	0.396	0.164	4184	1733
1942	13748	0.377	0.149	5183	2048
1943	11253	0.359	0.135	4040	1519
1944	10534	0.342	0.123	3603	1296
1945	9989	0.326	0.112	3256	1119
1946	12029	0.310	0.102	3729	1227
1947	12320	0.205	0.092	3634	1133
1948	15944	0.281	0.084	4480	1339
1949	16234	0.268	0.076	4351	1234
1950	21398	0.255	0.069	5456	1476
1951	28898	0.243	0.063	7022	1821
1952	29508	0.231	0.057	6816	1682
1953	39443	0.220	0.052	8677	2051
1954	45316	0.210	0.047	9516	2130
1955	42293	0.200	0.043	8459	1819
1956	29344	0.190	0.039	5575	1144
1957	24929	0.181	0.036	4512	897
1958	30792	0.173	0.032	5327	985
1959	28998	0.164	0.029	4756	841
1960	30498	0.157	0.027	4788	823
Fds at 1960	82739	0.157	0.027	-12990	-2234
				299688	192783

Note: Calculated using Table 5.1

TABLE 5.3 Costs of potato research: A breakdown of expense on the basis of time periods corresponding to the 'development' periods of successful SPBS varieties

	Potato expenses 1971 values	Share of expenses to individual varieties		Discounted expenses of individual varieties			
		Nos.	Share	Pentland Crown		Pentland Dell	
(a)	(b)	(c)	(d)	(f)		(g)	
				5%	10%	5%	10%
Fds at April 1950	45432	2	22716	22716	22716		
1951	28898	2	14449	14449	14449		
1952	29508	2	14754	14046	13411		
Fds at April 1952	38188	3	12729			12729	12729
1953	39443	3	13148	11925	8471	13148	13148
1954	45316	3	15105	13051	11344	14380	13730
1955	42293	3	14098	11603	9629	12787	11645
1956	29344	2	14672	11503	9111	12677	11019
1957	24929	2	12464	9298	7030	10259	8513
1958	30792	3	10264	7298	4793	8047	6374
Fds at April 1958	75760	3	25253	-17955	-11793		
				97934	89161		
1959	28998	3	9666			7211	5452
1960	30498	3	10166			7228	5215
Fds at April 1960	82739	3	27580			-19608	-14149
						78857	73676

money is worth less received or paid in the future than it is when received or paid in the present, and is a method which involves weighting investment costs and benefits, by use of an interest rate, so that they reflect 'present values'. For example, if the cost of an investor, in terms of foregoing current consumption, is 10% (this is called his time preference), then £121 due to be received or paid in two years' time, should be discounted by a 10% interest rate, which would deflate the sum in present value terms to £100, at the start of the two years.

The principle works in reverse to the idea of compound interest: if £100 is lent out now for two years at 10% compound interest, then the amount due to the investor would be £121 at the end of the period. More formally, present value is expressed by the following formula:

$$P = A/(1+r)^n$$

where P is the present value of a future sum; A is the future sum itself; r is the discount rate, and n is the number of years.

The process of discounting costs and benefits is simplified by the availability of present value (or discounted cash flow) tables. These state the present value of 1 receivable at various future years: for instance, totals are usually presented for 1% to 10% interest rates, for one to fifty years from the present time. Tables are contained in an appendix to Merret and Sykes (1966, pp.150-157), and are calculated from the above formula.

(b) The choice of an appropriate interest rate for discounting

The major problem associated with discounting is that a choice must be made as to which interest rate is most appropriate to reflect the decision maker's time preference. This is important, since it might make the difference between whether or not an investment looks acceptable. A high rate of interest lends greater weight to costs and benefits realised towards the beginning of an investment project, than would a low one. A large proportion of public investment is probably of a type where costs are initially high, but with benefits delayed a long time into the future.

This is certainly the case with plant breeding investment. In fact, given the whole potato R & D investment cost assumption, it is approximately forty-three years from the starting date of the investment to when the first net benefit is recorded. Unfortunately, the problem is not straightforward. If a relatively low rate of interest is adopted for publicly funded investment, it is likely that, ultimately, the size of the public sector would grow relative to that of the private. Thus, the issue tends to be controversial: a large part of the theoretical literature associated with CBA application is about the choice of discount rates.

In a perfectly competitive economy a single rate of interest will, in equilibrium, indicate not only time preference but also measure the opportunity cost of investment funds (the returns foregone, obtainable from alternative investment). In the real world, however, many interest rates are observable.

For some years past, government departments appear to have generally applied a discount rate of 10% (Harrison and Mackie, 1973). It appears that this figure is held to be approximately equal to the minimum return on capital acceptable from private investment projects; after allowing for distortions caused by taxation, risk, et cetera (see H.M. Treasury, 1966).

This ignores the possibility that differences might exist between private and social, individual and collective, time preferences. These could exist for several reasons, but most notably because of market distortions (see Musgrave, 1969; Metzler, 1951), or more simply, because the needs of individuals and firms tend to be more immediate than those of society collectively (Pigou, op cit). These reasons suggest that the discount rates which would be appropriate for private investment might be too high for public investment appraisal.

The arguments surrounding discount rates have generally been avoided by analysts themselves. This is because it is possible to present CBA results for a range of discount rates, without unduly extending space given to calculations, and thereby leave the problem of choice to the decision-maker.[1]

This, it was decided, would be done for this present study, taking two rates, 5% and 10%. These are generally the two picked for previous studies of investment in agricultural R & D. The inception of investment and so year 0 for discounting, are assumed at 1922, for the whole potato R & D investment cost, and 1951 and 1952 for the development investment costs of Pentland Crown and Pentland Dell respectively.

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[1] Theoretically the consideration of appropriate discount rates can become very complicated, particularly with respect to the nature of opportunity cost resulting to the private sector from the different ways in which public investment may be financed. If public expenditure is increased at the expense of the private sector, both private investment and consumption might be displaced, with attendant multiplied effects for further investment and consumption. It may be that the benefit of the public investment itself, will have consequences for private spending.
Many practical difficulties arise in considering these possibilities; most of them associated with lack of knowledge. These involve knowing from where a specific investment's funds come from, the contribution from private consumption and investment, what kind of investment, and how market distortions and uncertainty could be important to interest rate determination. Feldstein has attempted to formalize some of these questions (see 1964 abc).
Prest and Turvey (op cit) have indicated that anlysts have not succeeded in quantifying the usually very difficult expressions involved. It seems necessary to assume that both costs and benefits of publicly funded investments consist exclusively of consumption, and that if private investment opportunities are influenced, the effects are only marginal, so that their present value is zero (for a discussion of the significance of marginality in association with these questions, see Millward, op cit: Section 9.5).

No discount greater than 10% was chosen because of the long time periods involved between the inception of R & D costs and realisation of net benefit. A high rate would seem to make net benefit insignificant to investment cost. As it is, the effect of discount rates of 5% and 10% are quite marked, see tables 5.2 and 5.3. It is seen that potato expenses are markedly reduced towards the end of the investment periods; drastically adjusted downwards in the instance of the 1922 to 1960 expenses, under both discount assumptions, table 5.2. The effect upon net benefits received after the mid-1960s will be even more drastic.

An alternative method to taking present value at the inception of R & D investment is the inverse of discounting, the method of applying an interest charge to R & D costs and compounding expenses forward to a date at the end of the investment period (and discounting net benefits thereafter from that point). The results would be the same, that is, within the error of rounding off net benefit estimates. Since the straightforward application of the discounting from investment inception approach seems to be the one most commonly applied in British CBA studies it was decided to use it here.

The use of 5% and 10% rates of discount in conjunction with the R & D investment cost periods in tables 5.2 and 5.3, produces six estimates of R & D total investment cost. For the whole potato investment cost, incurred between 1922 and 1960, estimates of around £300,000 and £200,000 are obtained at the 5% and 10% rates of discount respectively, table 5.2. The total cost of Pentland Crown's development period, 1951 to 1958, is estimated at £100,000 and £90,000, at the 5% and 10% rates respectively; whilst for Pentland Dell, 1953 to 1960, it is £80,000 and £70,000 respectively, table 5.3. These are the investment costs of R & D upon which a rate of return can be based.[1]

[1] These are presented here as the best indication of costs: to see how sensitive the overall CBA results are to estimates of investment cost, a range of investment cost is considered below, Section 9.5

5.6 R & D costs incurred outside the SPBS

Costs involved in R & D, testing and extension of information about Pentland Crown and Pentland Dell, incurred by agencies and organisations external to the SPBS were not included in the estimates of investment cost. Included in these might be the costs associated with virus research abroad, particularly that of Hutton in Australia (and before that, America), without which Pentland Crown's virus Y resistance would not have been obtained.

However, since this present study is concerned with Britain, no attempt has been made to consider the international contribution to the SPBS's work. Instead, it might reasonably be assumed that any costs to outside agencies (including those in Britain) are matched by the costs to the SPBS (and therefore, included in the whole potato R & D investment cost assumption) of its own contribution to outside.[1]

Since extra seed costs will be included as a consideration in the derivation of net benefit, to include effects upon the certified seed industry in investment cost would be to double count. However, the condition of the industry might easily have been affected by the new varieties for several reasons, and therefore, the effects of the new varieties upon it are given separate consideration elsewhere (Section 11.4).

Of costs incurred by the extension and advisory services there is little available information. Records of expenses relevant to the time when the new varieties were first being handled seem generally to be in the form of input accountancy, and would, therefore, be difficult to unravel. Given the limited financial resources available to this study, and the likelihood of little information in a usable form, the question of costs was not gone into in detail.

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[1] For instance, Kenya Akifa, was a variety selected in Kenya from material sent from the SPBS (it has been described as "stop-gap" until that country is able to produce better varieties, Macarthur, op cit: p.12).

Generally, spokesmen for the organisations concerned with extension and advisory work felt that no extra costs would have resulted from the SPBS innovation, that probably would not have been incurred anyway. If new varieties had not been introduced, budgets and costs would have remained largely unchanged. Thus, in this case, it seems reasonable to assume that outside costs were insignificant enough to be inside the error that has anyway to be associated with the derivation of R & D investment cost.

CHAPTER SIX

Potato production costs

6.1 Introduction

No varietal growing cost data for commercial conditions is available, on a consistent basis, which could enable a comparison to be made between on the one hand, Pentland Crown and Pentland Dell, and on the other, Majestic. Thus, there is no clear basis on which to base a comparison in a 'with' situation in terms of resource cost with a presumed 'without' one.

The National Farmers' Union (NFU) had carried out some survey work which involved potato varietal costings, with regard to growing for processing (NFU, 1972ab), and raw data was made available for this present study, so that differences in varietal costs might be identified and estimated. Unfortunately, this proved too fragmentary to give consistent results. Another possible source of varietal information was the PMB but material from there was not available to outsiders.

6.2 General sources of information regarding potato production costs

Hence, it was necessary to derive estimates of varietal cost by inference from published material concerned with potato costs generally. Published sources fall into two categories: case studies of costings, and idealised costings based upon case studies and surveys. Of the former, costings are unfortunately few, and local in character: they include, Anderson, 1966 and 1967; Bone and Haughs, 1968; Davison, 1967; MacPherson, 1962 and 1967; Mathias, 1965; and Rayner 1965. These costings were all conducted by agricultural education establishments.

The second category may be subdivided into two: farm management pocket books and recent PMB published information. The former base their cost information on existing published information supplemented by material from elsewhere: their purpose is to give useful indications in a form amenable to farm planning, and they do not pretend to give reliable average estimates for national conditions as a whole (in fact, farm management pocket books appear to be widely used by agricultural organisations for planning, or constructing their own cost surveys). Examples of this kind of publication are Nix/A: and Davidson/A, both of them annual publications from Wye College and Cambridge University respectively.

6.3 <u>PMB production cost publications, and their usefulness for this study</u>

The PMB publications were based upon the results (or partial results: there are indications that the PMB was not able to process survey data to its full extent) of a survey of the 1970 maincrop. The sample consisted of the 1680 farms, which were held to be representative of national conditions. Publications stemming from this work consisted of a potato costs handbook, and a list of average costings for the country as a whole.

The former was held to represent a 'model farm' situation, where twenty acres of potatoes was grown (see PMB, 1972c). The list was circulated to certain agricultural organisations (a copy was passed on to the author by the NFU), and was published later in an EDCA report (1972). A copy is contained in Appendix 10. It is these sources of information that are used for this study, because of their nationally representative character.

Unfortunately, the PMB costings relate to a single year only, and it is not possible to know for certain if they hold good for the years 1965 to 1972. Indeed, given that Majestic had taken a large proportion of the planted maincrop acreage, then its replacement by the new varieties might well be expected to have a significant effect upon total maincrop growing costs, so that 1970 costs might not be representative (after adjustment to 1971 £s) of say, 1965.

A comparison of PMB costs with those estimated in earlier case-studies (op cit) in real terms, is summarised in Appendix 10. The fragmentary nature of the latter work might make the comparison meaningless: however, there is some indication that costs in 1970 were in real terms generally higher. The total average cost per acre as reckoned by the PMB survey was £176.5 (1971 £s) in 1970. For 1961 it was put at £165 (MacPherson, 1962 op cit); 1963 and 1964 at £158 and £163 respectively (Raynor op cit); 1965 between a range of £125 to £156 (Anderson, 1965 op cit; Bone and Haughs, op cit; Davidson op cit, and Mathias op cit): 1966, a range between £148 and £168 (Anderson, 1967; Bone and Haughs op cit; MacPherson 1967 op cit). All are below the PMB estimate in real terms.

More uncertainty has to be attached to the PMB costs when total cost is compared to what might be taken as the average market return per acre for maincrop in 1970. Given an average market price observed for 1970-1971 (1971 £s) of £15.67 per ton (table 7.7), and an average maincrop yield of 11.28 tons per acre (PMB/A), the average market return might have been approximately £176.8 (providing that all of crop yield could have been sold). This compares to an average total cost of £176.5. This is the more surprising, when many growers themselves have apparently felt that returns have been too high (MAFF et al, 1973: para 12).

There are possibly four main reasons why the PMB estimate of average cost per acre seems high in relation to market revenue (and to average costs obtained elsewhere). The first is that many growers might grow potatoes not as a main cash crop but for rotational (and other husbandry) reasons: these might be high cost enterprises. However, there is no evidence to suggest this is so. Secondly, the PMB estimates might be designed to give the costs of husbandry practices which are typically carried on, rather than indicate what might be an average (and lower) cost. Thirdly, the PMB might have tended to be generous where cost assumptions were open to discretion, so that high cost assumptions rather than realistic ones were made. Fourthly, it might be that costs were in 1970 higher than they would have been in an average year.

A NFU costing for the 1970/71 season gave estimates different from the PMB ones. The total average costs per acre on crop grown for freezing and dehydration processing were estimated to be £146.3. Howevery, the sample of growers was small, twenty-one only (NFU, 1972a op cit). Also, the NFU believed that these growers were amongst the better growers who were more likely to use good quality inputs which were associated with higher costs. Thus, the fourth point must, like the first, remain uncertain.[1]

The possibilities that the PMB estimates are based upon typical husbandry practices and generous cost assumptions is best considered with direct reference to the cost categories themselves. In considering these, costs will be referred to, as above, on a 'cost per acre' basis. This is a method of exposition only, and does not imply that costs can be related to changes in acreage.[2] The relevant cost categories are

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[1] In 1973 the PMB published estimates of the costs of potato growing for that year (PMB, 1973d). In pound adjusted terms (1971 £s) these indicate a fall overall of £17 per acre. This does not mean that the 1970 costs were unusually high, however, since the PMB appears to have used the 1970 estimates as a basis for calculating the 1973 ones, which implies that largely the two sets of figures are not independently comparable.

[2] There are alternative ways to express costs which might be more appropriat for some husbandry practices, and these are used when appropriate: for example, grading costs can be expressed in terms of weight of produce handled (a 'per ton' basis). This study, however, generally follows afte the usual practice in farm costings of presenting costs on a per acre basi Growers are likely to see the importance of cost categories as variable. Particularly in terms of operational flexibility: that is, if they can be varied with acreage decisions, and afterwards, during the growing and marketing of the crop itself. It is likely that overall, growers evaluated costs in terms of farm resources as a whole.

shown in Table 6.1, and their relative importance in terms of size, is expressed there as a percentage of the average cost per acre estimated in the 1970 PMB survey. The results of this survey are given in Appendix 10.

TABLE 6.1

Maincrop Potato Production Costs PMB, 1970 Survey
(Expressed as a percentage of total costs per acre)

Category of Potato Costs			% of average total growing costs per acre 1970
1.	Seed		20%
2.	Fertilisers		12%
3.	Herbicides		2%
4.	Pesticides		1%
5.	Fungicides		2%
6.	Haulm defoliants		1%
7.	Labour:	planting, cultivations, spraying	4%
8.		harvesting	8%
9.		grading	4%
10.	Machinery:	tractor	5%
11.		specialised machinery	10%
12.		general macninery	4%
13.	Chitting		2%
14.	Irrigation		2%
15.	PMB		2%
16.	Rent/rates		6%
17.	Interest		3%
18.	Share of general farm expenses		6%
19.	Storage		5%
Total			99%

Note: Figures do not add up to 100% due to a rounding of figures.

Source: PMB survey results, Appendix 6.

6.4 Potato seed costs

the 1970 maincrop cost survey estimated that seed costs were 20%

of the average total costs per acre, see table 6.1. The average being reckoned at £32.3 per acre, with a range of £21 to £53 per acre. These estimates were based upon seed prices stated by growers, with an allowance for a use of own-grown seed and a degree of wastage (see Appendix 10).

The price of seed refers to that of 'certified' seed. Since the main potato growing areas are situated in a part of Britain where aphids are very active in spreading virus diseases which are degenerative in their effects upon seed stocks and crop yields, seed has frequently to be replaced by imports (certified to standards of freedom from virus, and other diseases) from other regions. The need to buy certified seed varies according to locality, variety and husbandry practice. For instance, some varieties are less susceptible to virus attack than others, and, therefore, growers might be able to retain a larger part of their output for use as 'own-grown' seed.

Of course, own-grown seed is generally cheaper to use, although it does entail some cost. It has to be prepared, stored and inspected: but most important, there is an opportunity cost to the grower of not marketing it for human consumption. On this basis, in its assumptions to derive a seed cost for its 1970 survey, the PMB assumed a cost for own-grown seed of £16 per ton (that is, £17.3, 1971 £s). The average market price in 1970/71 was £14.5 (£15.7) (table 7.7)

The PMB estimate seems to be exaggerated, since it seems likely that not all of the tubers held back for seed could have been marketed for human consumption. This is because the seed size is largely outside that required for human consumption (NFU, written communication). For out-grades the market opportunity cost might be very low indeed and the other costs associated with own grown seed, not great enough to bring the total cost up to the PMB estimate.

The overall impact of the cost of own-grown upon total seed costs depends upon the proportion of total acreage planted with this kind of seed. In the PMB handbook this was placed at 40%, and it seems likely that this figure was used for the 1970 survey results.

Both the alternative market costs of using own-grown seed and the prices of certified seed might vary markedly between years. If ware potato prices are high, fewer potatoes tend to be kept back for own-grown seed, and consequently the demand for, and hence prices of certified seed increase. This is a factor that has been observed by both the National Association of Seed Potato Merchants (NASPM/A) and Hay (in a report about the Scottish certified potato seed industry, op cit).

Another major factor which determines the price of certified seed is varietal choice. A variety much in demand and, or short in supply, will generally fetch a high price. In the instance of a new variety this can be very high. Another important factor, is the standard of health to which seed is certified: generally, however, ware growers have bought seed at the 'A' standard - (about 70% of the total certified seed acreage in Scotland was so planted during the period relevant to this study: DAFS, private communication).

Another factor, solely dependent upon variety, is seeding rate. This is defined as the weight of seed planted per acre, and varies according to varietal choice.

6.5 Fertiliser costs

The 1970 maincrop survey indicated that fertilisers made up 12% of the average costs per acre of producing potatoes, table 6.1. The average was £20.4 per acre, with a range of £12 to £29: the PMB assumed that the typical application would represent 10-14 cwt per acre of a high nitrogen fertiliser.

In addition to application of artificial fertilisers potatoes often receive large treatments of farm yard manure.[1] Allowances for this were not made in the costings. The most important factor in determining fertiliser applications is probably the size of planted acreage. Communications with officials of the ADAS for the purposes of this present study, indicated that no obvious varietal effects exist.

6.6 Chemical spraying costs

Chemical spraying cost categories include those of herbicides, pesticides, fungicides and haulm defoliant, which together accounted for about 6% of the average cost per acre in 1970, table 6.1. The average costs per acre, with the respective ranges, were £2.5 (£0.7-3.7), £2.0 (£1.5-2.8), £2.7 (£0.7-4.8), and £2.1 (£2.1-3.8), respectively.

For herbicide the typical application was assumed to represent a standard does of Gramoxone: the PMB observed that the estimate shown could be applied to 45% to 50% of producers, since only this number used a herbicide. The pesticide calculation was based upon the presumed use of a standard does of Metasystox: the PMB observed that only 60% of growers used a pesticide. The fungicide cost was based upon an assumption that three applications of Maneb were used, the haulm defoliant cost was based upon a standard dose of DHBP.

It might be expected that spraying costs would depend upon weather conditions, since disease is to a large extent dependent upon climate. However, it seems from fragmentary evidence in previous costings that growers generally apply applications as a precautionary measure, and spray on a consistent basis. Varietal choice is likely to be important, however, since there are observable differences in husbandry practice in crops of different varieties (PMB, 1968a).

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[1] It has been observed in a MAFF publication that feeding has been extended to a point where on many farms, crop yields have probably been adversely affected (Carter, 1972: p.99).

6.7 Labour costs

The PMB categorised labour into three kinds for the purposes of presenting its 1970 costings; those incurred prior to harvest (cultivations, planting, fertilising and spraying); those of harvesting, and grading. An allowance for labour was added to the overheads estimate and included in storage costs. Excluding the latter, the three types of labour made up 4%, 8% and 4% of the average cost per acre, table 6.1: which were £7.2 (£2.5-12.6), 13 (£9.6-20.3) and 7.4 (£4.5-17.5) per acre respectively.

Those incurred prior to harvested were assessed by the PMB upon the basis of 18 man-hours per acre, at the hourly cost for regular labour of £0.40. Harvest costs were assessed on the basis of 7 workers: three of them regular and employed on a tractor, and four casual, employed at £0.30 per hour on picking; using a one-row harvester, and lifting 1½ acres per day (this is 38 man-hours per acre). Grading costs were estimated for a situation of two regular and four casual workers, riddling an 11 ton crop at 3 tons per hour (22 man-hours per acre).

Potatoes are a relatively high labour demanding crop, but it is unlikely that regular labour would be employed for potato crop needs alone. Therefore, in this sense the cost of regular labour in terms of the requirements of the whole term enterprise is fixed (although the potato crop might provide opportunities for overtime, that might be missing with other crops). This is not so with casual labour which might be solely employed on potatoes.

Potatoes are most in need of labour at harvest (and sometimes grading), at a time which is a busy one for the farm generally. It is then that casual labour is likely to be employed. No reliable estimates appear to exist to indicate what the usage of casual labour is: the

NFU suggested to the author that perhaps a quarter of the maincrop acreage might be concerned with this kind of labour. The availability of casual labour is limited in some parts of potato producing regions: one observer has suggested this factor to be the most critical one in these areas, for the determination of whether potatoes are grown at all (Carter op cit).

The availability of casual labour might not be important to grading, if indoor storage facilities are available to permit sorting after dark, or at times when the weather is unfavourable for other farm activities. In fact, the opportunity cost of regular labour for use associated with grading might then be very low indeed since alternative opportunities for farm work are then fewer (see Ingersent, 1967; for an examination of grading costs).

6.8 Machinery costs

The 1970 PMB survey categorised machinery costs into three: those associated with tractor use, specialised machinery (to the potato crop) and general machinery. The specialized category was the largest of machinery costs at 10% of average costs per acre, followed by tractor and general machinery, at 5% and 4% respectively, see table 6.1: that is, £15.7 (£8.0-20.1), £8.4 (£4.5-11.7) and £6.7 (£4.0-11.2) per acre respectively.

The PMB based the tractor estimate upon allowances for fuel, depreciation and repairs; for 25.2 tractor hours, given a machine size between 45 and 65 hp, and charged at £0.30 per hour. The specialised machinery estimate was based upon the assumed use of a two-row automatic planter and a one-row harvester (plus an allowance for ridging and grading equipment). No explanation accompanied the 1970 survey results for the general machinery category: it is possible to gain something of an insight, however, if the PMB handbook is referred to, as is true for all these cost estimates (PMB, 1972c op cit).

Investment in general machinery and tractor expenditure must, of course, be determined by the farm economy generally. Investment in specialised machinery, however, is directly associated with potato growing, but is likely to be fixed over several seasons, and determined by the grower's expectation of average throughput of output over that time. Subject to capacity limits, growers will probably attempt to maximise crop output to reap economies of scale.

In the shorter term, machinery costs might vary for a number of reasons independent of investment cost (and so depreciation), which are associated with fuel and repairs. These are likely to be also important for labour time. The most important is associated with harvest, and the conditions prevailing at that time. In recent years weather has tended to make the period for harvesting short, about twenty days during 1969-1971, before the wet conditions usually experienced in November make lifting slow and damage levels very high (Crisford, 1972). It might therefore, be necessary to speed up harvesting, and use more fuel and risk more breakdowns (and pay overtime rates).

Other factors of importance might be distance that machinery must cover (from central buildings, as well as on the field), crop yield (weight as well as its soil depth and maturity), and management-harvester to store system (organisation, in addition to resources being used). The consequence of any individual one of these is difficult to predict. For example, the Sutton Bridge Experimental Station (SBES) has noted that trials using similar harvester to store systems show no significant differences in terms of cost when different sized outputs were handled (SBES, 1971b). It could be that local conditions, such as field soils, are very important.

The importance of varietal choice to costs associated with labour and machinery is generally uncertain since it is likely that varietal differences are marginal, when compared to all the other factors that might be involved. Where it is important, it is likely to be so in combination with a number of factors: for instance, if conditions favour a heavy yield and weather conditions are not suitable for harvesting, then a heavy yielding variety is, ceteris paribus, going to prolong the harvesting operation, and hence, costs.

6.9 Chitting, irrigation and storage costs

The 1970 PMB survey results indicate that chitting,* irrigation and storage costs accounted for around 2%, 2% and 5% of the total cost per acre respectively (that is £4, £3.5 and £8.5 per acre, with ranges of £3 to £7, £3 to £12.5 and £4.2 to £17.6 respectively), see table 6.1. For chitting the PMB estimates assumed that a majority of seed was chitted in a permanent building with lighting control. Nothing was stated about irrigation systems, although it was noted that only about 10% of the maincrop was regularly irrigated. Nothing was stated about storage systems.

All these cost categories involve practices which have been subject to recent development: both chitting and irrigation have become more important, and the use of indoor storage has increased in recent times (see MAFF, 1972b: for a general review of developments in husbandry). However, whilst some varieties might benefit from chitting, irrigation and improvements in storage, varietal effect upon costs is likely to be marginal, once systems have been installed on a farm.

6.10 Rent and PMB levy costs

The rent and PMB costs account for 6% and 2% of total costs per acre respectively, in the results from the 1970 PMB survey (that is, £9.5 and £3 per acre, with a range £5.5 to £17 for rent only), see table 6.1.

Explanations did not accompany the PMB survey results for these factors, but the former seems to be based upon what growers might expect to pay in terms of rent (plus an allowance for rates) for potato land, whether owned or not.

The estimate for rent appears to reflect the possibility that potatoes were planted on land of above average fertility: but an average of rents in the leading potato producing areas indicates a rent lower than that estimated for the 1970 PMB survey. The PMB handbook gives average rents for the leading potato areas in England: the average for these is £7.4 per acre, which is less than the survey estimate of £8.5 (in real terms, these are £8 and £10.3 respectively). The PMB cost refers to the levy, which after 1970 was increased to £4 and £4.20 per acre in 1971 and 1972 respectively.

6.11 <u>Other cost categories</u>

The remainder of costs are those which are associated with the general running of the farm enterprise, apportioned perhaps upon the basis of acreage share taken by potatoes; it is not clear how these were derived for the 1970 PMB estimates. Together these costs are reckoned at about 9% of total cost per acre (that is, £14.5 per acre), table 6.1. They include allowances for overhead labour, maintenance, management and office expenses; plus a category to allow for the opportunity cost of interest foregone on short term capital employed.

The PMB suggests in its handbook that this latter category is equivalent to the interest foregone on 'capital' that would have been available immediately, if a grower had not planted potatoes. This might be made up of expenditure upon materials, casual labour, running and repair costs associated with machinery and the PMB levy (in the handbook, all totalled to £74.34 per acre: which if invested at 5½% a year would yield £4.08: in real terms £80 and £4 respectively).

6.12 <u>The identification of the effects of Pentland Crown and Pentland Dell with regard to production costs, compared to a situation with only Majestic</u>

From the assumptions behind the 1970 PMB cost estimates it is seen that taken together, the average cost per acre given, is unlikely to be a true average; since the PMB might have been both generous, and concerned to give a typical (or model) cost, rather than average one. The generosity is observable particularly in the estimates of the cost of own-grown seed and rent category.

The cost assumptions used are not necessarily relevant to an average situation. It was noted by the PMB that only a part of the maincrop was subject to spraying and irrigation: one might also add that this is a qualification for a majority of the practices assumed to hold, and form a basis for estimating costs. For example, a one-row harvester was used on only a quarter of the maincrop (Crisford, op cit), and it was observed in 1968, that 37% of the maincrop was subject to chitted seed (PMB, 1968a op cit), so that the assumption that in 1970 a majority of growers used proper facilities for chitting seems unrealistic.

To reflect a realistic and average situation the PMB should have considered growers and acreages as a whole, since this might have made a difference to the category totals, and perhaps resulted in a lower average cost per acre, more in line with previous work in potato costings. The problem for this present study is whether these estimates can be used to derive estimates of changes in costs brought about by the displacement of Majestic, by Pentland Crown and Pentland Dell.

Generally, the individual cost categories can be used: for where it is felt that estimates err, they can be adjusted by the use of supplementary information. The advantage of the 1970 estimates is that they generally provide an assessment of costs which applies to the whole country and during a time which is relevant to the present study. However, it must be decided how general data can be used to assess the specific impact on costs of varieties.

It is necessary to identify varietal attributes, and assess whether these have any practical importance which can be measured for their effects upon production costs. Important varietal attributes can be identified by reference to authoritative literature and surveying grower opinion itself.

CHAPTER SEVEN

The identification of varietal attributes and the importance of the displacement of Majestic by Pentland Crown and Pentland Dell with regard to husbandry and costs

7.1 Authoritative recognition of differences in varietal attributes

It was stated in Section 4.8 that the main authoritative source for information about the suitability of potato varieties was the NIAB leaflet of recommended varieties. This, of course, recommends both Pentland Crown and Pentland Dell for commercial use, as well as Majestic. This latter variety is described as a good yielder, with moderate resistance to tuber blight, and good keeping quality. Its weaknesses are judged as a high susceptibility to common scab and propensity for tubers to crack.*

Pentland Crown is noted as a very high yielder, with tubers resistant to common scab, unlikely to crack, but with tubers on the large side. The variety is also noted as resistant to virus Y, and moderately resistant to leaf roll. Weaknesses of stolon retention* and late maturity are noted.

Pentland Dell is noted as an early maturing variety, with a propensity to give high yields of attractively shaped tubers, which make up very uniform samples involving little waste. Growers are advised to use well sprouted bold seed to ensure good establishment. Weaknesses of the variety's high susceptibility to spraying and tuber blight are noted. Full descriptions of some of the varieties recommended by the NIAB are included in Appendix 11.

The NIAB also lists in the advisory leaflet the relative performance of recommended varieties with regard to factors largely determined by variety, and of economic importance. The list is reproduced in table 7.1. Performances are indicated on a scale of 0-9, and high figures indicate that a variety shows a given character to a high degree.

Thus, Majestic scores 8 for storage (measured here by the length of dormancy: the longer it takes, the less will moisture loss result from sprouting), but only 4 for common scab.[1] Pentland Crown scores 9 for common scab, but only an average 6 for storage. These figures can only be taken as rough indications of how a variety might behave under commercial conditions. Local conditions and weather effects are important: of most importance is how a combination of variety, physical conditions, and production method works for any season.

The worth of the NIAB assessments is that they represent an authoritative view of the relative advantages and disadvantages of varieties. However, it is evident that they are only pointers to how a variety might behave, they say nothing specifically of how a variety might actually perform under commercial conditions, but are concerned rather, to recommend varieties generally.[2]

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[1] Staff at the NIAB commented that Majestic had been the best variety they had assessed for storage (private conversations with NIAB).

[2] This appears to have been implicitly recognised in the reasons for beginning trials and surveys in 1969, for the PMB publication 'Commercial Assessment of Recently Introduced Potato Varieties': "The performance of new varieties in replicated trials under a wide range of growing conditions over several seasons is also examined by the NIAB with a view to including the best varieties on the NIAB's Recommended List. However, detailed information on the bulk storage properties of a new variety, its susceptibility to mechanical damage and its marketability does not normally become available until a variety is grown, harvested, stored and marketed on a commercial scale." (PMB, 1975: p.1).
These assessments were begun too late to consider Pentland Crown and Pentland Dell (and in fact, were instituted after grower discoveries of faults in Pentland Dell: see Section 4.8).

TABLE 7.1

NIAB Recommended Maincrop Varieties: Assessments

Variety:	1	2	3	4	5	6	7	8*
Yield	6	5	6	7	8	8	6	8
Tubers:								
Size	8	6	8	7	8	8	7	8
Uniformity	6	6	6	8	6	9	6	7
Freedom from defects	5	7	4	6	6	8	5	6
Number per plant (Rating)	6	7	5	7	4	5	6	4
Storage	6	6	8	6	6	6	6	6
Quality:								
Freedom from discolouration	9	8	5	9	5	6	5	5
Flouriness	8	6	8	8	7	6	7	8
Dry matter	3	5	4	6	3	6	8	7
Disease Resistance:								
Tuber rots	5	7	6	6	7	6	5	6
Blight in foliage	6	3	4	4	4	4	5	4
Blight in tubers	5	2	6	4	6	1	5	7
Common scab	4	7	4	3	9	6	7	7
Leaf roll	5	6	5	6	7	6	4	6
Severe mosaic	7	4	6	6	8	5	4	8
Spraing	3	6	4	6	3	1	7	1

Key to Variety Code - (1) Desiree; (2) King Edward; (3) Majestic; (4) Maris Piper; (5) Pentland Crown; (5) Pentland Crown; (6) Pentland Dell; (7) Record; (8) Pentland Ivory

* Provisionally recommended

High figures indicate that the variety shows the character to a high degree

Source: NIAB op cit.

7.2 The need for a survey of growers' attitudes to the substitution of Pentland Crown and Pentland Dell for Majestic

No published work was available in 1971 to indicate directly how Pentland Crown and Pentland Dell had performed under commercial conditions in comparison to Majestic. Also, there appeared to have been no attempt made to systematically identify factors that growers themselves might find important in relation to varietal choice. Hence to identify those varietal attributes important to the substitution of Pentland Crown and Pentland Dell for Majestic, it was decided to survey growers who had grown one or both of the new varieties, and Majestic.

7.3 Survey objectives

The objectives were twofold. To identify the importance of factors associated with varietal choice to growers, and secondly, to link these factors with grower assessments of how the new varieties had performed in contrast to Majestic. This will shed more light on what varietal attributes are commercially important, and perhaps pinpoint the main categories of costs affected. The concern is not to investigate reasons why growers opt for first trial of new varieties, but rather to discover the importance of varietal attributes in relation to Pentland Crown and Pentland Dell, in practice.

7.4 Methodology

The basis for survey methodology was determined more by opportunity than planning: because of limited finances it was impossible to investigate a representative sample of growers, however, the NFU offered assistance at an opportune time. The NFU provided distributive facilities and helped design the questionnaire. A copy is included in Appendix 12.

Questionnaires were sent to 200 growers located in the eastern potato growing counties of England (most of the British potato acreage is concentrated there). The survey was carried out during March, 1971. This is important for it was a time when growers were in the best position to judge between the three varieties, since many growers were still planting acreage of all three, or had recently grown them, so that the memory of their experience was still fresh.

The questionnaire listed factors which were considered relevant and important to varietal choice, with space to allow growers to write-in others, should they feel them to be important. Factors were chosen with the help of the NFU, and in the light of the potato growing industry's problems discussed in the previous chapter. Respondents were required to state in order of preference which factors they considered important, and then to place ticks or crosses against the factors, according to whether or not the new varieties rated a positive or negative performance over Majestic. Of course, some of the factors will not be independent of each other: for example, growers might rate disease resistance important because of its contribution to maximising yields. This cannot easily be allowed for, the factors were chosen in the form shown, primarily so that growers would understand them.

The nature of the sample was determined by the NFU mailing list. It was not known what the contacted growers were growing or acreage sizes involved. The only common link between the growers was that all of them had at some time grown a part of their crops for processing. Since a certain type of grower might produce for this market, there is a possible bias here, but beyond that it is impossible to go: this is because very little is known about what kind of grower produces for processing. Probably of more importance is the geographical confinement to eastern England. This includes the best potato land in Britain, and might not be representative of the national situation.[1]

7.5 Results

(a) Acreages of varieties grown by respondents

A total of 68 growers replied and filled in the forms correctly, that is, 34% of those contacted. Many growers felt that they had not grown Pentland Crown or Pentland Dell long enough to judge fairly. Of the rest, respondents had planted in 1970, and were planning to plant for 1971, the following:

	Pentland Crown	Pentland Dell	Majestic	Other Varieties
1970	1600	512	294	2278
1971	1370	935	251	2108

An indication of how this corresponds to national figures can be more easily seen in the ratios of the new varieties' acreages to those of Majestic. The sample returns a ratio of Pentland Crown to Majestic acreage of 5.4:1 and 5.5:1 for 1970 and 1971 respectively, against a national ratio of 1.1:1 and 1.6:1 respectively. The sample ratio of Pentland Dell acreage to that of Majestic is 1.7:1 and 3.1:1 for 1970 and 1971 respectively, against a national ratio of 0.5:1 and 0.7:1 respectively. Thus, the impression is that Majestic is less popular with respondents than it might be with growers generally. However, it is important to note that growers should have disqualified themselves from answering the questionnaire if they had not grown the new varieties, or not grown them long enough to be able to judge fairly, and it is likely that many of such growers would still be growing Majestic.

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[1] A study of regional acreage statistics suggests that there were quite marked variations in the adoption patterns for Pentland Crown and Pentland Dell. Both the timing and shape of adoption curves differ. As a check to the survey results, the opinions of local and regional officials of the ADAS and PMB were solicited by mail. Generally, the survey results were supported by regional comment and observation. The methodology of this mail survey, along with diagrammatic illustrations of adoption curves, are found in Appendix 13. In the same place are notes based on the comments of the regional officials contacted. These cast an informative light upon varietal choice, not just in association with the new varieties popularity compared to Majestic, but in regard to other widely grown varieties.

(b) Factor preference

The pattern of grower preference for varietal factors is shown in table 7.2. Three groups of factors may be distinguishable from the table: those listed 1 to 6, 7 to 10 and 11 to 15. The superiority of the yield factor is manifest. All but one or two of the respondents mentioned this factor and most placed at the top, or near to the top of their preferences.

TABLE 7.2 Ranking of factors important in ware potato growing

Factors		Points* (a)	Times mentioned (b)	as % of growers (c)
1.	Higher yields of ware quality	993	61	(98)
2.	Rapid tuber bulking and early maturity	848	41	(66)
3.	Uniformity of tuber size and shape	795	51	(82)
4.	Stores well	716	50	(81)
5.	Less frequent replacement of seed	684	41	(66)
6.	Increased reliability	604	43	(69)
7.	Tolerant of a wide range of soils	484	37	(60)
8.	Lower damage levels	483	40	(65)
9.	Tolerant of a wide range of weather	467	34	(65)
10.	Better disease resistance	438	38	(61)
11.	Lower seed rate required	324	33	(53)
12.	Lower fertilizer application	282	29	(47)
13.	Lower fungicide application	267	30	(48)
14.	Lower herbicide application	231	30	(48)
15.	Lower pesticide application	214	30	(48)

Note: *Points are based on order of ranking, so that 1 = 20 points, 2 = 19 points and so on.

'Rapid tuber bulking and early maturity' is a factor important to timing and flexibility of harvesting. The faster yield bulks up, and the earlier is tuber maturity, then the more time a grower has to harvest and choose his marketing time.

The high placing given to this factor, and to storage, see table, raises a possibility that should be borne in mind in relation to Pentland Crown. The 1970/71 season was the bad one for this variety, and at the time of the survey many growers seemed to be aware of this. This might have meant that growers gave to storage and early maturity an importance which in other seasons might not apply so strongly.

Generally, factors with a direct bearing upon production costs were given a low order of preference, most of them coming in group 11 to 15. Many respondents did not rate them at all. However, the factor associated with own-grown seed was placed high at 5, table 7.2.

Respondents' assessments of the performances of Pentland Crown and Pentland Dell in relation to Majestic, and for the factors listed, are summarised in table 7.3.

(c) <u>Higher yields of ware quality</u>

The new varieties rated very highly for the yield factor. All the respondents who answered for Pentland Dell noted the variety's superiority, and for Pentland Crown, only one respondent marked negatively, see table 7.3. Considering how soil conditions might vary between farms, this shows a very consistent performance. This result seems to confirm the NIAB's observation that the new varieties are high yielders. Ware quality might be better than Majestic's, since as the NIAB noted, cracking is less, and samples of Pentland Dell especially, involve little grading waste.

(d) <u>Rapid tuber bulking, early maturity</u>

For this factor, the new varieties generally did well, which is surprising in the instance of Pentland Crown, given that the NIAB notes it for late maturity. It might be that respondents confused rapid bulking with high crop yield potential, and did not connect tuber

TABLE 7.3

Performances of Crown and Dell compared to Majestic

Factors	Crown ticks (a)	Dell ticks (b)	Crown crosses (c)	Dell crosses (d)
Higher yields of ware quality	59 (95)	48 (100)	1 (2)	0 (0)
Rapid tuber bulking, early maturity	36 (58)	22 (46)	3 (5)	6 (12)
Uniformity of tuber size and shape	58 (94)	43 (90)	0 (0)	0 (0)
Stores well	12 (19)	20 (42)	34 (55)	18 (37)
less frequent replacement of seed	32 (52)	9 (19)	3 (5)	4 (8)
Increased reliability	28 (45)	18 (37)	7 (11)	6 (12)
Tolerant of wide range of soils	43 (69)	17 (35)	2 (11)	10 (21)
Lower damage levels	14 (23)	18 (37)	27 (44)	11 (23)
Tolerant of wide range of weather	20 (32)	10 (21)	3 (5)	10 (21)
Better disease resistance	25 (40)	6 (12)	13 (21)	20 (42)
Lower seed rate required	13 (21)	12 (25)	8 (13)	2 (4)
Lower fertilizer application	1 (2)	1 (2)	3 (5)	3 (6)
Lower fungicide application	2 (3)	1 (2)	10 (16)	16 (33)
Lower herbicide application	10 (16)	8 (17)	8 (6)	1 (2)
Lower pesticide application	1 (2)	1 (2)	1 (2)	1 (2)
Written-in factors				
Common scab protection	19 (31)	16 (33)	0 (0)	0 (0)
Cracking	10 (31)	10 (21)	0 (0)	0 (0)
Market demands	4 (6)	1 (2)	0 (0)	0 (0)
Saleable yield	0 (0)	1 (2)	0 (0)	0 (0)
Spraing	0 (0)	0 (0)	0 (0)	1 (2)
Planting	0 (0)	0 (0)	0 (0)	1 (2)

Notes: (1) Bracketed figures denote assessments as percentage of total of respondents growing variety

(2) 62 growers assessed Pentland Crown, 48 growers assessed Pentland Dell

damage and storage troubles with late maturity. Also, stolon retention, a trouble associated with Pentland Crown's late maturity by the NIAB (written communication) was not noted by any respondents.

(e) Uniformity of tuber size and shape

Both the new varieties did very well indeed, compared to Majestic, for this factor, table 7.3. No respondent noted a negative performance. Some wrote in how pleased they were with Pentland Dell. This factor is particularly important for pre-pack samples if wastage is to be avoided. Pentland Dell's tubers are described by the NIAB as attractively shaped.

(f) Storage and damage factors and Pentland Crown

More than half of the respondents assessed Pentland Crown negatively. This might have been expected given that it was being compared to an excellent storage variety, Majestic. However, Pentland Crown seems worse in the comparison than does Pentland Dell. It might be that Pentland Crown's poor performance for 'lower damage levels' (and perhaps, its mixed result for 'better disease resistance'), has worked to make it particularly bad for storage. The NIAB notes that Pentland Crown is sometimes subject to stolon retention and late maturity, both of these might be contributory factors to increased incidence of damage in the lifted crop, (see below, Section 7.8).

(g) Disease resistance and fungicide applications and Pentland Dell

Pentland Dell's blight susceptibility appears to have made itself felt for both disease resistance and fungicide applications. The variety's poor performance for the former factor might also be explained by its susceptibility to spraing. Both blight and spraing are specifically warned against with regard to Pentland Dell by the NIAB.

(h) Other factors

Pentland Crown exhibited a generally favourable assessment with regard to seed replacement, reliability and soil tolerance (factors 5-7, table 7.3). The former perhaps reflects the variety's resistance to virus Y and leaf roll, noted as important by the NIAB. Reliability and soil tolerance might refer generally to all the advantages noted above for Pentland Crown, being maintained over a range of conditions. Consistency is, of course, necessary for general acceptance. The variety's lower susceptibility, than that of Majestic, to common scab and cracking is likely to be important for soils and conditions which favour dry soils, since a lack of water at certain times might encourage both troubles.

For Pentland Dell, assessments under the remaining factor categories are subject to low response rates, and are generally mixed. Some respondents noted that Pentland Dell rated well in comparison with Majestic for common scab. Pentland Dell has no known resistance, but perhaps the susceptibility of Majestic is greater. It might be that respondents are not clear in their minds about what constitutes scab symptoms, and that tuber skin marks generally are linked with common scab.

7.6 The significance of varietal attributes, as identified, for varietal effects upon production costs

The key factors noted by the NIAB, as associated with the new varieties and Majestic, Section 7.1, and confirmed as important by the survey, can be summarised as keeping quality of yields, and virus resistance. Whilst the new varieties do not compare well with Majestic on the first count, they do well with respect to yield and quality, and Pentland Crown with virus resistance, and what this implies for seed replacement. The importance of stolon retention and late maturity in the case of Pentland Crown is not obvious from the survey results, except perhaps, the low rating given to the variety for damage levels (and storage). Similarly, the NIAB observations about Pentland Dell's blight and spraing susceptibility might be confirmed in the low rating given for disease resistance.

Generally the survey underlines the importance to growers of output (the size and suitability of crops for marketing) factors, and it is likely that the new varieties were used instead of Majestic for output reasons rather than ones directly to do with costs. This suggests that it is possible growing costs per acre might not have been reduced by the displacement of Majestic, and indeed, costs might have risen if the rise was obviously less than what growers could expect from extra income associated with the marketing of higher outputs per acre.

One obvious cost saving factor is the need to replace less seed associated with the use of Pentland Crown. However, the indirect consequences for costs, associated with handling a higher yield, higher damage levels and storage, might be significant enough to off-set savings. Other categories which are obviously more directly related to costs, those of seed rates and chemical applications were given low ratings of importance.[1]

However, whilst these might not be important to individual growers, any difference in applications between crops of different varieties across the country as a whole, might add up and, therefore, require consideration in this present study. Thus, to know more about general effects, it is necessary to inquire further as to the consequences of Pentland Crown and Pentland Dell, from what might be expected, given the information so far presented and with reference to additional

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[1] Staff at the NIAB felt that providing new varieties were not unreliable, disease resistance was a bonus point to the main one of increased output (private conversations, NIAB).

material. Using the general cost information in Chapter 6, varietal attributes will be linked more closely with husbandry practices and costs.

This is conveniently done, for exposition purposes, by considering varietal effects under five headings. These are two associated with output related costs, weight and quality of yield: one each with seed costs, observed differences in husbandry practices on crops of different varieties, and considerations not otherwise examined. The aim will be to identify the consequences of the new varieties for costs, and decide whether or not, effects can be measured.

7.7 <u>Output related costs - weight of yield</u>

The NIAB and the survey suggest that Pentland Crown and Pentland Dell possess a large yield advantage over Majestic. This is confirmed in PMB yields statistics for different varieties; and represented here in diagrammatical form, figures 7.1 and 7.2, for England and Wales, and Scotland respectively.[1]

The yield advantage implies that an extra weight may have given rise to additional costs per acre for harvesting, handling into store, and grading. However, as indicated in Section 6.8, this is uncertain

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[1] The new varieties yield advantage over other varieties has grown less over time. This might be because early users of Pentland Crown and Pentland Dell were those who could best afford the initially high cost of seed of (the under-supplied) the new varieties. These growers are probably relatively successful, and therefore, the ones most likely to be using high quality inputs and, therefore, obtaining high yields. As adoption became more widespread, it is likely that these growers came to form a smaller proportion of total Pentland Crown and Pentland Dell growers (this process has been claimed for cereal varieties, see Brittan, 1969). Other factors might also have been involved. For example, the general health of seed stocks could have become worse as growers increasingly retained a proportion of their outputs for own-grown seed, whilst using less certified. Also, Pentland Dell's yield potential might have been affected by the collapse of its blight immunity, since the threat of the fungus often necessitates premature destruction of haulm.

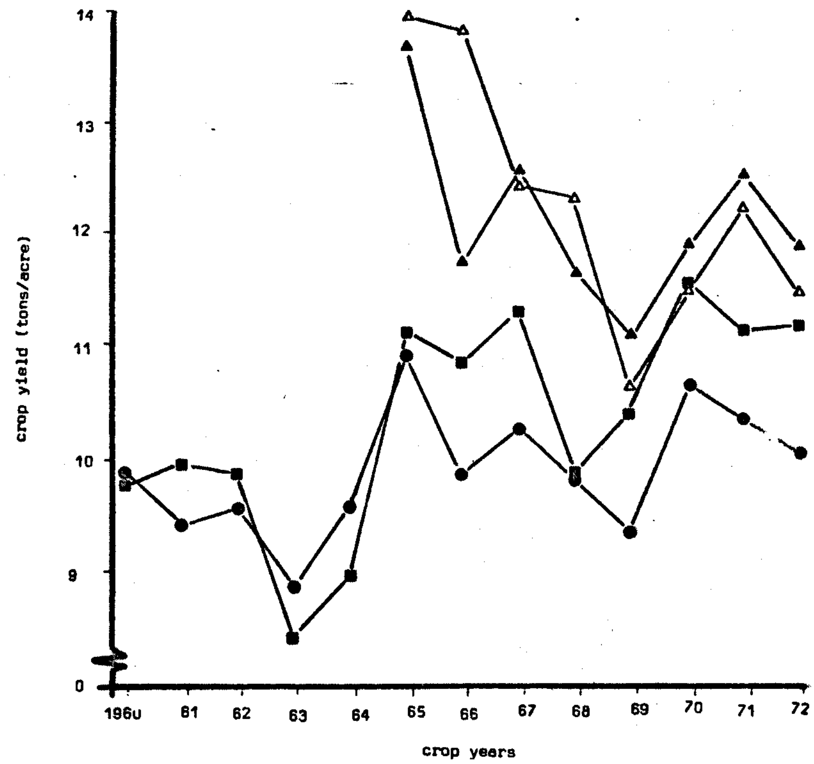

Figure 7.1 Selected maincrop varietal yields, England and Wales, 1960 to 1972

Annotation: Pentland Crown ▲ , Pentland Dell △ , King Edward VII ■ , Majestic ● .

Sources: Table 8.1 and Appendix 7

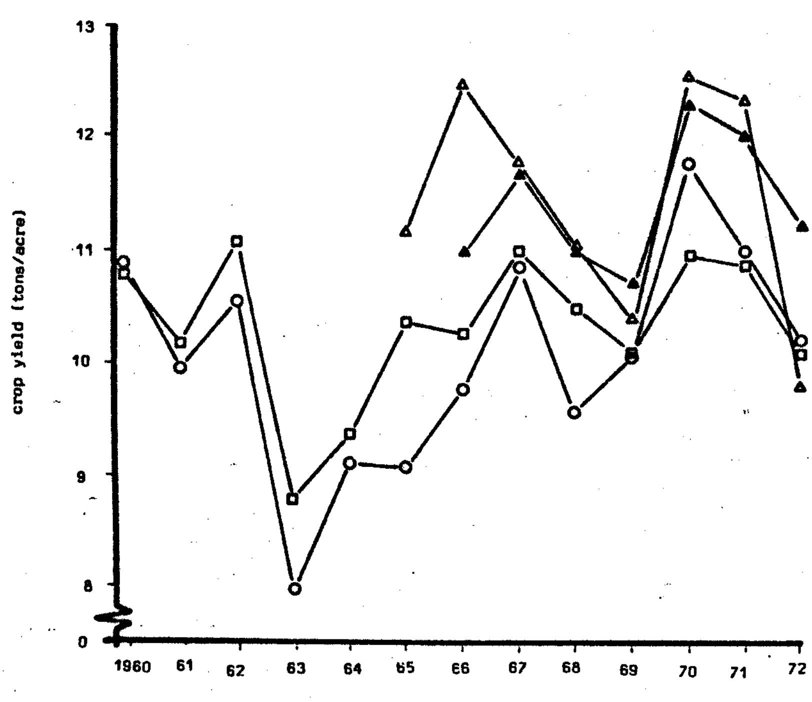

Figure 7.2 Selected maincrop varietal yields, Scotland, 1960 to 1972

Annotation: Pentland Crown ▲ , Pentland Dell △ , Kerr's Pink and Redskin □ , Majestic and others ○

Sources: Table 8.1 and Appendix 7.

since changes in weight of yield seem marginal, and only one of a combination of factors which determine harvester-to-store efficiency. For example, it is conceivable that in some instances, extra weight upon a harvester elevator might improve the flow of tuber uptake into the lorry, since fewer tubers are likely to roll and fall backwards into the soil (NIAB, private conversations).[1]

A general consensus of opinion collected from regional offices of the ADAS and PMB is that Pentland Crown and Pentland Dell, by displacing Majestic, have not significantly affected harvesting costs (written communications). The relative unimportance of weight to harvesting is implicitly recognised in costings, including that of the PMB in 1970, where costs are generally reckoned upon the basis of acreage travelled by the harvester (as the factor which determines time spent on harvesting).

Changes in weight of yield similarly seem to be unimportant for storage costs, where the predominant determining factor is depreciation upon the investment made in buildings and associated control facilities. It is handling into store which is most dependent upon yield weight. Unfortunately, there are no reliable estimates for this category of cost.

Weight is probably of most importance for grading, where extra output is likely to involve additional sorting labour time. This is recognised in costings, where grading cost estimates are generally based upon tonnage handled. Although this assumption is also subject to qualification; that whilst generally, labour costs increase with weight handled, there are other important determinants such as the condition of yield (particularly when adversely affected by soil and weather conditions).

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[1] Weight of soil that the harvester must sort through is, on the other hand, likely to contribute to slower harvesting, and variety might have some effect. Pentland Dell has a slight tendency to set its tubers deeper in the soil than most other varieties (a feature which might mean that the variety is less affected by greening*, caused by exposure of tubers to the light (see table 7.4): in some instances, this might require the harvester to handle more soil (NIAB, private conversations).

Taking the importance of extra weight caused by the new varieties yield advantage for costs overall, it is to be assumed that effects are uncertain. In terms of harvesting and storage costs, they cannot be measured for this present study: all that can be observed is that the new varieties might have marginally contributed, in combination with other factors, to higher costs in some seasons. In terms of grading, it is assumed for this present study, that grading costs have been affected adversely by increased outputs: it is possible to derive an estimate for this, by taking the assumptions used in the 1970 PMB study, Section 6.7.[1]

7.8 Output related costs - quality of yield

The results of the survey, Section 7.5, generally indicated that growers assessed the new varieties highly for quality of yield: ratings were good for ware quality, uniform size and shape of sample (particularly Pentland Dell), and in common with the NIAB descriptions, some respondents noted a lower incidence of scab and cracking. However, Pentland Crown and Pentland Dell were not assessed so highly for damage and disease, factors which are important determinants upon quality: they also affect keeping qualities, and so the quality of output out of store (it was noted in the survey that Pentland Crown rated badly for storage). This implies that for some years, at least, the new varieties might have had associated with them extra costs connected with a need for careful handling (and hence, slower harvesting and sorting).

Since 1969 the PMB and MAFF have co-operated in a series of trials designed to assess the commercial prospects of recently introduced

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[1] Some American farm costings suggest a strong association of high crop yields with high crop costs (for example, Maier and Loftsgard, 1964). However, this seems to be an association which involves costs generally, not just those which could be affected by weight of output, and might, therefore, simply reflect that the most successful farmers are the ones who purchase the best, and hence, most costly inputs.

varieties:[1] these were too late, of course, to consider specifically Pentland Crown and Pentland Dell, however, these and Majestic have been used as controls, and some results which indicate how the three varieties compare in terms of grading quality have been published (PMB, 1972f and 1973e). These are reproduced in table 7.4, and are for the years 1970 and 1971. It is not known how comparable the results are, but they should serve to indicate the presence of significant differences between the three varieties. Also, the grading standards that the results are based upon, are ones above the minimum ware standard and would be suitable for quality pre-packed potatoes, this means that under average commercial conditions, rejection rates would be less severe.

Generally, the results shown in table 7.4 correspond with the NIAB observations (Section 7.1) and the survey results (Section 7.5). The good keeping quality of Majestic is evident in its very low level of sprouting, although in terms of moisture loss and rots the difference between the three varieties does not appear significant. Also, Majestic records a higher incidence of cracking and irregular shaped tuber, although this is at a low level.[2]

Overall the new varieties are shown as superior, in terms of grading out-grade both prior to and after storage, to Majestic. Pentland Dell is shown as particularly good, especially with regard to silver scurf, Helminthosporium solani, and poor skin quality, factors which are

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[1] It is these trials which were instituted to complement information supplied by the NIAB (Section 7.1: footnote and Section 4.8).

[2] A propensity of Majestic to give irregular shaped tubers, although not noted by the NIAB in its leaflet, has been frequently observed in potato literature: for example, one often quoted survey, indicated that 16% of Majestic's tubers were badly shaped against an average of 6% for other varieties (Church et al, 1970). Conversations with processors' representatives, indicated that Pentland Crown might be particularly prone to internal symptoms of secondary growth, such as hollow heart: however, in the result for internal defects in table 7.4, indicates that the variety is likely to do better than Majestic for internal defects generally (which includes internal bruising).

TABLE 7.4

Comparison betw[illegible]n Majestic and Pentland Crown in PMB "Commercial Scale Testing of New and Recently Introduced Varieties"

Ware Crop	Majestic Crop Year 1970	1971	Pentland Crown Crop Year 1970	1971	Pentland Dell Crop Year 1970	1971
At harvest and loading into store						
% grading out-turn	39	49	45	55	43	63
% tubers $1\frac{3}{4}$" - 3"	56	72	60	75	55	77
Damage Index	360	261	331	279	307	243
% common scab	30	57	19	30	23	45
% growth cracks and shape	6	7	1	4	+	-
% greening	6	9	8	3	3	-
After storage						
% tubers sprouted after 10 weeks storage (1970/1971)	26	-	82	-	76	-
% moisture loss	4.8	4.6	6.5	4.9	6.3	4.3
% rots	0.1	1.5	0.8	1.4	0.5	0.5
% grading out-turn	39	46	41	52	46	63
% by number of ware-size tubers with defects						
internal defects	18	9	15	1	14	9
gangrene	4	5	17	11	7	4
skin spot	9	15	6	2	10	6
silver scurf	58	40	51	25	18	16
poor skin quality	89	53	68	53	62	25

Notes: Grading out-turn is the proportion of potatoes within the size range $1\frac{3}{4}$-3 inches judged suitable after washing and grading for quality pre-packaging purposes and which are free from the following defects as defined: mechanical damage which is associated with any secondary infection causing tissue breakdown and/or which is not removable by peeling and minor trimming. Greening of a high colour intensity. Pest damage which cannot be removed by peeling and minor trimming, and blight, blackleg, gangrene and dry rot which cannot be removed by peeling or minor trimming. Growth cracks and shape: gross irregularities, secondary growths and growth cracks.

Tubers $1\frac{3}{4}$-3 inches: those tubers which pass through a $1\frac{3}{4}$in. riddle and which will stand on a 3in. riddle are discarded. The remaining tubers are counted at ware grade.

Damage Index: of a sample was defined as (% by wt. surface scuffed) + 3 (% by wt. peeler damaged) + 7 (% by wt. severely damaged)

where surface scuffed = skin only broken
peeler damage = flesh wounds of less than 2mm in depth
severe damage = wounds of more than 2mm in depth

Moisture loss: difference in weight of the samples between loading into store and removal from storage.

Rots: those tubers which would disintegrate during normal handling.

Internal defects: any tuber suffering from bruising or necrosis.

Surface blemishes: common scab and skin spot are considered to be present on any tuber which is infected but silver scurf is only recorded if the area affected exceeds 25% of the total surface area.

Skin quality: is an indication of the suitability for washing. Poor skin quality refers to those tubers which are severely blemished and which are unsuitable for washing.

Source: PMB 1972f op cit, 1973e op cit.

important for high quality pre-pack samples (Cox, op cit).[1]

It is noticeable that Pentland Crown is still liable to be affected by common scab (as high as 30% of output in 1971) although at levels significantly lower than might occur in the other varieties. Common scab is the only disease which is given prominence in the PMB quality speficiations (Section 10.7): it is associated with light soils, and is most active in dry conditions when tubers are setting. Apart from careful siting of crops, the only effective, non-varietal, method of control, is that of well-timed irrigation (Wellings has indicated that two extra water applications are required to normal irrigation practice, 1972).[2]

Pentland Dell appears no more susceptible to internal effects than either Majestic or Pentland Crown. This might not have been expected since the variety has a high susceptibility to spraing, and may be more liable to internal bruising. Spraing symptoms are stripes or blotches in the tuber flesh, and are caused by soil-borne viruses: the most important and the one associated with Pentland Dell, is tobacco rattle virus. Ellis has suggested that this virus was responsible for the decline of Pentland Dell's acreage on light textured soils during the late 1960s (1971).

The propensity of Pentland Dell to be susceptible to internal bruising, is suggested by drop tests, for example at the National Institute of Agricultural Engineering, Scotland (written communication). The

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1 Silver scurf is often present in samples since it is very prevalent: it has been estimated that perhaps about 50% to 85% of stored potatoes are affected (AHRF, written communication). The trouble may give a rough feel and appearance to a tuber, but need not appear unsightly.

2 In the early 1950s, a comprehensive survey suggested that between 2% and 4% of the national output might have been lost as a result of the disease (Large and Honey, 1955). Since that time, the effects of common scab have probably become more commercially significant with the growth of the pre-pack trade. A full description of common scab is given in MAFF (1971a).

variety apparently has a relatively thick skin, which acts against tuber splitting, but does not prevent internal damage. The commercial significance of this kind of damage is that it is difficult to inspect, and affected tubers may be passed on to customers.

It is possible that these troubles were avoided by the growers who took part in the PMB-MAFF test because they were aware of the variety's weaknesses, and had stopped planting on spraing susceptible soils, and had taken care in handling. This implies that growers were no longer experiencing a 'learning process' with the new varieties. However, there is evidence that this was not so in the instance of Pentland Crown.[1] Although the results in table 7.4 indicate that for damage Pentland Crown is not significantly more susceptible than Majestic, growers generally had trouble handling the newer variety because, probably, they made mistakes.

7.9 Troubles experienced by growers in handling Pentland Crown with regard to mechanically caused tuber damage

Current agricultural practices and trends seem adverse to any variety not particularly suited to rough handling. Mechanization of the potato crop has in recent times greatly expanded. In harvesting, (and the potato is a difficult crop to lift out of the soil without damage) only around 3% of the national maincrop was lifted by complete harvester in 1958 and by 1973 the proportion had expanded to 51% (Statham 1974). Possibly this was the maximum level given soil type, technology and varieties at that time (Statham, 1972). Evidence that complete harvesters might render double the proportion of potatoes in a crop unfit for ware, as other types of harvesting machine (allowing more labour) was presented by Twiss (1963).

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[1] The growers involved in the PMB-MAFF tests might have been ones whose husbandry and behaviour is relatively progressive, and, therefore, more aware of varietal needs and associated handling requirements.

The potato is a fragile vegetable (possible this has only recently been generally realised, see Norkett, 1972), which is susceptible to mechanical damage. In fact, the main cause of tuber damage and disease has probably been mechanical in origin (see for example, Twiss and Jones, 1965). This might have had particular consequences for storage quality. Gangrene, Phoma spp, a rotting disease which has caused widespread losses in store during recent years (Hampson, 1972b), has been linked to mechanically caused tuber damage (Hirst et al, 1970): once, this disease was considered rare (Hessayon and Fenemore, op cit).

In Eastern England during 1970 and 1971 the author encountered a great deal of comment from growers at the NFU concerned with Pentland Crown, its reaction to damage and subsequent performance in store (comment which seemed to be substantiated by conversations with NIAB staff in 1973). The consensus of opinion suggested the following.

During 1970/71 a number of factors combined to act against Pentland Crown. Crops were late maturing and lifting conditions poor due to bad weather. Fearful of continuing bad weather, and anxious to plant a following crop of winter wheat, crop yields seemed high enough to justify rushing harvest, even if a part of the crop would be lost as damaged by the faster working of the harvester. It was only later however, that the full extent of tuber damage was realised in store; by that time, widespread losses had resulted from rot diseases, particularly gangrene.[1]

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[1] The results in table 7.4 indicate a higher incidence of the disease in Pentland Crown than the other varieties. It was originally thought that Pentland Crown might have a moderate resistance to gangrene (SPBS, 1959): but commercial conditions have seemed such as to render it relatively susceptible.
A contributory factor to storage losses in 1970/71 (and perhaps, some winters thereafter) could have been the presence of mild temperatures. This would make storage management more difficult (sprouting more likely), and combine with growers inexperience in keeping Pentland Crown (as opposed to Majestic), to give problems.

A consensus of opinion indicated that this situation would not have arisen with Majestic, and some growers suggested to the author that they would stop expanding plantings of Pentland Crown in favour of other varieties. Indeed, the growth in the variety's percentage share of the maincrop acreage did stop (and decline slightly) after this time (see figures 1.1 and 1.2). In conversations, the NIAB suggested that the effect of a 'bad year' was important psychologically for varietal choice, and that Pentland Crown's popularity had probably been badly affected (NIAB, private conversations).

There are several features about Pentland Crown which have been noted in the potato literature. The NIAB observed that the variety was likely to mature late (Section 7.1), and this is a factor which is likely to increase mechanical damage in two ways (other than an associated grower desire to hurry lifting a late crop): stolon retention and scuffing occur more frequently with immature crops. The former trouble (noted by the NIAB), where haulm remains fixed to the tuber at lifting, results in damage if stolons are torn away from the tuber uncleanly, so that a gash is left behind.[1] Scuffing is a scraping of the tuber skin, and is more likely to occur in immature tubers because the skin is less hard wearing.

It has also been suggested that Pentland Crown has an above average tendency to give fewer but larger tubers (Scott and Younger, 1973). It is likely that this tends to render the variety more liable than other varieties to damage from tuber scuffing and perhaps, splitting (ADAS, written communication).[2]

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[1] Stolon retention also results in a loss of yield, since many tubers are likely to be pulled to one side with the haulm, and be disposed of with the haulm.

[2] The introduction of a top riddle size in 1972, after complaints that graded samples had tubers which were too large is a measure which might have had an effect both upon size of marketable yield, and grading time. There appears to be no estimates to indicate what proportion of Pentland Crown's yield is likely to be out-graded, relative to other varieties.

7.10 The effects of changes in quality of yield upon costs

The question of quality of yield has been developed above at some length, because later in the text, the quality of the new varieties, particularly that of Pentland Crown, is examined as an issue of importance with regard to other considerations, Chapter 12. However, the immediate concern here is to assess whether by displacing Majestic, the new varieties have significantly changed production costs.

The overall impact of the new varieties upon costs, and whether this compares favourably or otherwise with a situation where only Majestic would have been grown, depends upon the balance of a combination of factors. Generally Pentland Dell has probably facilitated cost savings, because of its propensity to give uniformly high quality samples, and although it tends to keep less well than Majestic (and thus, demand more inspection and applications of sprout suppressant), this is not enough to off-set advantages in terms of handling and general inspection.

However, there might have been significant costs associated with sorting and grading the variety in those years when spraing and tuber blight occurred. These might have been relatively high, since more growers had planted Pentland Dell in those years, than since, in more recent times.

The situation with regard to Pentland Crown is more uncertain. The general impression is that whilst the variety might, potentially, give quality at least as good as Majestic, it requires careful handling. If this had been done then extra costs are likely to have been involved with slower harvesting speeds and careful inspection. However, evidence of problems in 1970 and 1971 suggests that improper handling and practices might have occurred so that these costs were not realised, except ones associated with clearing wastage.[1]

It seems, therefore, that overall no more can be stated about the cost effects of changes in quality of yield, than that the consequences are uncertain, but that probably they have tended to involve extra costs. This observation must be added as a qualification to the quantified cost effects derived in Chapter 8.

7.11 Varietal effects upon potato seed costs

In terms of the cost category classification used in Chapter 6, the most important category was that of seed, and the one which varietal influences are most likely to affect and be of most importance. It was noted, (Section 6.4) that variety is important to seeding rate, the price of certified seed, and the viability of seed stocks for use as own-grown seed. The growers' survey indicated that the factor of 'less seed replacement' might be important in the instance of Pentland Crown, but that for both the new varieties, seeding rate considerations did not seem important to growers (Section 7.5).

(a) Varietal differences in seeding rates

It was observed above, that whilst cost differences between varieties might not be of major concern to individual growers, if these are small in relation to output considerations, nationally these might add up, and, therefore, be relevant to this present study (Section 7.6). This applied to varietal differences in seeding rates.

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[1] Plus losses in income associated with marketable output foregone (probably, the main cost to growers).
There is some evidence to suggest that the incentive to ensure that growers grade their potatoes to a minimum standard required by the PMB quality specifications has been only partly effective (Section 12.5): hence, growers might not have been too predisposed to prevent low quality or releasing it to the market (the loss in marketable output might not have been as extensive, therefore).

The 1968 national maincrop survey indicated that, on average, rates of 21.2 cwt per acre, 23.9 and 22.4, had been used for crops of Majestic, Pentland Crown and Pentland Dell respectively (PMB, 1968a op cit table 5.3). The ADAS has published recommended optimal rates (see Shotton and Jarvis, 1972). These differ slightly from the rates observed in 1968. Majestic seemed to have been slightly over-planted in 1968 but the new varieties were being planted quite close to official recommendations (perhaps not surprisingly, given their novelty).

(b) Seed prices

Varietal seed prices differ according to the conditions of the supply and demand for individual varieties. A list of certified seed prices for Majestic, Pentland Crown and Pentland Dell, is given for 1965/66 to 1971/72 in table 7.5. These are only rough approximations to the market average. This is because price information is collected in an ad hoc manner; the PMB is geared to the ware end of the potato market, and whilst it keeps abreast of price developments in the seed market, it does not appear to keep consistent records. The prices shown in the table are based upon information from the PMB, and also from additional material supplied by the NASPM.

Majestic's prices are likely to have been altered from those which would have prevailed in a situation without the new varieties, in two ways. Prior to 1969, the year in which the PMB applied acreage restrictions, the new varieties might have contributed to surplus ware conditions, affected average market price, and so had an effect upon the use of own grown seed (the relationship between the ware and certified seed market was noted above, Section 6.5). Secondly, the substitution of the new varieties for Majestic might affect the supply and demand conditions sufficiently to affect certified seed price.

Prior to 1965 when the new varieties had still to make an impact upon the national maincrop acreages, Majestic's certified seed prices were similar, on average and in real terms, to those shown for the late 1960s in table 7.5. The most critical years were 1966/67 and 1967/68, a time when the NASPM noted a tendency for Majestic to be over-supplied. This was when Pentland Crown and Pentland Dell were being rapidly adopted.

TABLE 7.5

Average (1971 £s) price of Scottish certified seed per ton

	Majestic	£(1971)	Pentland Dell	£(1971)	Pentland Crown	£(1971)
1965/65*	17	(24)	35	(49)	35	(49)
65/66	16	(21)	34	(45)	34	(45)
66/67	23	(30)	34	(44)	34	(44)
67/68*	18	(22)	16	(20)	29	(36)
68/69	18	(22)	15	(18)	19	(23)
69/70	26	(30)	18	(21)	29	(33)
70/71*	28	(30)	20	(22)	31	(33)
71/72	28	(28)	29	(29)	31	(31)

Source: NASPM, PMB

Another feature noted is that the new varieties attracted high prices during the early period of their adoptions, as demand was strong in relation to supply. After Pentland Dell's 'blight immunity' breakdown and associated weakening in the demand for its certified seed, the variety's prices declined to levels generally below Majestic prices. The demand for Pentland Crown's seed has generally remained firm.

The certified seed prices shown in table 7.5 can be used in conjunction with the observed seeding rates, to derive varietal certified seed costs per acre. These are shown in table 7.6. It is seen that the costs associated with Pentland Crown are significantly above those for the other two varieties. Quite low costs are shown associated with Pentland Dell.

TABLE 7.6

Estimated certified cost of seed per acre (1971 £s)

	Majestic	Pentland Dell	Pentland Crown
1965/66	22	50	54
1966/67	32	49	53
1967/68	23	22	43
1968/69	23	20	27
1969/70	32	24	39
1970/71	32	25	39
1971/72	30	32	37

Note: Estimated from seed prices, table 7.5, at seeding rates as observed in 1968 (PMB, 1968a op cit)

(c) Own-grown seed

The observed seeding rates can also be used to derive estimates for varietal own-grown seed costs per acre. A reasonable measure of the opportunity cost of own-grown seed might be say, quite arbitrarily, two-thirds of the average ware marketprice of the previous season (this is less than that used for the 1970 PMB survey, Section 6.5). Average market prices of potatoes bound for human consumption are shown in table 7.7. Taking those in column (c), and deflating them to two-thirds, estimates of opportunity cost of own-grown seed are derived: see column (a) in table 7.8.

Applying the observed seeding rates to these costs produces own-grown seed cost per acre as shown in table 7.8 columns (b) to (d), for Majestic, Pentland Crown and Pentland Dell respectively. The low seeding rate for Majestic gives this variety a cost advantage.

Total varietal seed costs per acre depend upon the proportion of crops planted with certified and own-grown seed. Since own-grown seed per acre is less expensive than that of certified seed (cf. tables 7.6 anf 7.8), it might be expected that Pentland Crown's resistance to viruses Y and leaf roll, in as far as this permits growers to retain

TABLE 7.7 Guaranteed and average growers prices per ton

	Guaranteed price	UK growers average price	1971 equivalent growers average price	5 year moving average 1971 £s
	(a)	(b)	(c)	(d)
1960/61	13.00	11.75	18.33	
61/62	13.25	18.25	27.74	
62/63	13.25	18.05	26.35	
63/64	13.75	15.00	21.60	
64/65	14.00	14.05	19.53	22.71
65/66	14.25	14.22	18.91	22.83
66/67	14.50	19.38	24.81	22.24
67/68	14.50	14.65	18.31	20.03
68/69	14.87	15.52	18.63	20.04
69/70	15.12	22.05	25.14	21.16
1970/71	15.87	14.51	15.67	20.51
71/72	16.55	15.06	15.06	18.56
72/73	16.55	19.71	18.32	18.56

Source: PMB

TABLE 7.8 Estimated cost of own-grown seed per acre

	Cost/ton	Majestic	Pentland Crown	Pentland Dell
	(a)	(b)	(c)	(d)
1964/65	14.4	15	17	16
65/66	13.0	14	16	15
66/67	12.6	13	15	14
67/68	16.5	17	20	18
68/69	12.2	13	15	14
69/70	12.4	13	15	14
70/71	16.8	18	20	19
71/72	10.4	11	12	12
72/73	10.1	11	12	11

Note: Estimated from table 7.7 at seeding rates observed in 1968.

* At two-thirds of alternative ware market value.

own-grown seed longer than normal, might have resulted in reduced total seed costs per acre. Although the high prices of this variety's certified seed has probably tended to off-set this.

(d) Pentland Crown and virus Y and leaf roll

The need to import potato seed certified free of virus disease into the main potato regions was noted above (Section 6.4). Since potato seed is vegatatively reproduced, virus infection of parents is liable to be passed on to progeny, with increased severity of symptoms: the effect upon crop yields after the first year of infection may be very large. For a full examination of how viruses work, their effects upon potato plants, see MAFF (1971b).

Virus Y and leaf roll virus are the most damaging in the denegerative process.[1] The former (sometimes called severe mosaic) is probably the most significant commercially, because it is more difficult to control than leaf roll virus. Since the vector, the peach potato aphid, Myzus persiac, spreads virus Y immediately it feeds upon an unaffected plant, but six hours are required for the aphid to spread leaf roll: thus spraying is likely to be more effective in the latter instance (Carden, 1972).

Pentland Crown is the only variety (apart from the moderate resistance of Desiree to virus Y, see table 7.2) which has good resistance to virus Y and moderate resistance to leaf roll. This might cause spraying to be more effective as a virus control measure, and possibly enable growers to keep own-grown seed longer than would otherwise be possible. In southern and coastal areas where virus Y is likely to be most severe, growers possibly replace seed stocks annually: in

[1] The mild viruses possibly play an important part (see Richardson, 1970); however, in terms of a high use of own-grown seed, the field immunity of Pentland Dell to the common mild virus (see Section 4.5) seems to have had no discernible affect (see table 7.9): perhaps because its susceptibility to severe viruses cancels out any potential advantage.

northern and western areas where leaf roll is likely to be most severe, growers possibly have to replace stocks every three years (as recommended by Mi-dox, 1971). In the former instance, Pentland Crown's resistance might enable growers to keep seed for a year longer: perhaps in average areas, as long as 3 to 4 years longer (suggested to the author by the NIAB).

(e) Varietal usage of own-grown seed

Differences in varietal usage of own-grown seed can be inferred from acreage statistics of certified seed and ware crops; more specifically, if varietal certified seed acreage of one year is compared to the ware acreage of a subsequent year. Table 7.9 gives varietal ratios of certified seed acreage to ware. On average for the period shown, the ratios for Majestic, Pentland Crown and Pentland Dell, were 1:9, 1:14 and 1:7 respectively.

TABLE 7.9

Ratios of a season's maincrop ware acreage to preceding certified seed acreage

Year	Pentland Crown (a)	Pentland Dell (b)	Majestic (c)
1964/65	21.5	5.1	9.1
65/66	20.7	7.7	6.8
66/67	17.5	10.5	9.0
67/68	13.2	6.3	9.2
68/69	7.1	3.3	9.4
69/70	13.0	6.6	11.6
70/71	12.5	6.2	10.2
71/72	11.1	5.7	11.1
72/73	12.6	7.6	7.6

Note: Calculated from statistics in table 8.3

The table is based upon certified acreage planted in Scotland, so that assuming that other sources of certified seed are relatively unimportant (see below, Section 11.4, for a note on the importance of the Scottish certified seed industry), and that differences in crop yield are not sufficient to distort the significance of the ratios, then it seems clear that Pentland Crown was planted with a high proportion of own-grown seed and Pentland Dell was not.

It has been estimated that in 1972 about 42% of the maincrop had been planted with own-grown seed (PMB, 1972a). If this is correct, and taking the maincrop acreage to be 464,647 acres in 1972, then 278,792 acres (60%) might have been planted with certified seed. If this proportion is compared to the 1971 certified seed acreage of 50,473 (maincrop varieties only), then the average ratio of certified seed to ware acreage is estimated at around 1:5.5.

If this estimate is applied to Pentland Crown's acreages, that is, 100 acres of its certified seed is likely to produce 550 ware acres, then it seems likely that in 1972 a large part of the variety's ware acreage was attributable not just to once but twice or more grown seed. The ratio for Pentland Crown in table 7.9 for 1971/72 is 1:11.1, that is 100 certified seed acres might be associated with 1,110 ware: if from this the average estimate of 550 is subtracted, then 560 acres might then be associated with twice or more grown seed. Pentland Crown's seed to ware acreage ratio appears to have fallen over time table 7.9. This might be associated with the fact that the variety's certified seed price has tended to decline, and with it the incentive to save on seed costs, or simply that the variety's virus resistance has weakened.

Pentland Dell's ratios have been generally low. This might be because seed stocks are easily infected by severe viruses, or because of other reasons. For instance, bold tubers are required for seed, this, and given the variety's tendency to produce uniform tuber samples, is likely to have made the ware market opportunity cost of seed relatively high. If this is so, then the estimates of cost of own-grown seed per acre, table 7.8, are too low, and perhaps more realistically, should reflect whole market price rather than two-thirds.

Another explanation might be that the acreage certified for seed might be greater than the potential market would justify.[1] The need to produce bold tubers allows the certified seed producer to grow more of his crops to full maturity, which tends to increase the proportion of output that can be marketed for ware. This proportion is known as 'tops trade' in Scotland, and involves the sale of tubers too large for seed for pre-packing (see Produce Studies op cit).

The seed ratios of Majestic appear in recent years to have become larger. This might have resulted from general reasons for an increased use of own-grown seed (see Section 11.4).

The importance of these ratios for deriving the proportions of varietal acreage planted with the two types of seed is discussed more fully in the following chapter (Section 8.5). It suffices here to observe that now the varietal costs per acre associated with certified and own-grown seed have been estimated, tables 7.7 and 7.8 respectively, it remains only to derive the acreage proportions, before the effects of the new varieties upon total seed costs can be estimated.

7.12 The implications of differences in varietal chemical applications for costs

The PMB survey of the 1968 maincrop indicated differences in pesticide, fungicide, herbicide and haulm defoliant applications for

[1] This might in part explain why Pentland Dell appears to be more popular in Scotland, on a percentage of planted acreage basis (cf. figures 1.1 and 1.2), than in England and Wales. Also, why the price of its certified seed has been relatively inexpensive (table 7.5).

different varieties (PMB, 1968a op cit). These are reproduced for Pentland Crown, Pentland Dell, Majestic and King Edward IV below in table 7.10. Fungicide is used against blight, as generally, so is haulm defoliant.[1] Majestic is shown to have required fewer applications: this might reflect the moderate resistance of Majestic to tuber blight noted by the NIAB (Section 7.1).[2] And partly explain why it recorded a lower level of pesticide application, since pesticides are sometimes combined with fungicides.

The lowest herbicide application is shown for Pentland Crown. This corresponds with the growers' survey result for herbicide, where the variety records a small but positive performance compared to Majestic (cf. table 7.3). This might result from Pentland Crown's tendency to have its haulm spread relatively quickly between the rows, to shorten the time available for spraying.

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[1] Haulm defoliant is sometimes used to stop a crop early where greater time is required for harvesting. Otherwise, haulm is destroyed to stop blight from spreading into the ground and infecting tubers, to cause rotting. It has been suggested that the potential loss from tuber blight is small, only about 1% of potential output liable to loss in a bad blight year (Cox op cit). The commercial significance of blight proper, is that after first appearance on a crop, the fungus is in favourable conditions likely to destroy the whole crop (Brenchley, 1972). Blight affects yield by a premature dstruction of the haulm, when tuber growth is stopped. However, control can delay blight, perhaps by a month: since weather conditions (and the crops dense enough) to favour its spread occur only later in a season, a month's delay can save a major part of a crop's potential yield. A full description of blight and its effects is in MAFF (1972c). Since individual crops might be seriously affected by blight, growers tend to take a minimum of risks and indulge in insurance spraying. In national terms this behaviour might be more costly than the potential losses (see Cox and Large, 1960.

[2] It has been stated that the commercial success of Majestic has been due to its moderate resistance to tuber blight (Cox and Large, op cit). However, in the growers survey this factor did not appear important in relation to others.
Probably of more importance is reliability in the face of disease generally. The success of Majestic is s triumph of mediocrity in that the variety does not have any spectacular resistance to disease, but is not very susceptible to any.

TABLE 7.10

Varietal differences in disease control: PMB National Maincrop Survey 1968
(Figures represent percentage of GB crops treated)

Variety	(a) Pesticides*	(b) Fungicide	(c) Herbicide	(d) Haulm defoliant
Majestic	39	50	40	59
King Edward	58	94	45	86
Pentland Crown	43	68	38	69
Pentland Dell	35	55	48	68

Note: *Estimates for England and Wales. No figure for pesticides used in Scotland.

Source: PMB, 1968a op cit

The timing of the survey might have importance to the interpretation of the varietal comparisons. Pentland Crown and Pentland Dell were in 1968 still being adopted for the first time by many growers, and the relatively high chemical applications compared to those for Majestic might reflect an abnormal care, on the part of growers, not to take unnecessaruy chances. It is likely that in the instance of Pentland Dell, these crop observations would have been different after 1968: for in 1969, advisory groups began to recommend the same fungicide and defoliant treatments as those normally given to crops of King Edward VII (see Hardie and Hampson, op cit). Thus, it is possible that for after 1968, fungicide and haulm defoliant applications on crops of Pentland Dell were similar to those shown in table 7.10 for King Edward VII.

Another factor of possible importance, is the geographical distribution of crops surveyed. After Pentland Dell's blight immunity breakdown, it is possible that plantings of this variety were less affected in northern (and perhaps inland areas): these are areas less likely to be affected by aphids, and thus, in average terms, pesticide applications might be reduced for Pentland Dell. Table 7.10 does indicate that the location effect was already being felt. The worst effects of the blight breakdown were felt generally in 1967, and, therefore, the variety's acreage in blight prone areas had probably already fallen.

If the 1968 crop observations can be assumed to hold for other seasons, bearing in mind what has just been written, they can be used in conjunction with the spraying cost estimates of the 1970 PMB cost survey, to derive estimates of varietal spraying costs. For example, converting the 1970 cost for pesticide to real terms, and rounding off, £2 per acre is obtained: this can then be multiplied by the observed proportion of Majestic's crops in 1968, which were treated with pesticide (39%, table 7.10). If this is done for the other spraying categories, and the total added, an estimate for Majestic's chemical cost per acre is derived; see row (a) table 7.11. Majestic's chemical costs per acre are estimated at £4.27.

TABLE 7.11

Estimates of varietal chemical costs

Majestic	2(.39)	+	3(.50)	+	2(.40)	+	2(.59)	=	£4.27/ac
Pentland Crown	2(.43)	+	3(.68)	+	2(.38)	+	2(.69)	=	£5.04/ac
Pentland Dell to end 1968	2(.35)	+	3(.55)	+	2(.48)	+	2(.68)	=	£5.06/ac
PD post 1968	2(.58)	+	3(.94)	+	2(.48)	+	2(.86)	=	£6.66/ac

For Pentland Crown an estimate of £5.04 per acre is similarly derived. For Pentland Dell, £5.06 per acre, and if it can be assumed that in 1969 and therafter, chemical applications were the same as for King Edward VII, £6.66 per acre. See rows (b) to (d) respectively, table 7.11. Of course, it is likely that Pentland Dell's fungicide and haulm defoliant applications prior to 1968 might have been less than those indicated by the observations in table 7.10, given that breakdown occurred first in 1966, and generally in 1967. However, there is no evidence on which to base any figures.

There will be regular labour costs associated with spraying applications. These can be inferred in a similar way, using the 1968 crop observations. Unfortunately, the 1970 survey cost elements associated with spraying are hidden in the general cost category of "those incurred prior to harvest" (Chapter 6). However, information of some detail is contained about spraying activities and associated costs in the PMB handbook (PMB, 1972c op cit), and this can be used instead. See (Section 8.5) for a full explanation.

Table 7.11 indicates that differences in terms of costs per acre are small between different varieties. However, in terms of what these small differences imply overall for national resources, differences in varietal performance might be important. The full implication is shown below (ibid).

7.13 Additional factors involved in the displacement of Majestic which might be important to costs

There are three influences which will tend to bring about cost changes, which are indirect in their effects. These involve the possibility that the increased use of the new varieties instead of Majestic might have brought about a change in production techniques; that the new varieties in being suited to particular soils might have changed a range of costs, and the consequences for planted acreage and associated costs of an increased output potential.

The 1960s were years of technical change in potato production, and it is likely that this change would have occurred had the new varieties been introduced or not.[1] However, the care required to store Pentland Crown might have encouraged some growers to adopt more sophisticated storage systems, or, more likely, encouraged the spread of

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[1] Indeed, the new developments in some instances might not have favoured the new varieties: for example, an increased mechanisation of harvesting might not have worked to favour Pentland Crown (Section 7.9). See Jones (1972) for an account of changes in husbandry during the 1960s.

chitting. Majestic is probably not helped by chitting, since the variety is relatively late to sprout, and crop maturity is generally not a problem.

However, Pentland Crown's crops sometimes do mature late, and chitting acts to prolong the growing season. Chitting may be of particular benefit to Pentland Dell. Since this variety sometimes reacts badly to low soil temperatures to give blanking (non-emergence of plants) from little potato,* chitting enables seed to be kept back longer from planting without yield loss, until weather conditions improve.

Differences in the versatility of varieties in terms of particular soils might have led to plantings on land, which otherwise with only Majestic available, would not have been used for potato growing: this might have affected a range of costs. However, whilst there are indications that Pentland Crown's common scab resistance has allowed an expansion of acreage on lighter soils (more suited to the employment of complete mechanised harvesting), and Pentland Dell's acreage has tended to be sited away from light soils associated with spraing, no general trend is obvious.

The last of the influences noted above is the most important. Whilst it is only possible that chitting and storage costs might have risen, and the effects of versatility are unknown, the consequences of the added output potential provided by the new varieties in higher yields are likely to be large. This is because the demand for potatoes is highly inelastic, and if surplus conditions are to be avoided (as in the example of hybrid corn, Section 3.7) then acreage must be released from potato production.

The adjustment of the size of industry is the responsibility of the PMB, and more is stated about this below, Chapter 10. It is enough here to observe that acreage was first taken out of potato production as a result of the increased output potential brought by the new varieties in 1969. This resulted in cost savings associated with that acreage, many affecting cost categories not otherwise influenced by variety. These will be examined in detail in the following chapter.

7.14 A summary of the cost implications of varietal attributes

In terms of output related costs, the extra weight of the new varieties output, implied additional costs for harvesting to store to grading. It is possible, however, only to measure the effects upon the latter: grading costs seem the most obvious of the relevant cost categories to be affected. The quality of yield has probably been such that on balance, extra costs per acre were incurred with the use of new varieties, from harvesting through storage to grading.

The effects of the new varieties upon seed costs are measurable. In terms of certified seed cost per acre, Pentland Crown's costs are higher, and Pentland Dell's lower than Majestic's: in terms of own-grown seed, both the new varieties, because of the seeding rates, are the more expensive. However, it seems likely that Pentland Crown had permitted a much greater use of own-grown seed, which will have tended to reduce the certified seed cost element of total seed costs. Pentland Dell had not.

The implications of the new varieties for chemical costs are also measurable. They are higher costing per acre than Majestic, Pentland Dell particularly so after its blight immunity.

That might have been additional costs for chitting and storage, if the new varieties influenced their development. These are not measurable. There might be cost implications associated with soil versatility, however, these are unknown. Of most importance, will be costs saved as a result of reduced acreage brought about by a need to compensate for the new varieties' higher yields.

Overall, ignoring the possibility of savings associated with reduced acreages, the costs per acre of growing Pentland Crown and Pentland Dell seem likely to be higher than would be the situation if only Majestic had been grown. This suggests that resource costs per acre will have been increased.

CHAPTER EIGHT

The measurement of the effects of Pentland Crown and Pentland Dell upon the potato industry

8.1 The main ways in which potato production costs and market prices for potatoes will have been affected

The overall effect that the substitution of Pentland Crown and Pentland Dell for Majestic has had upon potato production costs, will have depended upon the timing of the PMB's measures to restrict acreage to compensate the extra output potential of higher yields. This also is an important determinant of the substitution's effect upon market prices and growers' incomes, and the need for the PMB to embark upon market support and surplus disposal programmes. Thus, these considerations will be taken together in this chapter for measurement, along with the consideration of cost implications resulting from changes in growing costs per acre, identified in the previous chapter.

It was seen that growing costs per acre probably were higher with Pentland Crown and Pentland Dell (Section 7.14); however, the advantages to their growers was probably in terms of extra output sold (Section 7.6). There is a more general effect of the new varieties that would affect growers' receipts generally. This would occur if the contribution of the new varieties' extra output, in higher yields, was large enough to influence market trading conditions so that an approximate balance between supply and demand was transformed into a surplus supply of potatoes.

Of course, extra output, to result in greater pressures upon resources used in the PMB's market support and surplus disposal programmes, need only occur in what are already surplus conditions. The effect upon general prices in such trading conditions will then depend upon the success the PMB has in maintaining growers' prices.

Of course, transfer effects are involved in these questions. The loss in growers' incomes as a result of lower prices imply, at least in part, depending upon how changes in growers' prices are reflected through the distributive system, that consumers will gain. Also, if the new varieties bring about the incurment of extra costs associated with market support and surplus disposal, these might be funded by government (and therefore, the tax-payer) if the PMB's finances become over-stretched.[1]

After the imposition of acreage restrictions, the contributory effect of the new varieties' extra output should have been allowed for and, therefore, neutralised. However, this will have been achieved at a general loss in potential market revenue from the returns associated with acreage that has been taken out of potato production. Against this, however, are opportunities for growers to use freed potato resources in other alternative occupations and, thereby, realise revenue from other crops. Of course, general potato market prices will tend to be higher in non-surplus seasons than they would have been immediately prior to acreage restrictions. Additionally, the growers of the new varieties will still have been earning extra revenue associated with higher outputs per acre.

The effect upon consumers of changes in production costs might have been reflected in market prices. If acreage restriction has been substantial then large amounts of resources are likely to have been freed from potato production, so that the total cost of potatoes per ton bound for human consumption will have been significantly reduced. The

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[1] If the situation were to continue (the effects of the new varieties' extra output were not compensated for by acreage restrictions) then one might expect growers' levies to the PMB to be increased. Also, a continuing pressure upon growers' incomes would tend to affect investment and perhaps long-term prices. The role and workings of the PMB are examined below (Chapter 10).

extent to which this is reflected in market prices will probably depend upon to what extent the extra costs (if any) of growing the new varieties off-set savings associated with acreage restrictions.

It is seen from these observations that the size of the new varieties' extra output is an important factor. It can be defined as the new varieties' crop yield advantage over substituted varieties, times the new varieties' planted acreage. The implicit assumption is that other varieties have been substituted to an extent that is equivalent to the new varieties' acreage. In fact, the attractions of the new varieties might have generated plantings additional to a situation without the new varieties: however, given the nature of the PMB's basic acreage allocations, the scope for generated acreage is probably very small (the margin between basic acreage, and actual grower up-take of the basic, is indicated by statistics in PMB/A: table 1).

8.2 Derivation of estimates for Pentland Crown's and Pentland Dell's extra output

As a first step in the derivation of estimates for the new varieties' extra outputs, it is necessary to compare varietal crop yields to establish Pentland Crown's and Pentland Dell's crop yield advantage. Then secondly, to take the planted acreage observed to have been planted with the new varieties, and multiply this by crop yield advantage.

Estimates of varietal crop yields are published annually in a PMB handbook of potato statistics (PMB/A). These were used for this study, and supplemented by more specific detail from material supplied by the PMB statistics' branch at Oxford. A list of annual varietal crop yields, 1965 to 1972, is given in table 8.1. Only the varieties likely to have been substituted by Pentland Crown and Pentland Dell are shown. Estimates are given for England and Wales and Scotland separately.

The Scottish situation differs from that of England and Wales,

TABLE 8.1 Varietal Annual Crop Yields, 1965-72

Year	Pentland Crown (a) E & W	Pentland Crown (a) Scot.	Pentland Dell (b) E & W	Pentland Dell (b) Scot.	Crown & Dell (c) E & W	Crown & Dell (c) Scot.	Majestic & others (d) E & W	Majestic & others (d) Scot.	Redskin Kerrs Pink (e) Scot.	Redskin Kerrs Pink Majestic & Others (f) Scot.
1965	13.65	-	13.95	11.20			10.90	9.25	10.40	9.82
66	11.75	11.05	13.80	12.50			9.85	9.85	10.30	10.07
67	12.55	11.70	12.40	11.80			10.25	11.00	11.00	11.00
68	11.65	11.00	12.30	11.05			9.85	9.65	10.50	10.07
69	11.10	10.75	10.65	10.40	10.95	10.55	9.35	10.15	10.15	10.15
1970	11.90	12.30	11.50	12.55	11.80	12.40	10.65	11.85	11.00	11.42
71	12.55	12.05	12.25	12.35	12.50	12.25	10.35	11.05	10.95	11.00
72	11.90	11.25	11.50	9.80	11.80	10.65	10.50	10.25	10.15	10.20

Notes:

(1) Crop yields assessed on 1½ riddle, tons per acre.

(2) E & W, Scot., denote England and Wales and Scotland respectively.

(3) 'Others' in columns (d) and (f) are varieties of similar marketability to Majestic and take up a negligible share of the total planted maincrop acreage. This excludes crop yields of varieties newer than Pentlands Crown and Dell.

(4) Column (f) estimated by taking an average between yields shown in columns (d) and (e).

Sources: PMB/A; PMB Statistics Branch, Oxford (written communications) because varietal acreage patterns are more complex in Scotland (cf. figures 1.1 and 1.2), and that Scottish potato statistics are influenced by the important Scottish certified seed industry. The nature of this latter factor is one essentially of a supply industry to the main part of the potato industry. It is likely, therefore, that changes within it might be reflected in the price of certified seed to ware growers. To include cost changes in the seed industry in the main cost benefit arithmetic, along with changes associated with seed price to ware growers, would be to double count in terms of efficiency criterion. This is not to suggest that changes produced by the SPBS's innovation upon the certified seed industry are unimportant, but that they should receive separate consideration (Section 11.4).

Thus, the concern is to omit the influence of the certified seed industry from the Scottish statistics. Ideally it would be helpful to know how Scottish crop yields might be influenced by certified seed crops, since such crops are sometimes stopped relatively early to ensure that the proportion of tubers suitable for seed samples is maximised, and crop yield is consequently reduced below what it might have been if the crops had been grown to full maturity. However, a large proportion of crops have been grown on a 'seed-cum-ware' basis, that is, grown to full maturity to maximise the ware content of yield (Produce Studies, 1973), and from the overall statistics there appears to be no obvious difference between size of crop yields in England and Wales, and Scotland.

So it is probably sufficient to weight the Scottish yields on the basis of the estimated proportion of acreage planted with crops grown for ware, and those certified for seed (this can be done by using estimates of maincrop acreage for seed, supplied by the DAFS). The intention is to combine the national estimates to derive varietal crop yield advantages for Britain as a whole. This is done in table 8.2.

TABLE 8.2 Derivation of Pentland Crown's and Pentland Dell's crop yield advantage

Year	England and Wales weight	Scotland weight	% of Scottish maincrop planted with ware	Scottish amended weight	England and Wales amended weight	Pentland Crown yield advantage		Pentland Dell yield advantage		Pentland Crown combined	Pentland Dell combined
						E & W	Scot	E & W	Scot		
1965	.79	.21	.45	.09	0.91	2.7	1.4	3.0	1.4	2.6	2.9
1966	.80	.20	.50	.10	0.90	1.9	1.0	3.9	2.4	1.8	3.7
1967	.80	.20	.49	.10	0.90	2.3	0.7	2.1	0.8	2.1	2.0
1968	.82	.18	.49	.09	0.91	1.8	0.9	2.4	1.0	2.2	2.3
1969	.82	.18	.49	.09	0.91	1.7	0.6	1.3	0.2	1.6	1.2
1970	.82	.18	.46	.08	0.92	1.2	0.9	0.8	1.1	1.2	0.8
1971	.83	.17	.46	.08	0.92	2.2	1.0	1.9	1.3	2.1	1.9
1972	.83	.17	.46	.08	0.92	1.8	1.0	1.4	-0.4	1.7	1.3
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)

Note: Calculated from tables 8.1 and 8.3

TABLE 8.3 Planted acreages of Majestic, Pentland Crown and Pentland Dell, Great Britain

	(a)			(b)			(c)		
	Total planted acreage			Scottish certified seed acreage			Estimated ware acreage		
	M	PC	PD	M	PC	PD	M	PC	PD
1964	267185	-	-	32979	304	530	234206	-	-
65	268505	7222	3841	30928	696	1498	299435	6526	2685
66	231956	16073	15535	22068	1673	3965	209888	14420	11570
67	215105	32847	50709	17382	3553	9209	197723	29294	41500
68	171382	52637	67385	12131	5842	9115	159251	46795	58270
69	123241	49564	36515	8785	7817	6456	114456	41747	30059
70	108964	109298	50373	6758	8882	7472	102206	101826	42901
71	72948	120705	54415	4083	9591	7831	68865	111124	46583
72	48579	114387	49890	3405	7509	5414	45174	106873	44476
73	28372	100892	44715	2334	6414	3602	26038	94478	41113

Note: Estimate ware acreage derived from subtracting (b) from (a)

Sources: Calculated from DAFS register of certified potato seed crops and PMB/A.

The crop yield advantages of the new varieties for England and Wales, and Scotland are shown in columns (a) and (b). The proportions of the British acreage taken by the two areas are shown in columns (c) and (d), and after the proportion of the Scottish acreage taken by ware is calculated, column (e), these are amended to the proportions shown in columns (f) and (g). These amended proportions are than used as weights to combine the totals in columns (a) and (b) into totals, for Pentland Crown's and Pentland Dell's crop yield advantages for British conditions generally, columns (h) and (i) respectively.

Estimates of varietal acreages were obtained for use in this study from the PMB handbook (1972c op cit: table 2), and deflated to allow for acreage certified for seed[1] by varietal acreage statistics supplied by the DAFS: see table 8.3. These estimates are multiplied by the information derived in table 8.2 to obtain totals for 1965 to 1972 which approximate to the new varieties extra output. These are shown in table 8.4.

TABLE 8.4

Pentland Crown's and Pentland Dell's Extra Output

Year	Pentland Crown Extra Output (tons)	Pentland Dell Extra Output (tons)
1965	16968	7786
66	25956	42809
67	41521	83000
68	102949	134021
69	66795	36071
70	122191	34321
71	233360	88508
72	181693	53447

Note: Calculated from tables 8.2 and 8.3

[1] There are acreages certified for seed in England, but these represent a small proportion of the whole, see Appendix 14.

There are three features to note about these estimates for extra output. They must be regarded as only approximations. For example, prior to 1969 the PMB crop yield estimates were non-random, in a strict statistical sense, and, therefore, might not have been nationally representative. However, the estimates for extra output are crucial in the sense that they provide the basis for much of the arithmetic that follows.

Secondly, the estimates shown in table 8.4 constitute 'extra output' compared to a situation that would have existed without the new varieties.

However, this situation is inferred from actual observations. It is not possible to be certain what circumstances would have been in an alternative situation. For example, the observed crop yields of the substituted varieties might have been different. If the new varieties substituted Majestic on the best land than in an alternative situation, the crop yields of the older variety might have been higher than the observed ones (it was suggested that this might have happened in the early years of the new varieties' adoption, in respect to narrowing crop yield advantages, Section 7.7FN). On the other hand, the new varieties might have found particular application on soils less suited to Majestic, so that the acreage of the older variety became concentrated on land best suited to it, so that in an alternative situation its crop yields were on average lower than observed ones.

The third feature is that the estimates in table 8.4 are properly extra outputs, only in the period prior to the PMB acreage restrictions. That is, assuming that the PMB successfully adjusted quotas to specifically take account of the new varieties' additional contribution to the industry's supply potential. It is then possible, given this assumption, to suggest that the estimates of 'extra output' after the imposition of quotas in 1969, are those tonnages of potatoes that would have been produced by existing technology, and without the new varieties, on acreage additional to that actually planted in 1969 and thereafter.

8.3 Derivation of estimates for potato acreage freed as a consequence of extra output

It is now possible to derive estimates of the extent of extra potato acreage that would have been required to produce the new varieties' extra output. It is assumed that the extra output is necessary because the PMB should have allowed for the increase in supply potential when it imposed quotas. This might then reasonably be assumed equivalent to the acreage freed from potato production by the new varieties. Thus, freed acreage is simply the estimates for extra output in 1969 and thereafter, shown in table 8.4, divided by the average crop yield per acre of the substituted varieties, see table 8.5.

TABLE 8.5

Pentland Crown's and Pentland Dell's contribution to freed acreage

Average crop yield older varieties (tons/ac)	Acreage of older varieties required to produce extra output PC	PD	Total
10.7	1586	728	2314
9.9	2622	4324	6946
10.4	3922	7981	11973
9.9	10399*	13537*	23936*
9.5	7031	3797	10828
10.8	11314	3178	14492
10.5	22225	8429	30654
10.1	17989	5292	53281
Total	58559	20696	79255
Annual Total	14640	5174	19814

Note: Calculated from table 8.4

In the context of the arithmetic and the task of deriving the measurement of effects upon costs, it is unnecessary to derive directly the estimates for freed acreage. Since more simply, the yield advantage of the new varieties could be expressed as a percentage of the substituted varieties crop yield, and for example, multiplied by costs associated with changes in acreage. So if £x per acre can be meaningfully related to marginal changes in planted acreage, and crop yield advantage is say, 10%, then costs saved as a result of freed acreage is £x per acre times 0.10 times the new varieties planted acreage.

Of course, the estimates of costs will remain the same, since the difference of approach is one of presentation only. Freed acreage is used here, as this gives a clearer impression of the magnitudes involved and is, therefore, more useful for purposes of exposition.

This suggests that the new varieties' increased crop yield potential was a significant factor in the process which brought about a smaller acreage. It also points to a significant contribution from other factors which worked to increase crop yield per acre.[1] It is likely that the pressures leading to a chronic over-supply had been under way for some time, hence the general rise in varietal crop yields (figures 7.1 and 7.2), and that the new varieties were only the straw (albeit a heavy one) to break the camel's back, and force the PMB to note a permanent change in the underlying conditions of supply.

There are two features to note about the estimates for freed acreage, table 8.5. They assume that the proportion of waste in the extra output is similar to that which would have been produced by the output of the substituted varieties on the freed acreage. Otherwise, if the new varieties say, produced an extra output with very little waste at grading then possibly more acreage than that shown in table

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[1] Of course, a fall in consumption per head of population such as that which occurred in the late 1960s (Section 12.10) will have aggravated the trading situation: it is not known how the PMB took this factor into account in its quota imposition (changes in demand might have been viewed as temporary).

8.5 would have been required with the older varieties, if an amount equivalent to the extra output that is destined for human consumption is to be produced.

The second feature is that PMB quotas work in a blanket-like fashion upon plantings so that all growers are affected, whether they plant the new varieties or not. This suggests that it might have been possible that the increased output potential of the new varieties was to some extent, off-set by reduced plantings of varieties such as King Edward VII, and hence that the crop yields used to derive freed acreage are inappropriate and should include an allowance for King Edward VII. There might have been a tendency for King Edward's plantings to have been affected in the short term, but there is no indication that plantings were significantly affected (see Section 12.7).

8.4 The measurement of effects upon market price, grower market revenue and surpluses, prior to 1969

A good indication of where the effects of the SPBS's innovation might have been felt was given above (Section 8.1); this section makes an attempt to measure effects upon market prices, grower revenue, and surpluses of the new varieties' extra output prior to 1969. Taking revenue, the market value to growers of the new varieties' extra output is the tonnage (table 8.4) times average market price (table 7.7: column (c)). Rounding the estimates down to take account of the influence upon average market price of the higher priced red-skinned varieties, totals are derived indicative of extra market revenue from higher yields, (see table 8.6).

Even after allowing for rounding down, it is likely that these figures are over-statements of the market return to the extra output. Since they still assume that nearly all of the extra output can be sold for human consumption at prices close to the market average.[1] There might have been an extra market return associated with Pentland Crown's scab resistance.

Taking the variety's planted acreage and multiplying it by crop yield, estimates of output are obtained. If it can reasonably be assumed that between 2% and 4% of this output would have been lost if Majestic had been grown instead of Pentland Crown (see Section 7.8), then taking these proportions of the new variety's annual outputs and multiplying them by average market prices, produce values for extra market returns associated with common scab resistance. On average for 1965 to 1972, approximately £0.243m to £0.486m market revenue was received annually. It is likely that the lower figure is closer to reality, since it is possible that sometimes, Pentland Crown samples can be affected by scab to a significant extent (ibid, table 7.4).

The effect of the new varieties' extra output upon surpluses can be inferred, if extra output is expressed as a percentage of surpluses, see table 8.6. It seems reasonable to suppose that only in 1968 did the new varieties contribute substantially, when a potential balance between supply and demand might have been turned into a surplus.

TABLE 8.6

Estimates of extra output contribution to surpluses, market revenue (£1971ms)

		Extra output as % of surplus			Contribution to total costs of market support	
		PC	PD	Combined	PC	PD
	(a)		(b)		(c)	
1965	0.4	2	1	3	0.226	0.113
1966	1.7	-	-	-	-	-
1967	2.2	5	11	16	0.500	1.100
1968	4.4	51	66	117	1.150	1.150

Note: Calculated from tables 7.7, 6.1, 6.2 and 8.4

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[1] If allegations that growers have been able to unload bulk supplies of poor quality produce are correct, then the exaggeration is probably small, see Chapter 12.

It is possible to judge the impact of what this might have meant for average market price, by looking at other seasons when supply and demand were approximately in balance. Two such years were 1962 and 1969; taking an average of market prices in these two years, that is £25.14 per ton, and comparing it to that in 1968 (table 7.7), a price difference of £6.51 is obtained. Assuming that around 4.9m of maincrop potatoes went for human consumption in 1968 (table 10.4), then multiplying this by £6.5, suggests that the loss to growers in market revenue was around £31.85m. This is more than enough to off-set the gain to growers of the new varieties from the sale of extra output: in fact, a net loss of around £23m.

Of course, here is a gain to consumers, in that they were able to buy their potatoes at a generally lower price. The extent to which this happened would be dependent upon the price fixing practices of the retail (and to a lesser extent) wholesale trades. In fact, retail prices for white-skinned potatoes in 1968/69 were low when compared to those of the following season, 1969/70, 1.83 compared to 2.37p per lb (in real terms, estimated on the basis of retail prices in Appendix 15). The difference works out at £12.1 per ton, which at a human consumption rate of 4.9m tons is a price gain of £59.3m: that is, at over a pound per head of population. This does of course, assume that the 1968/69 and 1969/70 seasons are comparable: if so, this is a significant distributional benefit of the SPBS innovation.

However, there is a cost in terms of surplus disposal and market support, in addition to the effects upon growers' incomes. This might be inferred by assuming that the new varieties contribution to surplus costs is proportional to their contributions in terms of extra output. So multiplying the total costs of surpluses by the varieties' proportional shares of surplus, columns (b), the varietal contributions to costs are obtained, columns (c), table 8.6. Of course, in 1968, the whole of the cost is assumed caused by the new varieties.

Not all of surpluses are wasted, some will be used for stockfeed and some small tonnages used for other activities. The value of stockfeed was in 1968 around £0.8m, and in 1968 and 1967, apportioned upon the basis of assumed varietal contribution to total surplus, approximately £0.09m and £0.42m respectively (estimated from information in table 10.2).

It is assumed that for 1969 and thereafter, the new varieties made no significant contribution to changes in market price, due to effects upon general trading conditions. It might be possible that increased crop yield potential, at the expense of planted acreage, somehow causes output to be more volatile. There does not seem to be any evidence to indicate that this is so. However, if there are important cost changes resulting from the SPBS's innovation, these might become reflected in market prices.

8.5 Changes in the production costs of growers of the new varieties

When the new varieties' extra output was being considered above, this was in comparison to Majestic and to a far lesser extent, other minor varieties, such as Redskin and Kerr's Pink (particularly in Scotland). Very little is known about the costs of growing minor varieties and for this reason they will not be considered specifically in the measurement of costs. This is unlikely to make any significant difference to the overall estimates, since the commercial importance of Majestic has been overwhelmingly predominant.

As indicated in Chapter Seven, the main cost categories likely to have been affected by the substitution of Pentland Crown and Pentland Dell for Majestic, are those of seed, spraying and some labour and machinery costs. These are considered separately below.

(a) Seed costs

Varietal certified seed and own-grown seed costs per acre were derived in Chapter Seven for Majestic, Pentland Crown and Pentland Dell (see tables 7.6 and 7.8). It appeared that the older variety was less costly to plant for both types of seed. However, to know how the total seed cost associated with planting the new varieties, compare; to the cost of just planting Majestic, it is necessary to know in what proportions certified and own-grown seed were used for the new varieties, and would have been used if Majestic had been planted.

The varietal certified seed to ware acreage ratios, see table 7.9, give only a rough impression of the use of certified and own-grown seed. However, the lowest ratios may be used to infer what certified seed acreage produces in terms of ware acreage (similarly to the example used to illustrate that Pentland Crown's ware acreage was probably planted with once and more own-grown seed, see Section 7.9). Once an estimate is obtained that is indicative of what certified seed produces, then from a consideration of varietal certified seed acreages (in table 8.3), it is a simple matter to estimate the likely proportions of the following ware acreage planted with the two kinds of seed.

Pentland Dell exhibits the smallest ratios. It is possible that these might have been affected to some extent by the variety's blight immunity breakdown and associated limitation of the demand for certified seed. Thus it seems reasonable to take a ratio after the effects had probably been felt, but before the troubles associated with Pentland Crown's storage problems (it seemed possible that some growers might switch from Pentland Crown to Pentland Dell). The ratio for 1970/71 was chosen, 1:6.2; that is, it was assumed that an acre of certified seed was likely to result in 6.2 ware acres.

Multiplying the varietal certified seed acreages by 6.2 and subtracting the results from observed ware acreage in the following season (table 8.3) gives estimates indicative of the ware acreage planted with certified and own-grown seed respectively. The estimates are shown in table 8.7. The figures in parenthesis denote the use of own-grown seed as a proportion of ware acreage. These seem reasonable. For example, the PMB 1968 maincrop survey suggested that around 33% of acreage was planted with own-grown seed (PMB 1968a op cit): Majestic was still the dominant variety at that time and its proportion in table 8.7 indicates a use for own-grown seed of 32%.

TABLE 8.7

Varietal acreages estimated as planted with different types of seed

	Majestic		Pentland Crown		Pentland Dell	
	CSA*	OGA**	CSA	OGA	CBA	OGA
1965	204470	94963 (32)	1885	4641 (71)	2685	-
1966	191754	18134 (9)	4315	10105 (70)	9288	2282 (20)
1967	136822	60901 (31)	10373	18921 (65)	24583	16917 (41)
1968	107768	51483 (32)	22029	24766 (53)	57096	1174 (2)
1969	15212	39244 (34)	36220	5527 (13)	30059	-
1970	54467	47739 (47)	48465	53361 (52)	40027	2874 (7)
1971	41900	26965 (39)	55068	56056 (50)	46583	-
1972	25315	19859 (44)	59464	47414 (44)	44476	-
	(a)	(b)	(c)	(d)	(e)	(f)

The low use of own-grown seed for Majestic in 1966 might be associated with the rapidly increasing commercial success of the new varieties about that time: Majestic growers might have cut down on plantings of own-grown seed, whilst at the same time taken up the new varieties. The greatest use of own-grown seed for crops of Pentland Dell occurred during the years of the variety's greatest acreage expansion, and the decline in usage thereafter might be associated with blight immunity breakdown and what has been stated above (Section 7.9) about the use of bold seed. The low use of own-grown seed for crops of Pentland Crown in 1969 might also be associated with Pentland Dell's sudden loss in popularity and consequent strengthened demand for Pentland Crown.

The costs of growing Pentland Crown and Pentland Dell are now obtained by multiplying the acreage proportions of the two kinds of seed by the appropriate costs per acre lists in tables 7.5 and 7.7. However, to be able to compare these with the seed costs of Majestic, if it had been planted on the new varieties' ware acreage, it is necessary to derive a new list of estimates of acreage. This is done by taking the proportions of Majestic's actual planted ware acreage, taken by own-grown seed and applying it to the new varieties acreage. So, for example, in 1965 the proportion of Majestic's ware acreage planted with own-grown seed was 32%.

If it can reasonably be assumed that if Majestic had been planted on Pentland Crown's ware acreage in 1965, 32% would have been sown with own-grown seed, then the acreage of Majestic that would have been planted with the two kinds of seed works out at 4438 and 2088 acres for certified and own-grown seed respectively: which is 68% and 32% of Pentland Crown's ware acreage in 1965.

The proportions attributed to the two kinds of seed for Majestic, planted on Pentland Crown's and Pentland Dell's ware acreage, 1965 to 1972, are listed in table 8.8. To estimate the cost, the information with regard to Majestic in tables 7.5 and 7.7 is used as above and seed costs compared in table 8.9. It is to be seen that seed costs were lower only in the instance of Pentland Dell, during the period 1969 to end-1971. The main reason is the low certified seed cost of this variety and the decline in its popularity following the blight immunity breakdown. Despite Pentland Crown's virus resistance and associated greater use of own-grown seed, it is seen that the high certified seed price and greater seeding rate are sufficiently important

TABLE 8.8

Majestic acreage planted with different types of seed, if the variety had been planted on Pentland Crown's and Pentland Dell's acreage

	Majestic on Pentland Crown ware acreage		Majestic on Pentland Dell ware acreage	
	CSA*	OGA*	CSA	OGA
	(a)	(b)	(c)	(d)
1965	4438	2088	1826	859
1966	13122	1298	10529	1041
1967	20213	9081	28635	12865
1968	31821	14974	39624	18646
1969	27553	14194	19839	10220
1970	53968	47858	22738	20163
1971	67786	43338	28416	18167
1972	59852	47026	24907	19569

Notes: * acreage which might have been planted with certified seed

** acreage which might have been planted with own-grown seed

TABLE 8.9

Seed costs compared on planted acreage (£'000s)

	Cost of Majestic on Pentland Crown ware acreage		Cost of Pentland Crown		Cost of Majestic on Pentland Dell ware acreage		Cost of Pentland Dell	
1965	107	31	92	79	44	13	132	-
1966	276	18	194	162	221	15	418	34
1967	606	118	456	284	859	167	1082	237
1968	700	255	793	495	872	317	1142	21
1969	606	185	833	83	436	133	541	-
1970	1619	622	1599	800	682	262	841	40
1971	2034	780	1817	1121	852	327	1025	-
1972	1676	517	1843	569	697	215	1290	-

Note: Calculated from tables 8.7 and 8.8

to suggest that the new variety has had associated with it higher seed costs than Majestic might have had.

(b) Spraying costs

Varietal spraying costs per acre (materials only) were derived above (Section 7.10) from information gathered from the PMB 1969 main-crop survey, see table 7.11. These suggest that the differences in growing costs per acre for planting Majestic instead of Pentland Crown, Pentland Dell in the period up to and including 1968, and the period thereafter, have involved savings of £o.77, £0.79 and £2.39 per acre respectively. Multiplying these estimates by the new varieties planted acreage derives totals that might be indicative of extra costs associated with growing the new varieties.

(c) Labour costs

In principle the labour costs associated with spraying might be derived in the same way as the material costs, upon the basis of observations made in the PMB 1968 maincrop survey, see above (Section 7.11). Unfortunately, the information about labour costs associated with spraying cannot be taken from the 1970 cost survey, but must instead be taken from the costs handbook (PMB, 1972c op cit).

There it is assumed that spraying equipment consists of a hundred gallon tank and that 25 acres are covered per day: regular labour is used, working an eight hour day, at an hourly rate of £0.40 (not £0.45 as the handbook suggests: the higher figure was used in the handbook to allow for overtime payments). Data from the 1968 maincrop survey suggests that crops of Majestic, Pentland Crown and Pentland Dell, up to end-1968, received three spray applications: and Pentland Dell after 1968, five. This is based on the assumption that spraying is determined by the need to apply fungicide and haulm defoliant (that is, that pesticides are applied with fungicide).

The cost is worked out upon a per acre basis, according to the principles laid down in the handbook and then multiplied by the varietal crop proportions considered to have had spray treatments (in the 1968 survey). The derivation of total spraying costs per acre are shown in table 8.11. The costs per acre associated with Pentland Crown are shown as greater by £0.079 than those suggested for Majestic: for Pentland Dell prior to end-1968, greater by £0.41, and post-1968, greater than Majestic by £0.454 per acre. These are multiplied by the new varieties planted acreage to obtain estimates of extra costs associated with growing the new varieties.

TABLE 8.11

Estimated varietal labour costs associated with spraying (£ per acre)

	Pesticide (a)	Fungicide (b)	Herbicide (c)	Haulm defoliant (d)	
Majestic	0	0.384 (.50)	0.128 (.4)	0.128 (.59)	= 0.319
Pentland Crown	0	0.384 (.68)	0.128 (.38)	0.128 (.69)	= 0.398
P.D. to end 1968	0	0.384 (.55)	0.128 (.48)	0.128 (.68)	= 0.360
P.D. post 1968	0	0.64 (.94)	0.128 (.48)	0.128 (.86)	= 0.773

PC M = .079; PD 68 M = .041; PD p68 M = .454

Notes: Figures in parentheses denote proportions of varietal acreage likely to receive applications

Calculated using table 7.10

The herbicide category is interesting, since it is possible that herbicides allow growers to minimise cultivations (Evans, 1972).[1] That it might be assumed that where herbicides are applied say, one less cultivation is required. Using the PMB handbook again, the most appropriate cultivation to be affected is ridging: it is assumed that the equipment was a mould board ridger, capable of covering ten acres

[1] There might also be advantages associated with increased crop yield and faster harvesting (Evans ibid): but these do not seem to have been measured.

per day. The cost under this assumption works out at £0.32 per acre. Pentland Crown and Pentland Dell according to the 1968 crop observations had 2% less and 8% more of their acreage treated with herbicide than did Majestic (table 7.10) and, therefore, extra costs of £0.32 per acre associated with 2% of Pentland Crown's acreage and savings of that amount associated with 8% of Pentland Dell's acreage.

Of the other labour costs associated with growing the new varieties, only those associated with grading are relatively simple to derive. Both Pentland Crown and Pentland Dell seem to require care in handling and inspection, in activities concerned with such as chitting and planting, harvesting and storage (Chapter 7). There is no reliable information on which to base measurement of labour time spent upon these factors.

To derive grading costs, the assumptions of the 1970 PMB cost survey are used (Section 6.8), with the difference that it is assumed that only a quarter of the output is handled by casual labour; that is, for 25% of the output, four of the six workers are casually employed. The labour cost per ton in the all regular labour instance is £0.80 and where casual labour is used, £0.67 (£0.27 and £0.40 per ton, for the regular and casual labour respectively). Multiplying these estimates by the new varieties extra output (table 8.4), produces totals indicative of extra grading costs associated with the new varieties, see table 8.12.

TABLE 8.12 Estimated varietal gradings costs (£000s)

	Pentland Crown	Pentland Dell	Pentland Crown		Pentland Dell	
	RL	RL	RL	CL	RL	CL
	(a)	(b)	(c)	(d)	(e)	(f)
1965	10	5	1	2	1	1
1966	16	26	2	3	3	4
1967	25	50	3	4	6	8
1968	62	80	7	10	9	13

Notes: RL = regular labour costs; CL = casual labour costs .

No grading costs are derived for the period after 1968, since the imposition of quotas in 1969 should have compensated for the extra output from higher crop yields. Although of course, there might still have been grading cost differences stemming from the substitution of Majestic, if the new varieties first order quality was such that grading practices were somehow altered. In addition, as regards the estimates prior to 1969, it is by no means certain that grading costs can be meaningfully related to weight of output (Section 6.8), particularly if samples were marketed without proper inspection. For these reasons, such estimates of grading costs might be exaggerated.

(d) Machinery costs

There are probably consequences for machinery costs (and associated running expenses to do with building costs) from the replacement of Majestic by the new varieties: such factors as tractor time (affecting fuel and repairs) involved with spraying and harvesting. Given the 1968 varietal maincrop observations, only those costs associated with spraying can be indicated, if the same approach as that used for materials and labour is followed (that is, by assessing the proportions of acreage affected).

A cost estimate for fuel and repairs per acre of maincrop is provided by Nix (1972). This is put at £8, which is close to the 1970 PMB estimate of £9 per acre: it was decided to use the former, because of the depreciation element present in the PMB estimate (a factor not dependent upon varietal use in a direct sense, but upon machinery price and obsolescence considerations).

However, the figure of £8 covers all potato husbandry activities, including the costly one of harvesting. The 1970 PMB cost survey suggested that about two-thirds of labour cost was associated with harvesting; therefore, the machinery cost per acre estimate might be scaled down to something over two-thirds, say, one-fifth as associated with spraying activities. The cost differences between growing the new varities instead of Majestic are shown in table 8.13. Multiplying these by the new varieties planted acreage derives estimates of extra costs associated with growing the new varieties.

TABLE 8.13

Estimated varietal machinery costs associated with spraying (£'000s)

	F	H	C	HO
Majestic	4.5 (.50)	1.5 (.40)	1.5 (.60)	1.5 (.59) = 4.64
Pentland Crown	4.5 (.68)	1.5 (.38)	1.5 (.72)	1.5 (.69) = 5.75
Pentland Dell to end 1968	4.5 (.58)	1.5 (.48)	1.5 (.52)	1.5 (.68) = 5.13
Pentland Dell post 1968	7.5 (.94)	1.5 (.48)	1.5 (.52)	1.5 (.86) = 9.84

PC M = 1.11; PD M = 0.49; PDB M = 5.20

Notes: Figures in parentheses denote proportions of varietal acreage likely to receive applications.

Calculated using table 7.10

(e) Summary of extra costs associated with growing the new varieties instead of Majestic

The annual additional costs associated with growing the new varieties instead of Majestic are shown according to cost factor category in tables 8.14 and 8.15, for Pentland Crown and Pentland Dell respectively. Given the assumptions underlying the estimates shown, perhaps those for machinery and grading costs are the least reliable. It must be remembered in any case, that these are estimates and of a very rough kind. However, they do provide insights into the relative importance of different cost categories.

The cost estimates are high and indicate clearly that the new varieties have probably been more costly to grow per acre than Majestic might have been. In total the extra costs on average per annum are approximately £0.260m and £0.300m for Pentland Crown and Pentland Dell respectively. This represents around £4 and £7 per acre extra, for Pentland Crown and Pentland Dell compared to what Majestic might have cost. These high estimates were not obvious at the start of this study.

TABLE 8.14

Extra costs associated with Pentland Crown's planted acreage

	seed	Spraying mat.	lab.	cult.	grad.	mach.	Total
1965	33	5	1	-	13	7	59
1966	62	11	1	-	21	16	111
1967	16	23	2	-	32	33	106
1968	333	36	4	-	79	52	504
1969	125	32	3	-	-	46	206
1970	158	78	8	-1	-	113	356
1971	124	86	9	-1	-	123	341
1972	219	82	8	-1	-	119	427

TABLE 8.15

Extra costs associated with Pentland Dell's planted acreage

	seed	Spraying mat.	lab.	cult.	grad.	mach.	Total
1965	75	2	-	-	7	1	85
1966	216	9	-	-	33	6	264
1967	293	33	2	1	64	20	413
1968	26	46	2	2	102	29	207
1969	-28	72	14	1	-	156	215
1970	-63	103	19	1	-	223	283
1971	-154	111	21	1	-	242	221
1972	378	106	20	1	-	231	736

Previous work at the SPBS suggested that the new varieties had entailed little or no extra costs, that the revenue from difference in output, was virtually 'free profit' (Simmons, 1974 op cit: p.15). It was thought that Pentland Crown's virus resistance and Pentland Dell's blight immunity prior to 1967 would have reduced seed and spraying costs respectively.

The only cost category to exhibit significant savings is that of seed, in the instance of Pentland Dell. This appears to be associated with the variet·'s bligh immunity breakdown and consequent fall in popularity and certified seed price. There might have been some small savings associated with fewer cultivations on crops of Pentland Dell, but it seems too small to attach any significance to the estimates.

8.6 Cost savings consequent upon freed acreage

The greatest impact of the new varieties upon costs is likely to have been felt after quota imposition in 1969, and associated with savings resulting from a reduced acreage. Some costs will have been saved approximately in proportion to acreage taken out of production. With these it is a relatively straightforward process of estimating Majestic's cost per acre and multiplying this by the freed acreage contributable to the new varieties (table 8.5), to derive saved costs. Other costs might be affected less directly and these cannot be easily measured.

Those cost categories which can be most closely related to acreage are seed, rent, the PMB levy (these three are the most directly linked), fertilisers, spraying costs and to a lesser extent, labour and machinery costs. Where possible the costs estimated as saved as a result of reduced acreage, should be those of Majestic. This is easily done with seed and spraying, since estimates of costs per acre have been derived for Majestic above (tables 7.5, 7.7 and 7.11).

The spraying cost of Majestic was put at £4.27 per acre. For seed, it must be established what acreage of that freed, would have been planted with certified and own-grown seed, so that the freed acreage associated with each type can be valued by the appropriate seed cost per acre. Using the derived proportions of Majestic's actual acreage planted with own-grown seed (table 8.7), this is done in table 8.16.

TABLE 8.16

Varietal seed costs saved, associated with freed acreage contributable to Pentland Crown and Pentland Dell (£1000s)

	% PC FA planted with Majestic		% PD FA if planted with Majestic		Cost PC		Cost PD	
	CS	OGS	CS	OGS	CS	OGS	CS	OGS
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
1969	4640	2391	2506	1291	107	31	58	17
1970	5996	5318	1684	1494	192	69	54	19
1971	13557	8668	5142	3287	434	156	165	59
1972	10074	7715	2964	2328	302	87	89	26

Notes: FA = freed acreage; CS = certified seed;
OGS = own-grown seed.

The other cost categories are not easily associated with Majestic specifically. Given the lack of specific information about this consideration, it is necessary instead to use average estimated of costs per acre. For rent, the lower handbook estimate is preferred to the one given as a result in the 1970 PMB cost survey, that £8 per acre (Section 6.12). The PMB levy is charged on a per acre basis and so will be saved (for the grower) with reduced acreage. However, in 1971 the PMB increased the levy to take account of a falling income from reduced plantings. Thus, from that time no savings are assumed. The rate assumed for the levy is £3.24 per acre.

Fertiliser cost savings are assessed at the result derived from the 1970 PMB cost survey, at £22 per acre. Labour costs are also taken from the PMB survey result, that is, for husbandry activities up to and including harvesting: the estimated cost is £21.82 per acre. This figure is chosen primarily for convenience since labour time depends so much upon a combination of factors (Section 6.8), that the relationship of cost with marginal changes in acreage must be uncertain.

Grading is not allowed for, given the method of measurement, which derives freed acreage estimates from extra output: the grading costs saved as a result of reduced acreage will be off-set exactly by the cost of grading the extra output from the new varieties higher yields, after 1968. For an estimate of machinery costs saved per acre, the Nix estimate of £8 is preferred to the 1970 PMB cost survey result, to exclude the latter's allowance for depreciation (Section 6.9). The cost of capital equipment (and buildings) will after acreage reduction, have to be spread over a smaller planted acreage (but tonnage will remain approximately the same for the industry generally).

Other costs such as storage, chitting and irrigation are unlikely to change very much with marginal changes in acreages (see Section 6.1a). These are, therefore, left out of consideration.

Summaries of estimates of costs saved are given in tables 8.17 and 8.18, for freed acreage associated with Pentland Crown and Pentland Dell respectively. It is seen that the largest categories are those of seed, followed by fertilisers and labour. In total, saved costs associated with reduced acreages appear to have been large; around £1.298m and £0.458m annually between 1967 and 1972, for Pentland Crown and Pentland Dell respectively. They represent an annual range of £84 to £91 per acre for both varieties; which is about 50% of the 1970 PMB cost survey estimate of total cost per acre, or about 60% of those costs which might vary with acreage.

TABLE 8.17

Costs saved associated with freed acreage brought about by Pentland Crown

	Seed (a)	Fert. (b)	Spray Mat. (c)	Lab. (d)	Mach. (e)	Levy (f)	Rent (g)	Total
1969	138	155	30	153	58	23	56	611
1970	261	249	48	247	91	37	91	1024
1971	590	489	95	485	178	-	178	2015
1972	389	396	77	393	144	-	144	1543

TABLE 8.18

Costs saved associated with freed acreage brought about by Pentland Dell

	Seed (a)	Fert. (b)	SPS (c)	Lab. (d)	Mach. (e)	Levy (f)	Rent (g)	Total
1969	75	84	16	83	30	12	30	330
1970	73	70	14	69	25	10	25	286
1971	224	185	36	184	67	-	67	763
1972	115	116	23	115	42	-	42	453

8.7 Conclusion to Chapter

If these cost savings are combined with the extra costs associated with planted acreage, then it seems that the SPBS innovation prior to 1969 raised potato costs around £0.437m annually and, thereafter, lowered them by about £1.060m annually. Given a human consumption of four million tons, the overall impact of the cost savings after 1969, on an annual basis, is very small indeed in terms of final retail price (if the benefit were passed on). The saving works out at around £0.265 per ton of potatoes going for human consumption, and after allowing for an average mark-up of 160% (Section 12.10), the effect spread across all potatoes sold for human consumption upon retail price might be around 0.0003p per lb.

An overall summary of the effects which the SPBS innovation has had upon the potato industry between 1965 and 1972 is presented in table 8.19. These cover only those effects which lend themselves to measurement. The effects upon the distributive trades, processing industry and catering trade, are uncertain; the possibility that they might have been affected has been discussed below (Section 10.10). Attempts are made elsewhere to assess the impact of the new varieties upon the certified seed industry (Section 11.4), and the importance of varietal quality to the final consumer (Chapter 12).

This chapter has been concerned with pecuniary costs and benefits, it has not sought directly to measure resource cost. Table 8.19 notes measurements of financial cost and benefit in relation to which group they affect. However, most of the information derived in this chapter about potato production costs will be of relevance to the measurement of resource cost and the derivation of a rate of return.

TABLE 8.19

Main measurements of the innovation's effects within the potato industry

Sector	Costs	Benefits	Balance
Growers	Market revenue lost from competition with extra output, 1965-68; £m4.46.	Market revenue gain from extra output 1965-68: £m8.70	+ 4.24
	General surplus effect on revenue 1968: £m26.00	Growing costs saved associated with freed acreage 1969-72: £m7.02	+ 2.49
	Extra varietal growing costs, 1965-72: £m4.53		- 26.00
			- 19.27
Consumers		General surplus effect on prices, 1968: £26.00m. Uncertain price effect consequent upon cost changes	+ 26.00
			+ 26.00
PMB	Market support operations 1965-68: £m4.24		- 4.24
	Levy income losses 1969-70 £m0.08		- 0.08
			- 4.32

CHAPTER NINE

Derivation of social rates of return to investment cost

9.1 Potato production costs and resource cost

The aim of this chapter is to derive estimates of social rates of return to the SPBS investment cost derived in Chapter 5. In the first instance, rates of return will be derived upon the basis of resource cost changes within agriculture for 1965 to 1972. To test the sensitivity of certain cost factors, some alternative methods are applied. Then the impact of several considerations upon these rate of return estimates is considered in the following order: the resource costs involved with market support operations, the timing of acreage restrictions, future returns after 1972, and the contribution of other SPBS varieties. Lastly, some observations are made as to the significance and comparability of the rate of return estimates.

The measurements of the effects of Pentland Crown and Pentland Dell have had upon production costs are summarised in tables 8.14, 8.15, 8.17 and 8.18, and may be used to derive a resource cost rate of return, to the estimated costs of investment derived in Chapter 5. The resource cost criterion involves the measurement of resources in terms of their productive potential in a next best alternative. Thus, if the cost information derived in Chapter 8 is to be used in the rate of return arithmetic, it is necessary to be reasonably sure that estimates reflect these opportunity costs.

The only cost category considered in the tables which is not obviously a reflection of production opportunities elsewhere is that for the PMB levy. This is a subscription and, therefore, reflects no change in resource use, it is essentially a transfer of grower's incomes to the PMB: hence, a reduction in acreage, merely transfers money back from the PMB to growers.[1] Thus, this category is omitted from the measurements of resource cost.

Of the other cost categories in the tables, all are relevant to resource cost, but it is less certain whether the market values used as a basis for deriving the cost estimates are adequate reflections of opportunity cost. There are several instances of doubt which it is as well to note, so that the estimates which go to make up resource cost might be qualified.

The value of own-grown seed was estimated upon a basis of market opportunity cost to growers, of not selling the seed to the ware market (Section 7.11). This is not altogether meaningful in terms of resource use, since market price is dependent upon trading conditions as much as it is upon the cost of producing potatoes for market. The question is whether the cost of resources which went into producing the seed is likely to be close to two-thirds of market opportunity cost.

Another possibility associated with seed costs is that the initially high prices of the new varieties' certified seed might have reflected monopolistic elements. That is, prices might not only reflect resource use in supplying seed, but also the exploitation of scarcity value. Unfortunately, very little is known about the costs of certified seed growers, to be able to state with certainty that the high prices might have meant that producers had been earning excess profits. If prices have contained monopolistic elements the effect will have been to cast

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[1] It might be thought that the levy reflects the resources used by the PMB to deal with surpluses: that therefore, because the acreage restrictions remove pressures to conditions which lead to surplus, then the levies saved as a result of reduced acreage reflect resources saved associated with the reduced need to cope with surpluses. It is doubtful if there is a meaningful relationship between levy and resource use in market support operations, however; for example, the PMB sought during the 1960s to have its levies increased since it was felt that running costs exceeded the PMB's income. In addition, it is impossible to have savings associated with not having the new varieties' extra output, since without the new varieties no extra output would have existed anyway.

a conservative bias upon the estimation of net benefit.

There is also uncertainty as to whether or not agricultural wage rates are an adequate measure of labour opportunity costs. A high proportion of casual labour used for potatoes might not have available to it alternative employment. This applies most notably to family labour (which could be important, for example, one observer reported an estimate which put family labour at about three-fifths of the total British farm work force, see Cherrington, 1973b). The resource cost of such labour is debatable. It may be seen as leisure time, which has been valued by some cost-benefit analysts at approximately 25% of average hourly earnings (CTLA, 1971: op cit).

Another approach might be to use a surrogate price based upon say, the earnings of domestic servants (as suggested by Weisbrod, (1960), to measure the opportunity costs of housewives). Such approaches produce results not dissimilar to the values for the market rate paid for casual labour in agriculture. Thus the casual labour estimates might not be exaggerated in terms of resource cost.

Another factor to be noted is the valuation of farmers' time. This was implicitly assessed in the previous chapter as equivalent to that of regular labour, since no special allowance was made for it in the labour cost estimates. However, it may be that farmers have entrepreneurial and management facilities which make their time more valuable in terms of alternative employment on other crops.[1]

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[1] If the resource cost rate of return is to be used to compare the productivity of investments in agriculture to that of investments elsewhere in the economy, then it is likely that many reasons have generally made agricultural wage rates basically lower than those for comparable skills outside agriculture (see Cherrington, 1972, and 1973a), and that, therefore, labour costs are less than their opportunity costs to the economy generally. However, it has been noted that given the degree of state interest in agriculture, it is not wise to compare rates of return to investment in agriculturally associated fields with those for investment elsewhere in the economy. See Section 2.6 and 9.14.

The opportunity cost of land has received a great deal of attention in studies associated with agricultural production. Conventionally, there are three ways to approximate the alternative value of land: to compute a standard interest rate on the sale value of land, to take the net return expected from an alternative crop or to use rent. Estimates of the latter were derived in Chapter 8 and so these will be used here.

There is some indication that rents have generally lagged behind increases in agricultural productivity. On the other hand, rent might include allowances for non-productivity factors, such as the value of other merits of having land, landlord costs and so on (see Wibberly and Boddington, 1970, for a full consideration of whether or not land rents and prices reflect productivity). This might off-set the importance of the lag factor. Land agents, Jones Lang Woolton, have been reported as believing that generally rents have been related to what farmers can afford to pay and therefore, productivity (Farmers Weekly, 1972).

Taking all these qualifying factors together, the effects in terms of distortions are probably not large, and within the distorting effects of errors which might reasonably be associated with the kind of general cost data used for this present study. In addition, to use the parlance of Prest and Turvey, the divergences from opportunity costs are "unknowable" and not "obvious", and, therefore, can be ignored (Section 2.6).[1]

9.2 The rotation factor

One factor not considered at all in the chapter on the measurement of effects within the potato industry was that of rotation. It has sometimes been suggested by observers that apart from sugar beet (a crop that is limited by quotas) potatoes are the only available cash crop*

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[1] However, since seed costs make up a large part of costs affected by the new varieties, this category is considered again on alternative assumptions, to test the sensitivity of the rate of return to this factor, Section 9.4

for breaking cereal rotations (for example, see Richardson, 1973): other crops might not be sufficiently profitable to be worthwhile. The EDCA has suggested that the continuous growing of cereals is a major cause of yield loss (1968).

The restriction of acreage brought about by quota imposition in 1969 will have limited potatoes for use in rotations. This is likely to have resulted in losses to cereal yield. If it can be assumed that this lost output is necessary so that extra resources have had to be spent on procuring it (say, by spending on products that canbe exported, so that foreign exchange may be earned and cereals imported), then the rotation factor is of relevance to resource cost.

Nix has noted that the effect of a break crop upon a following season's cereal crop yield is variable, given different conditions (op cit). He suggests that for winter wheat, a first crop after rotation might be two cwt. above average and thereafter, in subsequent years crops might yield two cwt. less. These estimates may be conservative with respect to potatoes, given the high applications of fertilisers potatoes generally receive and, therefore, the likelihood that a large residual remains for a following crop.

To arrive at an approximation of resource loss associated with the new varieties' contributions to freed acreage, it is necessary to assume that the market prices for cereals reflect the resources required to produce the cereals. In the years prior to 1972 market prices was generally below guaranteed levels (MAFF, 1974). It may be, therefore, that market price had been below the resource cost of producing domestic cereals. However, because the aim here is to derive a figure representative of the resources required to produce the cereal output loss through reduced rotations and given that this output would probably have had to have been imported (domestic cereal production has probably been close to the maximum possible with the available soils: see EDCA, 1968 op cit), this is not important.[1]

The resource cost of lost cereal yields is estimated for 1970 to 1972 only, because of a lag effect (rotation effects are, of course, felt subsequently to the year of a break crop), and found by first estimating the market value per acre of cereals. This is approximated by using the average annual market prices for wheat in the afore-stated years (£29.85, £24.11 and £32.61 per ton, respectively) and multiplying this by average annual wheat yields (table 9.11). Since not all of the national potato maincrop acreage is likely to be followed by cereal crops (and given that the most intensive arable acreage is located in the eastern and east midlands of England, see figure A13.3) the yield loss of 0.10 tons per acre by Nix is halved: then used to multiply the estimated market value of cereals per acre.

This derives totals of £2.5, £2.1 and £2.8 per acre lost annually per acre for each acre freed from potato production. To find the total cost, these estimates are simply multiplied by the freed acreage estimates in table 8.5. The results for Pentland Crown, 1970 to 1972, are £0.028m, £0.047m and £0.050m and Pentland Dell, £0.008m, £0.018m and £0.015m.

9.3 A social rate of return to potato R & D investment at the SPBS

Combining the estimates presented in tables 8.14, 8.15, 8.17 and 8.18 (excluding the levy category) with those costs associated with the rotation factor, produces estimates for resource cost, shown in column

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[1] This assumes that the resources expended in the UK on exports to pay for the additional imports of cereals is approximately equal to those expended upon cereal production overseas. A wider implication is that cereal production overseas is less resource costing than in the UK and that, therefore, it might seem that efficiency would be best served if the UK concentrated upon exports and grew fewer cereal crops. There are other advantages associated however, with a large domestic cereal production, most notably strategic ones (see EDCA, 1968 op cit).

(a) tables 9.1, 9.2 and 9.3, for Pentland Crown, Pentland Dell and both varieties combined, respectively. The estimates for the new varieties individually, tables 9.1 and 9.2 are subject to discount factors equal to 0 at the beginning of Pentland Crown's and Pentland Dell's development periods, 1951 and 1953 respectively: and in the instance of both varieties, table 9.3, the discount factor is 0 in 1922, at the start of the R & D programme at SPBS (see Section 5.4).

TABLE 9.1

Net benefit associated with Pentland Crown (£'000s)

	Net benefit	Discount factors		Discounted net benefit	
		5%	10%	5%	10%
1965	- 59	.505	.263	- 29.8	- 15.5
1966	- 111	.481	.239	- 53.4	- 26.5
1967	- 106	.458	.218	- 48.5	- 23.1
1968	- 504	.436	.198	-219.7	- 99.8
1969	382	.416	.180	158.9	68.8
1970	622	.396	.164	246.3	102.0
1971	1654	.377	.149	623.6	246.4
1972	1097	.359	.135	393.8	148.1
				1071.2	400.4

TABLE 9.2

Net benefit associated with Pentland Dell (£'000s)

	Net benefit	Discount factors		Discounted net benefit	
		5%	10%	5%	10%
1965	- 85	.557	.319	- 47.3	- 27.1
1966	- 264	.530	.290	-139.9	- 76.6
1967	- 413	.505	.243	-208.6	-108.6
1968	- 207	.481	.279	- 99.6	- 49.5
1969	103	.458	.218	47.2	22.5
1970	- 11	.436	.198	- 4.8	- 2.2
1971	532	.416	.180	221.3	95.8
1972	- 292	.396	.164	-115.6	- 47.9
				-347.3	-193.6

TABLE 9.3

Net benefit associated with Pentland Crown and Pentland Dell (£'000s)

	Net benefit	Discount factors		Discounted net benefit	
		5%	10%	5%	10%
1965	- 144	.123	.017	- 17.7	- 2.4
1966	- 375	.117	.015	- 43.9	- 5.6
1967	- 519	.111	.014	- 57.6	- 7.3
1968	- 711	.106	.012	- 75.4	- 8.5
1969	485	.101	.011	49.0	5.3
1970	611	.096	.010	58.7	6.1
1971*	2186	.092	.009	201.1	19.7
1972	805	.087	.009	70.0	7.2
				184.2	14.5

Note: *The year of break-even, when return had cumulated sufficiently to balance costs.

Given these very long time periods it is seen from the tables that the discount factors deflate resource cost considerably; this reduces net benefit, shown here as positive numbers, in relation to the earlier R & D cost. It is seen from the tables that Pentland Crown produces a sizeable net benefit, about £1.071m and £0.400m at the 5% and 10% discount rates respectively, over the 1965, to end-1972 period. Pentland Dell, on the other hand, might have led to an overall loss in resources, around £0.347m and £0.194m respectively. For both varieties, Pentland Crown's resource savings was probably enough to off-set the effects of Pentland Dell, so that net benefit was around £0.184m and £0.014m respectively.

Taking the cumulated R & D costs derived in the previous chapter and the cumulated net benefit in tables 9.1, 9.2 and 9.3, the latter may be expressed as a percentage of the former, to obtain rates of return, as shown in table 9.4. These suggest that for example at the 5% discount for Pentland Crown, £1 invested between 1951 and 1958 at the SPBS on the assumed development of the variety, yielded about £11 between 1965 and 1972. Which is more than £1 annually between 1965 and 1972. Pentland Dell does, of course, show negative rates of return, see table 9.4.

TABLE 9.4

Rates of return attributable to investment in R & D consequent on the success of Pentland Crown and Pentland Dell

	Pentland Crown	Pentland Dell	Both varieties
(a) Cumulated research expenses (£'000s)			
5%	98	79	300
10%	89	74	193
(b) Cumulated net returns (£'000s)			
5%	1071	-347	184
10%	400	-194	14
(c) Rate of return (100 $(\frac{b}{a})$ %)			
5%	1093	-493	61
10%	449	-262	7
(d) Rate of return as annual return 1965-72			
5%	137	- 55	8
10%	56	- 33	1

Pentland Dell's poor performance is to some extent a reflection of the timing of its blight immunity breakdown. The immunity lasted just long enough to ensure that the variety recorded the high growing costs prior to 1968 (comparable to those of Pentland Crown), but not enough to ensure that plantings would be increased after that time, when its extra output would have led to freed acreage and associated cost savings, on a scale at least equivalent to that of Pentland Crown's. Of course, had immunity breakdown occurred later than 1967, Pentland Crown's success might not have been so great.

9.4 The sensitivity of the rate of return to changes in seed cost assumptions

Of the doubts expressed above (Section 9.1) about whether potato production costs reflected resource opportunity cost, the most critical factor is that of seed. The estimates which are most suspect are those for own-grown seed cost per acre, for the years shown marked in table 7.8

with an asterisk: these are for totals based upon market opportunity costs when ware market prices were high because trading conditions reflected below average output conditions. Taking an average of the costs shown for other years and applying them to the asterisked seasons shown, produces own-grown seed cost of £12, £14 and £13 per acre, for Majestic, Pentland Crown and Pentland Dell respectively.

Similarly, if the certified seed costs per acre, shown in table 7.6 for the years 1964/65 to 1966/67 are adjusted to an average of the costs for 1969/70 and 1971/72; that is, £38 and £27 per acre for Pentland Crown and Pentland Dell respectively; to remove the possibility that prices reflect scarcity of the new varieties. Then the seed costs associated with the new varieties are those shown in columns (a), table 9.5. This changes net benefit to that shown in column (b), which changes the rates of return to those shown at the foot of table 13.5.

TABLE 9.5

Sensitivity of rates of return to changes in assumptions behind seed costs

	(a) Adjusted seed costs		(b) Adjusted net benefit		
	Pentland Crown	Pentland Dell	Pentland Crown	Pentland Dell	Both
1965	- 5	- 18	- 31	- 28	- 59
1966	- 32	- 49	- 81	- 97	-178
1967	46	125	- 44	5	- 39
1968	- 58	190	-229	9	-220
1969	13	103	382	103	485
1970	103	136	622	- 11	611
1971	783	330	1971	484	2455
1972	170	-263	1097	-292	805
	Discounted net benefit				
		5%	1367.4	67.9	347.9
		10%	530.1	25.7	33.9
	Adjusted annual rates of return	5%	174	11	14
		10%	74	4	2

It is seen that the overall effect is to increase the rates of return, by nearly 40% for the most favourable estimate, at the 5% discount rate for Pentland Crown. A notable feature is that Pentland Dell's rates of return have become positive. This points to the importance of the seed cost assumptions, particularly the question of whether it is valid to use the market value of the initially high prices of certified seed as indicators of resource cost.

It is, if these prices are truly indicative of the resources that went into the extension, multiplication of the new certified seed stock. One might expect the initially high costs of marketing the new varieties to have been passed on, eventually, in prices to ware growers. Unfortunately, little is known about such costs (Section 4.8 and 5.6). Thus, the original seed cost assumptions should be accepted, but recognised as a conservative influence on the rate of return arithmetic.

Little in general is known about what the effects of the new varieties might have been in the period immediately after their introduction, and prior to 1965. In particular, what the extent of the ware acreage of the new varieties might have been. It is likely that there were net resources costs incurred during that time since certified seed prices were very high. Given that the ware acreage of the new varieties was very small, it was decided to omit this consideration from measurement.

9.5 The sensitivity of the rates of return to changes in investment cost

The sensitivity of these rates to changes in investment cost are shown in table 9.6. They are similar at the 20% change to the results that come from changing the seed cost assumptions, but not quite as large. A 20% increase in investment cost, for example, produces approximately, a 35% increase in the annual rate of return for Pentland Crown at the 5% discount rate: given a 10% change, however, the rate is increased by 15%. For both varieties, rates are not very sensitive.

TABLE 9.6

Sensitivity of annual rates of return to changes in investment cost

		± 10% change	± 20% change
Pentland Crown	5%	124 to 152 %	113 to 172 %
	10%	51 to 62 %	47 to 70 %
Pentland Dell	5%	-61 to -50 %	-69 to -46 %
	10%	-36 to -30 %	-41 to -27 %
Both varieties	5%	7 to 9 %	6 to 10 %
	10%	1%	1%

Of the two approaches used to derive a rate of return, that is, apportioning R & D costs upon the basis of varietal development (to derive the Pentland Crown and Pentland Dell results, above), and using the whole of potato R & D costs to 1960 to compute a return (to derive the 'both varieties' results), the author prefers the latter. This is because it takes into account the whole system of R & D at SPBS, the principle aim of which, is to produce varieties like Pentland Crown and Pentland Dell (Section 5.4). Up until 1972, the success of Pentland Crown and Pentland Dell represented nearly the whole economic success, in terms of resource cost, of the system (the importance of other SPBS varieties is discussed in Section 9.10).

Thus, the relative insensitivity of the rate of return for 'both varieties' is important, as it affects the more significant of the two approaches used to derive investment cost. However, the derivation of rates for Pentland Crown and Pentland Dell is not pointless, rather it provides an indication of what returns might be from investment success associated with a future hybridisation and development programme apart from the investment in the whole R & D system. Also, it distinguishes between the contribution of Pentland Crown on the one hand, and Pentland Dell on the other. Seen in terms of the 'both varieties' approach, the commercial success of Pentland Dell actually reduced the overall return, off-setting to some extent the benefits from the commercial success of Pentland Crown. Commercial success does not guarantee an overall social benefit in resource terms. The assumptions behind the resource cost criterion presuppose the existence of alternative occupations for resources. Net benefit implies that production opportunities have somewhere been enhanced. In the above estimation of the rate of return, the alternative productivity of land was taken into account by inclusion of the rent cost category. It was noted, however, that an alternative measure is to consider more directly what the alternative to potato production is and consider the return to that alternative occupation (Section 9.1).

9.6 Alternative enterprise to that of potato growing: alternative method of deriving a rate of return

The attempt to derive a rate of return upon the basis of comparison of the potato to another enterprise raises the question of where potato land might otherwise be employed. No published information exists which specifically answers this. It is possible that the imposition of quotas might, for example, have resulted in land leaving agricultural production altogether. Total arable acreage declined by 2% between 1968 and 1972, of which a large proportion went to urban development, the remainder to animal rearing and forestry (MAFF statistics).

However, it is likely that potatoes are grown on some of the most productive soils in regions removed from large centres of urban development. Also, there is some evidence to suggest that because potatoes are a relatively large cost enterprise, they are not commonly grown on land marginal to agriculture (Gasson, 1966).

The potato acreage is only a small proportion of the total arable acreage and so it is impossible to obtain a detailed impression from agricultural acreage statistics of how a reduced acreage in 1969 and thereafter, might have been reflected in other crop acreages. However, an overall picture does show trends in commercial practice, see table 9.7.

Maincrop potato acreage shows a significant fall, whilst the percentage shares of other crop plantings have remained steady, except cereals. Wheat has expanded most of all in recent years. One feature of interest is that bare fallow (included under 'others' in the table) showed an increase in 1969, but thereafter returned to normal. Perhaps this represents a pause whilst growers waited to see if the PMB quota restrictions would be permanent.

In the light of this evidence it seems most likely that potato land would otherwise have been employed for wheat. This contention was supported by comment from the NFU (private conversations) that freed potato acreage would be employed in wheat and barley enterprises. Since barley is in terms of planted acreage the most important crop grown in Britain, it seemed worthwhile to consider this crop and wheat, as alternatives to potato production.

Hence, this study makes two alternative assumptions: (A) that freed acreage went into wheat production, or (B) into barley. However, not all of Britain is good arable land, and it is likely that other uses in agriculture made use of potato land. Thus, it will be assumed that only half of freed acreage went, under assumptions (A) and (B), to wheat and barley and that the productivity of the rest might be approximated by the rent cost category. In addition, given the information about bare fallow, it will be assumed that in 1969, only half of the freed acreage was actually used.

The same cost categories as before are relevant, except of course that of rent in the instance of the half of freed acreage assumed planted with cereals. The costs associated with growing the new varieties on planted acreage instead of Majestic, are shown reproduced

TABLE 9.7 Change in composition of arable land use, Great Britain 1960-72

	Wheat	Barley	Cereals	Beet	Fodder crops	Other	Vegetables	Temporary Grass	Total Potatoes	Maincrop Potatoes
1960	11.6	18.7	12.6	2.4	6.7	2.9	2.3	38.0	4.6	3.0
1961	10.2	21.3	10.6	2.4	6.3	3.9	2.0	39.5	3.9	2.5
1962	12.5	22.0	9.2	2.3	5.9	3.0	2.1	38.8	4.1	2.7
1963	10.6	25.9	7.8	2.3	5.3	3.3	2.2	38.5	4.2	2.8
1964	12.0	27.4	6.7	2.4	4.9	2.9	2.1	37.5	4.2	2.8
1965	13.7	29.1	5.9	2.5	4.5	2.7	2.0	35.5	4.0	2.8
1966	12.1	33.2	5.4	2.4	4.2	3.2	2.0	34.0	3.6	2.6
1967	12.6	32.9	6.1	2.5	4.2	3.1	2.2	32.6	3.9	2.8
1968	13.3	32.5	5.9	2.5	4.5	2.9	2.4	32.2	3.8	2.7
1969	11.5	33.2	6.2	2.5	4.5	4.0	2.6	32.0	3.4	2.4
1970	14.0	31.2	6.4	2.6	4.1	3.0	2.9	32.0	3.8	2.6
1971	15.2	31.2	6.5	2.6	3.9	2.6	2.5	32.0	3.6	2.5
1972	15.6	31.2	5.3	2.6	3.7	2.7	2.5	32.6	3.3	2.3

Notes: (1) 'Other cereals' over 90% accounted for by oats, others include may rye

(2) 'Fodder crops' include beans, peas, turnips and swedes, mangolds etc.

(3) 'Other' includes hops, mustard, fruit, flowers, bare fallow etc.

Source: Appendix 16

in column (a), tables 9.8, 9.9 and 9.10 for Pentland Crown, Pentland Dell and both varieties, respectively. The costs associated with the new varieties' contributions to freed acreage are shown in column (b): these are those totals shown in tables 8.17 and 8.18 halved as applicable to that proportion of acreage not planted with cereals and quartered in 1969, to allow for the possibility that half the freed acreage was then left as bare fallow).

TABLE 9.8

Alternative use assumptions: net benefit and rates of return associated with Pentland Crown (£'000s)

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
1965	- 59				- 29.8	- 15.5	- 29.8	- 15.5
1966	-111				- 53.4	- 26.5	- 53.4	- 26.5
1967	-106				- 48.5	- 23.1	- 48.5	- 23.1
1968	-504				-219.7	- 99.8	-219.7	- 99.8
1969	-206	147	144	132	35.4	15.3	30.4	13.1
1970	-356	493	504	462	253.8	105.1	237.2	98.2
1971	-341	1007	948	894	608.5	240.5	588.1	232.4
1972	-427	771	833	756	422.5	158.9	394.9	148.5
					968.8	345.9	899.2	327.3
	Rate of return				988%	399%	918%	368%

TABLE 9.9

Alternative use assumptions: net benefit and rates of return associated with Pentland Dell (£000s)

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
1965	- 85				- 47.3	- 27.1	- 47.3	27.1
1966	-264				-139.9	- 76.6	-139.9	- 76.6
1967	-413				-208.6	-108.6	-208.6	-108.6
1968	-207				- 99.6	- 49.5	- 99.6	- 49.5
1969	-215	80	77	71	- 26.6	- 12.6	- 29.3	- 14.0
1970	-283	138	210	199	28.3	12.9	23.5	10.7
1971	-221	381	359	339	215.9	93.4	207.6	89.8
1972	-736	226	235	222	-104.9	- 43.5	-114.0	- 47.2
					-382.7	-211.6	-407.6	-222.5
	Rate of return				-484%	-286%	-516%	-301%

TABLE 9.10

Alternative use assumptions: net benefit and rates of return associated with both varieties (£'000s)

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
1965	-144				- 17.7	- 2.4	- 17.7	- 2.4
1966	-375				- 43.9	- 5.6	- 43.9	- 5.6
1967	-519				- 57.6	- 7.3	- 57.6	- 7.3
1968	-711				- 75.4	- 8.5	- 75.4	- 8.5
1969	-421	227	221	293	2.7	0.3	0.9	0.1
1970	-639	631	714	661	67.8	7.1	62.7	6.5
1971	-562	1388	1307	1233	196.2	19.2	189.4	18.5
1972	-1163	997	1078	978	79.0	8.2	70.6	7.3
					151.1	11.0	129.0	8.6
		Rate of return			50%	6%	43%	4%

Notes for tables 9.8, 9.9 and 9.6

(a) growing costs associated with planting the new varieties instead of Majestic, tables 8.14 and 8.15

(b) growing costs saved associated with freed acreage: includes half those listed in tables 8.17 and 8.18, excluding levy, but including rent

(c) growing costs saved associated with freed acreage: estimated on assumption A

(d) growing costs saved associated with freed acreage: estimated on assumption B

(e) & (g) net benefit, under assumptions A and B respectively discounted at 5% discount rate, totalled at the foot of the columns, and there converted into rates of return

(f) & (h) net benefit, under assumptions A and B respectively, discounted at 10% discount rate, totalled at the foot of the columns, and there converted into rates of return

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For the proportion of freed acreage used for cereals, the aim is to estimate the market revenue earned on the acreage, and because potatoes are probably more resource consuming per acre than cereals, it will be necessary to subtract cereal costs associated with marginal changes in acreage, from those potato costs similarly dependent upon planted acreage. The result may be assumed a benefit to the non-agricultural economy. For example, if cereals require less fertiliser per acre than potatoes, then the consequent savings may be assumed equal to the resources saved in the manufacturing of fertiliser as a result. The implicit assumption is that these resources can be usefully employed elsewhere so that their marginal product is similar to what their cost was to the fertiliser industry.

The market revenue received per acre for cereals is found by multiplying average annual prices per ton by average annual yields, tons per acre; see table 9.11. Data for cereal costs per acre are contained in Nix (A) op cit. The fertiliser costs per acre are put at £6.5, spraying at £0.9 and machinery at £4.0, are given as the same for both wheat and barley. Seed costs per acre differ slightly, £4.1 for wheat and £3.1 for barley. This makes a total of £17 and £16 per acre for wheat and barley respectively. Unfortunately, there is no certain estimate for associated labour costs. It is therefore assumed that regular labour costs are equal to those for potatoes: casual labour, however, is left as a consideration in the calculations.

TABLE 9.11

Derivation of net benefit on alternative crops

	Market price/ton (a)		Crop yield tons/acre (b)	
	Wheat	Barley	Wheat	Barley
1969	27.01	24.75	1.61	1.43
1970	29.85	31.03	1.67	1.34
1971	24.11	24.52	1.75	1.49
1972	32.61	28.28	1.69	1.61

	Market revenue/acre (c)		Market revenue - cereal/costs (d)	
	Wheat	Barley	Wheat	Barley
1969	43.49	35.39	27.89	20.79
1970	49.85	41.58	31.75	24.48
1971	42.19	36.53	24.49	19.63
1972	55.11	45.53	36.71	28.13

Note: (d) includes allowances for rotation costs and casual labour savings.

Casual labour associated with grading is omitted for the same reasons as stated above (Section 8.6). However, there are still those associated with harvesting. To find these the assumptions of the 1970 PMB cost survey are used (Section 6.8). The value is estimated at £6.4 per acre; since casual labour is assumed to be used for only a quarter of an acre this is reduced to a quarter, £1.6 per acre. This figure may be multiplied by the annual proportion of freed acreage assumed planted with cereals, and included as a benefit.

The costs of cereal production enumerated above are most conveniently subtracted from the estimates of market revenue to give a net benefit, which can then be combined with potato costs saved associated with freed acreage in tables 8.17 and 8.18, but excluding the labour category (and rent of course) and divided by two. Allowances need to be made for rotational effects as before, except in the instance of barley, the loss in potential yield will be associated with wheat. In this instance, it is assumed that the yield affected is the same, but that its market value is determined by the barley price.

The cereal market revenues, minus costs, minus rotational costs per acre, are shown listed in table 9.11, column (d). These are multiplied by half the totals of the estimates for freed acreage in table 8.5, and then added to the potato costs saved as noted, to make up the estimates of benefit in columns (c) and (d), tables 9.8, 9.9 and 9.10. The next step is to add columns (a), (b) with (c) and (d) respectively, to derive net benefit for the wheat and barley assumptions shown discounted in columns (e) to (h).

The cumulated net benefit can now be expressed as a rate of return; these are shown at the foot of the relevant columns in the tables. Compared to the rate derived in the previous section it is seen that these are generally below those estimated upon the basis of the original arithmetic, using only the rent category to express alternative value of freed potato acreage (cf. table 9.4), although the difference is small and probably within the size of error caused by the nature of cost approximations derived in Chapter 8. There was no halving of costs saving associated with freed acreage in 1969, in the original arithmetic (that is, no allowance for bare fallow or non-use of land). If this had been included, then it is likely that the sets of results would have been even more similar.

Thus far in the consideration of rates of return attention has been given only to consequences for production resources on the farm. The impact of the new varieties upon the costs of market support was noted above (Section 8.4), but the effects in terms of resource cost were not examined. Consider this now, in relation to the first estimates derived as rates of return, that is, using rent only as an indicator of the alternative value of land.

9.7 Resource costs associated with market price support and surplus disposal

A rough approximation of resource cost may be obtained by subtracting from the total costs of market support, compensation payments, plus the value of surplus potatoes moved into stockfeeding; estimates for these three factors are listed in table 10.2. The remainder of the total may reasonably be a reflection of resource cost. It might, however, understate resources if total costs of surpluses hid the possibility that the pattern of the PMB resource use changes: for example, potato inspectors might be switched to market support buying, with less time to survey the marketed quality of potatoes. The consequences of this for resources is that the marketed quality of potatoes might decline, and consequently, somewhere along the distributive chain labour costs associated with sorting and removing damaged potatoes might rise (as well as labour time associated with meal or processing preparation).

The costs associated with compensation payments and stockfeed are essentially financial payments. Although this might be disputed if it can reasonably be assumed that compensation approximates to extra effort associated with the grower attempting to locate a market, or that, in the instance of stockfeed, extra resources are involved in transportation. In the former case, there is no evidence of extra effort: the compensation may be assumed as a payment designed to cover production costs (these have already been included in the rate of return arithmetic). With stockfeed, it may reasonably be assumed that transport costs are balanced by the value of resources saved, that would otherwise have gone to produce alternative animal feeds.

In fact, this might understate the value of stockfeed, since some potatoes will not leave the farm of origin, but be used nearby for feeding. Also, very recent evidence from the PMB 'outgrades scheme' for transporting surplus potatoes to animal rearing areas, indicates that the cost of transport per ton carried has been as little as £2 (PMB, 1974f: p.9). This implies a shortfall of more than £4 per ton at the price observed by Turff (1971: p.49). However, potatoes require special treatment before they can be fed to most animals and will therefore involve a certain amount of labour time; this might work to minimise the difference (ibid).

The assumed resource costs of surplus seasons, between 1965 and 1969 may be apportioned between Pentland Crown and Pentland Dell along similar lines to that done for varietal contribution to surplus and cost, above (Section 8.4). The result is that extra resource costs are attributable to the new varieties for 1965 of £0.138m and £0.069m; for 1967, £0.115m and £0.253m, and 1968 of £0.545m and £0.545m, for Pentland Crown and Pentland Dell respectively.

This changes cumulated net benefit at the 5% and 10% rates for

Pentland Crown, Pentland Dell and both varieties combined, to £0.710m and £0.230m; £-0.776m and £-0.412m; £0.002m and £-0.007m respectively; and associated rates of return to 724% and 258%; -982% and -557%; 1% and -4%. These represent a large fall, around 300% for the most favourable estimate, for Pentland Crown at the 5% discount rate (cf. table 9.4).

9.8 Timing of quote imposition

The actions of the PMB have probably been of most importance in terms of resource cost in the timing of its quote restrictions. To test this consider two alternatives, that the PMB had acted one year later and one earlier, to impose acreage quotas and thereby allow savings associated with freed acreage.[1] These situations can be compared approximately, by omitting benefit associated with freed acreage in 1969 from consideration in the latter alternative, and including an estimate for potential benefit associated with what might have been freed acreage in 1968, for the former.

It is likely that for both alternatives costs associated with growing the new varieties on planted acreage instead of Majestic, would be different than those estimate in Chapter Ten. This is because a delay in PMB quota imposition would permit growers generally to plant more acres, some of which might have the new varieties, and vice versa, with faster PMB action. However, this is debatable, since Pentland Crown was probably under-supplied and might have had the same acreage, whatever the PMB did. Another consideration is the effect upon resources used in market support. A delay on the part of the PMB in

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[1] Conversely, it might be though of in terms of earlier or later marketing in the new varieties: if they had taken one year later to be marketed (that is, feature in the PMB acreage statistics) then ceteris paribus, the PMB might have acted one year later. Of course, the situations are not strictly comparable, since the discounted costs associated with growing the new varieties on planted acreage instead of Majestic would be slightly different due to timing. PMB timing has no effect on the timing of these costs; but slower marketing will tend to delay them.

1969 might have resulted in a surplus in that year. On the other hand, earlier imposition of quotas might have prevented the surplus conditions of 1968/69. Thus, in one instance, costs might have been incurred, in the other saved.

For the delay alternative, benefit is omitted from the calculations in Section 9.3, of the order of £0.588m and £0.318m for Pentland Crown and Pentland Dell respectively in 1969. However, benefit is included for 1970 to allow for rotation effects (£0.028m and £0.008m respectively). This produces cumulative net benefit at the 5% discount rate of £0.838m, £-0.489m and £0.098m, for Pentland Crown, Pentland Dell and both varieties respectively. These estimates convert to rates of return 855%, -620% and 32% respectively. At the 10% discount rate, net benefit is £0.299m, £-0.216m and £0.005m, which converts to rates of return of 336%, -353% and 3%, for Pentland Crown, Pentland Dell and both varieties, respectively.

The savings associated with the faster action alternative may be based upon estimates of freed acreages derived similarly to those for 1969/72 in Chapter 8 (that is, those estimates for 1968 denoted by an asterisk in table 8.5). Costs associated with freed acreage between 1969/1972, averaged £86.82 and £86.68 per acre for Pentland Crown and Pentland Dell respectively (Section 9.9): multiplying these by freed acreage gives totals for costs saved if acreage imposition had been applied in 1968.

This benefit might have been £0.903m and £1.173m for Pentland Crown and Pentland Dell respectively in 1968. The cost in terms of rotation in 1969 might have been £0.025m and £0.032m respectively. At the 5% discount rate cumulated net benefit might have been £1.454m, £0.202m and £0.398m, for Pentland Crown, Pentland Dell and both varieties, respectively. Converted to rates of return, these become 1483%, 256%

and 133% respectively. At the 10% discount rate, cumulated net benefit might have been £0.575m, £0.118m and £0.039m, and rates of return 646%, 21% and 20% respectively.

The importance of the PMB's timing seems important from these estimates. In the year later instance, the most favourable rate is down around 200% (cf. table 9.4). A speedier imposition of quotas might have markedly increased rates, however. Pentland Crown's 5% rate is increased around 400%. The rates for Pentland Dell are transformed. A negative rate, at the 5% discount factor, of 439% becomes a positive one of 256%. This is to be expected, since the full effect of the variety's blight immunity breakdown had not been felt in 1968, consequently, its planted acreage was at a peak and hence, so was its extra output (the variable important to the estimation of freed acreage, Section 8.3).

Thus far in this chapter it might be suggested that measurements have only concentrated upon the 'bare bones' of resource costs. There is a possibility of a net benefit after 1972. In the instance of the combined varieties rate of return, to investment over 50 years at the SPBS; it might be consistent to include the costs and benefits associated with other varieties, if such exists. These factors need consideration.

9.9 Future returns to the SPBS innovation

In terms of present value the useful life of new varieties, the extent to which net benefit goes on being earned, is determined by the size of the discount rate and distance, in terms of time, of net benefit accruing. It was noted above (Section 5.5) that a high discount rate markedly reduces net benefit and thus lowers the rate of return. It is likely that net benefit accruing to Pentland Crown and Pentland Dell in future years, taking the 50 years investment period, might not add much to the rates of return shown in table 9.4.

Another factor important to longevity of life of net benefits is varietal obsolescence. This might result from developments such as breakdown in varietal resistance to disease, or the introduction of new varieties. To some extent Pentland Crown and Pentland Dell have experienced both (Section 7.8).

It could be argued that varietal success is but a step in a continuous process of progressively improving varietal stock, so that the benefits of individual varieties (which represent improvements) continue into perpetuity; perhaps with some additional R & D cost associated with the maintenance of varietal characteristics, see for example, Schultz (1971). Griliches assumed that the returns from hybrid corn varieties would continue indefinitely and he valued the whole research necessary to the development of individual hybrid corn varieties.

It may be that to be consistent with an overall approach such as this it is necessary in the instance of British Potato varieties, to consider all the potato research that has been conducted in Britain which would have been likely to produce maincrop varieties similar to Pentland Crown and Pentland Dell. However, this study has for its brief, only R & D relevant to Pentland Crown and Pentland Dell at the SPBS. The question being asked is what would be the cost to society of not having the SPBS varieties: had another variety been available with identical advantages the answer would be none. Thus, the innovation's timing is important; benefits last for as long as it can reasonably be assumed that no alternative varieties would have produced similar results.

Interestingly, the success of Pentland Crown and Pentland Dell heralded a spate of successful new maincrop varieties. These probably represent the first flush of fruit of the efforts of agency R & D with maincrop potatoes. It remains to be seen if this momentum can be maintained, particularly after the expansion programmes of the last two decades (there is some evidence of a pause, perhaps to allow for an adjustment to more modern methods of plant breeding: for an account of recent developments and prospects in potato plant breeding, against the background of previous work, see Simmonds, 1969, op cit).

Of these new varieties, the most successful has been Maris Piper (a variety bred at the PBI: its description appears in Appendix 11). This variety first appeared in PMB varietal acreage statistics for 1968 and has since increased its share of the British maincrop to 10% (1973). During the early 1970s it proved itself to be a close substitute for both Pentland Crown and Pentland Dell. Generally, the variety has no crop yield advantage over the SPBS varieties, but possessed superior cropping ability in eeelworm (or potato cyst nematode) infested areas.

Howard has suggested that between 25% to 50% of potato soils contain eeelworm populations high enough to lower crop yields by more than a ton per acre, many of the affected plants showing no symptoms (1971). Eeelworm is a principle reason for restricting potato plantings to one year in four/six on the same land (PMB, 1968a op cit), a measure that probably takes some of the most productive land out of potato production (Southey, 1965).

Maris Piper possesses a resitance to the common biotype of eelworm, Heterodera rostochiensis and this is undoubtedly the major reason for its success (regional offices of PMB, ADAS: written communications). It is a factor which could become more important still, if EEC eelworm regulations are rigorously enforced in Britain. These prohibit plantings of susceptible varieties, such as Pentland Crown and Pentland Dell, on infected land, unless the soil has been adequately cleared with insectidies (Directive 69/465/EEC 8/12/69).

Another factor that might have had a hand in Maris Piper's commercial success, is the damage done to Pentland Crown's quality reputation in recent commentaries. It seems likely that accounts in the potato trade literature (for example, British Farmer & Stockbreeder, 1973) have encouraged the view that Maris Piper is a superior variety to Pentland Crown, a view probably encouraged by the PMB (cf. PMB, 1972a op cit).[1]

The important point to note is that it is likely that had not the SPBS varieties existed, Maris Piper would probably have replaced Majestic as the mainstay of the British maincrop. This is because Maris Piper is a close substitute for Majestic and generally yields more. It is less certain when this would have occurred, probably in the early 1970s. Thus, the future net benefit likely to be achieved by Pentland Crown and Pentland Dell, will be approximated by consideration of situations with Majestic in one instance and with Maris Piper in the other.

As a first step it is necessary to assume estimates for the size of the planted acreage and crop yields of Pentland Crown and Pentland Dell after 1972. Concerning acreage, the pertinent question is the extent to which Maris Piper's success is likely to eat into the SPBS's varieties popularity. Quite arbitrarily, assume that Pentland Crown's ware acreage will stabilise at 90,000 acres and that of Pentland Dell's at 40,000; this is somewhat below that estimated for 1972, of around 107,000 and 45,000 acres respectively (cf. table 8.3).

The crop yields of Majestic, Pentland Crown and Pentland Dell are approximated for the future, by the average of 1969 to 1972, to give a

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[1] PMB home economists have rated Maris Piper's cooking quality superior to the SPBS's varieties (Section 12.9). There seems to be no firm evidence to suggest that Maris Piper is potentially a superior variety for grading, however.

crop yield advantage of 1.6 and 1.3 tons per acre, for Pentland Crown and Pentland Dell respectively. Maris Piper's future crop yield is approximated by an average of 1971 and 1972 of 11.7 tons per acre (PMB statistics branch, written communication), to give a crop yield advantage to Pentland Crown and Pentland Dell of 0.4 and 0.1 tons per acre respectively. Bearing in mind that the yield advantage of the SPBS varieties was observed to decline in the early years of their adoptions (Section 7.7 FN), it may be that Maris Piper's yield will also fall with time relative to the yields of other varieties, particularly if Maris Piper's eelworm resistance to the common biotype becomes less important with build-ups of the other main biotype, Heterodera pallida (TEHF, written communication). If so, Pentland Crown's and Pentland Dell's yield advantage will tend to become larger.

Consider the instance of where the SPBS's varieties might be held to have replaced Majestic in future years. An approximation of what this will imply in terms of resource costs can be obtained from an average of the cost information previously derived. An annual average will be used for the years 1969 to 1972, a period after the full effects of Pentland Dell's blight immunity had been felt.

The extra production costs associated with the new varieties' planted acreage, worked out on average at £3.87 (range: £3.07 to £4.93) per acre, and £8.76 (range: £4.74 to £16.55) per acre, for Pentland Crown and Pentland Dell respectively. The Pentland Dell estimate appears to have been inflated by the above average seed cost in 1972. An average for 1969 to 1971 only, produces a lower estimate of £6.17 (£4.75 to £7.15) per acre. This seems more reasonable and so it will be used. These estimates are next multiplied by the assumed future plantings to obtain estimates of extra resource costs of £0.348m and £0.247m for Pentland Crown and Pentland Dell respectively.

The annual average costs saved associated with freed acreage, 1969 to 1972, worked out at £86.82 and £86.68 (range for both varieties: £83.63 to £90.66) per acre for Pentland Crown and Pentland Dell respectively. Using the assumptions above future planted acreage and yield advantage above, estimates of saved costs amount to £1.226m and £0.442m for Pentland Crown and Pentland Dell respectively. Adding these to the extra costs, gives totals of £0.876m and £0.195m net benefit for the two varieties. For the varieties combined, it is £1.071m.

At the 5% discount rate the net returns for Pentland Crown accumulate to large proportions. In year 2000 (that is, 47 years after hybridization) net benefit might have amounted to £5.832m (£0.062m in that year), which represents an overall rate of return of 6000%, an annual one, of 165%. Pentland Dell in year 2000 (45 years after hybridization) might have accumulated net benefit of about £0.192m (£0.009m in 2000), an overall rate of return of around 165%; and annual one of 6%. The break-even point for this variety would occur around 1986.

However, in view of what has been stated about Maris Piper it is probably more realistic to compute future rates of returns upon a basis of a comparison of the SPBS's varieties with this variety. Unfortunately, very little information is available about Maris Piper's production costs. Thus, it will be assumed that they are similar to Majestic's (in fact, they are likely to be higher given the newer variety's higher certified seed prices: the effect of this assumption is such as to probably cast a conservative bias over the results). The difference, therefore, between this and the case with Majestic, will be in terms of freed acreage: smaller in size because Maris Piper's yield is assumed larger than that of Majestic's.

The totals for costs saved associated with freed acreage, amount to £0.267m and £0.030m for Pentland Crown and Pentland Dell respectively.

When these are combined with extra costs, the estimates for net benefit are £0.615m and £-0.217m for the two varieties. If Pentland Dell is to produce a positive net benefit, then it is necessary for the variety to show a yield advantage of 0.9 tons per acre over Maris Piper; but even then, at a 5% discount rate the variety is unlikely ever to break even. At the 5% discount rate, Pentland Crown's net benefit accumulates to around £4.241m by the year 2000. This is a rate of return of about 4000% (or 120% annually, after 1965).

These calculations are very approximate indeed, given the uncertainties of the future. The first area of uncertainty surrounds production costs. Weatherhogg (1973) for example, has suggested that the relative costs of producing white-skinned potatoes will change. At the time of writing fertiliser costs, an important category in the estimates associated with freed acreage have risen markedly after the 1973 middle east war and subsequent rise in oil prices (Financial Times, 1974). This would enhance savings in resources associated with freed acreage relative to extra costs associated with growing the SPBS's varieties.

Another important factor has been a general rise in world food prices. This has been reflected in a revival of demand for potatoes and near doubling in the market prices for cereals (MAFF statistics). Whilst world trading conditions might return to conditions similar to those previously prevailing, it seems likely that with Britain's membership of the EEC and full implementation of the common agricultural policy, that food prices might remain generally high. Thus, the value of potato production might have increased in two respects: the value of the crop as a relatively inexpensive food item and value of freed acreage to alternative crops.

A third general factor affecting the future is the possibility of changes in varietal popularity. There are indications that specialised purpose varieties might become more important. Maris Piper with its eelworm resistance is an example. There is a recently introduced variety that shows every sign of commercial acceptance, Stormont Enterprise, for its resistance to spraing. Any increase in importance of specialist varieties is likely to be at the expense of both Pentland Crown and Pentland Dell.[1] In conclusion, it is the view of the author that after 1972, the returns to the SPBS innovation are those which are based upon the comparison with Maris Piper. Since the yield advantage is small and probably not large enough to be significant in the face of the uncertainties of the future. It is necessary therefore, to state that future returns are likely to be small and will not significantly affect the rate of return results obtained for the period, 1965-1972.

9.10 Other potato varieties bred at the SPBS which have achieved some commercial success

A list of named SPBS varieties, with hybridization and registration dates, appears in Appendix 8 and varietal descriptions of those mentioned in this section appear in Appendix 11 (a general reference of varietal descriptions is PMB, 1965, op cit). Besides Pentland Crown and Pentland Dell, five SPBS varieties have been planted on a wide enough scale to merit inclusion in PMB varietal acreage statistics. These are Craigs Alliance, (Red) Craigs Royal, Pentland Beauty, Pentland Ivory and Pentland Hawk. Craigs Royal and Pentland Beauty are quite closely related to Pentland Dell and Pentland Ivory is a hybridization of Pentland Dell and Pentland Crown, see figure 4.1. The others, although less closely related to Pentland Dell and Pentland Crown, have probably contributed (albeit to a small extent) to potato expnses incurred at the SPBS prior to the 1960s (so too, probably, has the

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[1] Although Pentland Dell might be more resistant, since this variety might produce exceptional yields of first order quality on some farms (Section 7.8).

promising Pentland Marble). It might be appropriate therefore, to evaluate their net benefit, should it exist, and add it to the returns used to compute a rate of return to the investment cost incurred over the fifty years to 1960.

The impact of these other varieties upon the potato industry was considered and to some extent examined, but in the end not evaluated for this study. This was because varietal comparison was found to be difficult, information hard to obtain and probably the study would have become unwieldy to an extent where the importance of the Pentland Crown and Pentland Dell innovation might be obscured. Also, it seemed from preliminary investigation that no substantial extra benefit could be measured. A few notes about these other varieties will serve to indicate some of the difficulties.

Pentland Beauty, (Red) Craigs Royal and Craigs Alliance are early crop varieties (for the importance of the early crop trade, and a general reference about the nature of production, see Cox, 1972). Pentland Beauty was first marketed in 1956 and first appears in PMB acreage statistics for 1965, and reached its maximum share of the British early crop acreage in 1967, at around 4%. However, in 1973 the variety ceased to have enough acreage to be recorded in PMB statistics; the year previously the NIAB had withdrawn it from their recommended list.[1]

Craigs Royal was first introduced in 1948, and came into commercial prominence during the early 1950s[2]. In 1957, a red-skinned

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[1]The NIAB had described Pentland Beauty's cooking quality as very good (NIAB, 1971 op cit). In 1962 a red-tubered variant had been marketed by a Mr. Main (Windygate, Scotland). These two qualities of cooking propensity and colour might have made this variety suitable for a strong marketing compaign, however, it is doubtful if potato consumers generally were ever aware of the variety's existence.

[2]Craigs Royal began commercial life with a discovery, in 1953, of the presence of a leaf mottling of a mild mosaic type in stocks. This proved to be tobacco veinal necrosis caused by a mild strain of virus Y, and widespread in stocks of Craigs Royal. Stringent inspection of seed stocks eradicated most of this trouble (Todd 1962).

variant was introduced by J. Marshal (a certified seed merchant of Dunning, Perthshire: a raiser who had co-operated with the SPBS). This gained in popularity at the success of the original variety. The combined percentage share of both reached a peak around 1967, at about 24% of the early crop national acreage: it has since declined to around 16% (1973); probably as a result of competition from Maris Peer. The colour advantage of the variant seems likely, however, to ensure that the variety will continue to be grown generally: particularly for the southern markets (where King Edward VII is popular).

Not much information is generally available about these three early crop varieties, particularly with regard to what they replaced and why. It has been suggested that Craigs Royal became important at the expense of Great Scot (Howard, 1963a: p.18): if this was so, it seems more likely that success was maintained at the expense of Arran Pilot (see PMB early crop acreage statistics).[1] At first glance this might seem surprising since the older variety (and Great Scot) is an earlier maturing potato, whilst Craigs Royal is classified as a second early.

First early crop varieties have as their main husbandry advantage, a tendency to bulk early to allow marketing when prices are relatively high; whereas second early crop varieties bulk later but with relatively higher yields. It seems that in some areas Craigs Royal might bulk relatively early (Whitehead et al 1953). It is possible that this versatility led to a shift in the balance between the popularity of first and second early crops.

Plantings of (Red) Craigs Royal expanded to record levels in the early 1960s, which corresponded to a time when second early acreages expanded generally. This seemed to result from factors which affected the early crop as a whole, since plantings of first early crops also

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2 Great Scot's acreage had been at low levels. It was about 1% of the national early crop acreage in the mid-1950s.

increased significantly. This general increase in output potential seems to have produced surplus trading conditions, which led in its turn to a contraction of plantings. However, this appears to have occurred from the statistics (PMB/A op cit) in first early crops, a factor which probably led some observers to comment that a shift did occur between first and second early varieties (and indeed, might have in part brought about a concentration of early crop production in the earliest producing regions, see Cole, 1967).[1]

Craigs Alliance is listed by the NIAB as a second early crop but it can also be grown as a first early. The variety was first marketed in 1950 but was not recorded in the PMB acreage statistics until 1968. It appears to be at its maximum popularity at the present time, around 4% of the British early crop (1973). It was originally considered to be a competitor for Arran Pilot (Whitehead et al, op cit), and perhaps it has gained some success at that variety's expense. Craigs Alliance main advantage is the early high yield and it appears to have won popularity in the moister areas of England; it seems to be readily accepted in some west midlands of England markets (Waterson, 1968).

Given that in the rate of return associated with the combined results of both Pentland Crown and Pentland Dell, all potato R & D costs up to 1960 were assumed attributable to these two varieties, then any benefit from the three early crop varieties is a bonus to that rate of return. However, there is uncertainty about what Pentland Beauty and Craigs Alliance replaced and in the instance of Craigs Royal, how its yield advantage over Arran Pilot can be interpreted as meaningful;

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[1] A contributory factor to the depressed prices of these years might have been the influence of a carry over in maincrop surplus potatoes into the early crop season. This would depress early potato prices (ibid). The prospect of lower prices for early potatoes would make second crop varieties look more attractive to growers, since if prices failed to be high, then the versatility of (Red) Craigs Royal offered the possibility of bulking up crop yield to high levels, and thus, higher outputs.

given that plantings of early crops are variable and not subject to acreage quota impositions.

All three varieties have husbandry disadvantages which might affect costs. A PMB survey of the early crop in 1968 (PMB, 1968c) supplied information which suggested that (Red) Craigs Royal has received more applications of spraying than other leading early crop varieties. Pentland Beauty has the disadvantage that its tubers tend to be brittle and Craigs Alliance has a tendency to exhibit above average susceptibility to blight and blackleg (Macarthur op cit).

Pentland Ivory and Pentland Hawk are very recent introductions, both of them were named in 1966, and therefore will have involved R & D costs at the SPBS after 1960. Both varieties were early enough to affect the share of development costs attributable to Pentland Crown and Pentland Dell, however (Section 5.4)[1] Pentland Ivory had 4000 acres planted in 1971, and by 1973 had had this expanded to 16,000 about 4% of the national maincrop. This rate of increase might well slacken, since the variety's certified seed acreage remained virtually the same in 1973 as it had been the previous year.

The commercial success of Pentland Ivory is in some ways an extension of that of its parents, Pentland Crown and Pentland Dell, since it appears to possess many of their attributes without significantly passing them in overall advantage (cf. table 7.1). It has been suggested that Pentland Ivory has special qualities associated with tuber shape and size (PMB 1972f op cit). Its one main difference, however, seems to be a high dry matter content: this might make it suitable for crisp manufacturing.

Pentland Hawk appeared in the PMB avreage statistics for the first time in 1973, at less than 1% of the national acreage. Conversations

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[1] Pentland Beauty also had some influence in this respect (ibid).

with the NIAB suggested that the variety would not be "robust" enough for commercial conditions, yet it seems that the variety has started to win popularity on account of its tough tuber skin and associated resistance to mechanical damage (NASPM, 1975). This factor might become still more important and if so, Pentland Hawk might expand at the expense of Pentland Crown (Section 7.8).

The method by which the resource costs of Pentland Ivory and Pentland Hawk are derived, will depend upon whether the effects of the varieties are to be combined with those of Pentland Crown and Pentland Dell to derive a rate of return to the whole costs of potato R & D at the SPBS, or whether the aim is simply to derive a return to varietal development periods.[1] In the first instance, the question of relevance is how SPBS's varieties might be replaced if they were suddenly withdrawn. As indicated (Section 9.9), it seems likely that Maris Piper would be the variety most widely grown. Thus, the planted acreage and yield of Pentland Ivory and Pentland Hawk would have to be compared to that variety.

According to MAFF yield comparisons both varieties consistently yield more than Maris Piper and might, therefore, have cost savings associated with freed acreage. However, these effects would be difficult to translate into something which is meaningful to a combined rate of return, if year one for discounting is 1922: since future returns would involve discounting over 50 years.[2] Where the aim is to compute returns to costs incurred during varietal development periods, it is necessary to compare Pentland Ivory and Pentland Hawk to Pentland Crown and Pentland Dell, since these are likely to be the main competitors (assuming that Maris Piper is chiefly used for eelworm infested soils).

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[1] Pentland Ivory would not have existed without Pentland Crown and Pentland Dell, of course.

[2] Although R & D costs could be accumulated toward varietal introduction at a rate of interest, and thereafter, net benefit discounted, (see Section 5.5).

There appears to be no yield advantage for either Pentland Ivory or Pentland Hawk with respect to the older varieties. It might be that Pentland Hawk's damage resistance affects the size of marketed yield and therefore gives the variety a marked yield advantage. This might mean that less potato acreage is required to meet a given demand, and thus, freed acreage might be possible. However, there does not seem to be any evidence for this. On the whole, it seems that these varieties are unlikely to show any significant cost savings.

Perhaps this raises a general point, of why should varieties be grown if they yield less and have little significance overall, in terms of resource cost. The answer lies in reasons associated with local conditions (see Appendix 13): these varieties have attributes which tend to maximize the net return a grower can expect with his own individual conditions. Usually this means the maximisation of crop yields. Thus, low-yielding varieties in general terms might contribute to maximizing output overall. The question of relevance in relation to varieties which are being valued is what they replaced: for example, if the predominant reason for Maris Piper's adoption is its eelworm resistance, then the value of that variety is such compared to existing varieties' performances on eelworm soils.[1]

The problem for evaluation is ignorance. For example, it is not clear what the effects of Pentland Hawk's damage resistance are in terms of resources; either directly for production costs, or more indirectly, through the possibility of freed acreage (see above), compared to a situation where only Pentland Crown might have been grown.

There are SPBS varieties still to make their mark upon the national potato acreage, in whose pedigree is material that contributed to the

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[1] It has been reported that in heavily infested fields, Maris Piper can yield 12 tons per acre against 3 tons per acre for Majestic (Howard 1971 op cit).

Pentland Crown[1] and Pentland Dell success. Perhaps the most promising is Pentland Marble, a variety selected at the SPBS specifically for the processing industry. Its small round tubers are suited to canning uses (although they present serious disadvantages at harvesting and might be difficult to sell in alternative markets) and it appears to be the only competitor in this respect to Maris Peer (Price, 1974). The variety has seedlings 882(5) and 1104(2) as ancestors in common with Pentland Dell (see figure 4.1).

9.11 Summary of the annual rates of return to investment at the SPBS

A summary of annual returns derived in the previous sections of this chapter appears in table 9.12. Of course, they are very rough approximations, but generally they give the impression, even after allowing for the unreliability of data and associated approximations, that investment in potato R & D at the SPBS has been economically successful in terms of resource cost (in as much as it measures the productivity of potato resources in alternative employments). This is a result of Pentland Crown's commercial success, the extent of its planted acreage and size of its yield advantage over Majestic, between 1965 and 1972. It seems that Pentland Dell has not contributed to this economic success, largely because of its disease troubles. On these grounds it is more worthwhile to have had the SPBS, than for society to have gone without it (and thus, to have had to keep with Majestic from 1965 to 1972).

The SPBS rates of return do not compare favourably with those obtained in other studies of investment in agricultural R & D. Compare the rates shown in table 9.12 with those in table 9.13. The SPBS rates derived under the 'both varieties' approach are, in terms of scope, most comparable to the rates obtained in the Schultz, Griliches, and Schmitz and Seckler studies. The SPBS rates for 'Pentland Crown' and

[1] Pentland Crown is being used in breeding selection at the PBI. For example, it has been used in attempts to combine it with King Edward (PBI Annual Reports)

TABLE 9.12 Annual rates of return to investment in potato R & D at the SPBS

	Annual rates 1965/1972	Pentland Crown		Pentland Dell		Both Varieties	
		5%	10%	5%	10%	5%	10%
(1)	Farming resources (Section 9.3)	137%	56%	-55%	-33%	8%	1%
(2)	with amended seed assumptions (Section 9.4)	174%	74%	10%	4%	14%	2%
(3)	under alternative assumptions (Section 9.6) A	123%	49%	-61%	-35%	6%	1%
(4)	B	114%	46%	-65%	-38%	5%	1%
(5)	Farming and market support resources (Section 9.7)	91%	33%	-156%	-95%	0%	0%
(6)	(1) plus allowance for year's delay in freed acreage (Section 9.8)	107%	42%	-77%	-45%	4%	0%
(7)	(1) plus allowance for year's earlier freed acreage (Section 9.8)	186%	81%	32%	20%	17%	3%
(8)	Farming resources in 1965 to year 2000 (Section 9.9)						
	i Majestic	165%		6%			
	ii Maris Piper	120%					

'Pentland Dell', on the other hand, are most comparable to the rates obtained in the Grossfield and Heath, and Peterson studies.[1] In no instance do the SPBS's rates compare favourably.

TABLE 9.13 Annual rates of return estimated for investment in agricultural R & D (5% discount rate)

All USA Agricultural Research (Schultz, 1953, op cit); (Peterson, 1971)	75%
Hybrid Corn USA (Griliches, 1958, op cit)	750%
Hybrid Sorghum USA (Griliches, 1958, ibid)	360%
Potato Harvester UK (Grossfield & Heath, op cit)	264%
Poultry Research USA (Peterson, 1967, op cit)	600%
Tomato Harvester USA (Schmitz & Seckler, op cit)	900 to 1300% (-8 to 345% if compensation paid to displaced labour)

Sources indicated by parentheses

Of course, it is questionable just how closely these rates may be compared. It was noted above (Section 2.6) that inter-sectorial comparisons may be unwise where market values are influenced so strongly by government policy, as they are in agriculture. It seems appropriate to keep comparison within a sector, however, to compare the SPBS's rates with those in the table is to make comparison an international one, and because of this, perhaps to make it the more doubtful. For instance, the higher rates for hybrid corn are partly to be expected as market size in the USA is large, and given that innovation has been widespread, then output affected will also tend to be large.

In addition, it is to be wondered if these rates represent an optimistic view of investment effects. A feature of the work reviewed in chapter three was the simplistic approach employed by the studies. It is possible that they omitted important costs, or more simply assumed too much about the realisation of benefit. For instance, in view of

[1] The former group are essentially studies of broad R & D effort, which was designed to lead to the development of better agricultural inputs: the latter, more with the introduction of an improved input. The forestry study is not included in the table, because it was comparing two different kinds of production process for land use, and is therefore not strictly comparable to the studies in the table. In fact, the rate of return to forestry was negative: the results becoming positive only if a 20% premium for balance of payments considerations is added (5% to 7½%).

what was stated above about mechanised harvesting and associated damage levels, (Section 7.8). It seems surprising that the Grossfield and Heath study did not consider this possibility (Section 3.4).

9.12 Alternative methods for presenting returns

The rates of return above are sometimes termed 'external' rates of return, and may be expressed as:

$(100 \times \frac{NB}{IC})$ where NB = net benefit, and IC = investment cost.

It was adopted for use in this present study to follow the conventional practice of the authors of the CBA studies noted above.[1] This style of presenting returns in relation to investment cost is but one of many.

Another method which could be used is that of the present worth criterion. Present worth of an investment is the present value of the benefits it yields minus the present value of the investment cost (see Meek, 1971). If present worth is positive, this figure can be expressed as a percentage of investment cost. To convert the external rates of return used above, one needs only to subtract 100%.

A third method is that of the 'internal' rate of return. This is defined as the rate of interest which makes the accumulated present value of the flow of costs equal to the discounted present value of the flow of returns at a point in time. It can be ascertained by interpolation using the formula:

$$IRR = X + \frac{a}{a+b} (Y-X)$$

where X is an assumed discount rate lower than the internal rate of return (IRR), Y is an assumed discount rate higher than the IRR, a is the difference between the present values of the costs and benefits given x%, and b the difference between the present values of the costs and benefits at Y% (see Shaw, op cit).

[1] The ways in which to present returns in relation to investment cost are considered in Peterson (1971, op cit), and Wise (1975).

The IRR for Pentland Crown is 24%. It means that on average each pound invested in R & D returned 24% annually from the beginning of the investment. Although there is a large difference between this and the external rate of return, both are just two ways of expressing the same returns, as both are derived from the same data. The IRR is lower because of the long 'gestation' period, when no benefit is measurable, and costs are being incurred, 1951 to 1965.

A fourth method by which to present returns is the benefit-cost ratio. This involves the simple division of net benefit by investment cost. It is, therefore, almost exactly the same as the external rate of return, except the ratio is precisely that, and benefit is not expressed as a percentage of costs. However, it has been suggested by Wise (op cit) that this pproach is incomplete, since resource cost is not considered correct from a social viewpoint: what should concern public decision makers is the return expressed in terms of all resource costs.

Thus, the denominator should include all costs in resources as well as investment cost. Thus, the benefit-cost ratio for Pentland Crown, at the 5% discount rate, which is 10.9, would become 2.1. The effect then of this modified ratio is to make investment cost less significant for investment decisions, and the resource use consequent upon investment effects more important.[1] A major problem of this approach would seem to be the extent to which investment effects may be sub-divided: there would need to be a common consensus if arbitrary decisions were to be avoided and consistent comparison made possible. Since benefits are in terms of saving resources, the dichotomy between positive and negative resource effects does not seem particularly useful.

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[1] The advantage of this, Wise points out, is that less significance is placed upon R & D cost estimates, which are "notoriously difficult" to identify. The present study, (and previous applications of CBA to R & D subject areas) has derived investment cost on conservative assumptions, and so this advantage is not important.

9.12 Consideration of this present study's results with regard to what might have been expected by the SPBS

It seems that the scale of economic success represented by the rates of return in table 9.12 was something less than the SPBS might have expected. At the beginning of work for this present study, Simmons, the Director of SPBS, had indicated the economic benefits of Pentland Crown and Pentland Dell to be larger (Simmons, 1970). At a discount rate of 10% these were estimated to stand at £3.57m and £3.20m in 1982 for Pentland Crown and Pentland Dell respectively. Since that time, and during the period whilst this study was still in progress, Simmons published a more comprehensive analysis of the estimated economic return to the whole activities of the SPBS.

The Simmons' study suggested that net benefit was £13m (1972 £s), cumulated over a period 1963 to 1973; a total made up from benefit associated with freed acreage of £11.1m (assessed upon a basis of £113 per acre saved with each acre returned), savings associated with Pentland Dell's early blight immunity of £1.4m (£3 per acre of planted acreage, 1963 to 1967), and Pentland Crown's virus resistance, assumed to be worth £1.4m (assessed at £3 per acre, and upon the assumption that growers planted 75% of their acreage with own-grown seed).

This compares with a net benefit suggested in this present study, of about £2.49m (1971 £s) (cf. table 8.19). It was found that there are extra growing costs associated with the planted acreage of the new varieties compared to a situation where Majestic might have been grown, of around £4.53m. Also any advantage stemming from Pentland Crown's virus resistance was more than offset by high certified seed prices and seeding rates; in addition, the proportion of this variety's acreage planted with own-grown seed was assumed at only about 53% on average. Pentland Dell received no credit for saved spraying costs and, in fact, is represented in the CBA arithmetic as higher costing than Majestic.

Also, this study did not assume that acreage could be freed prior to PMB quota imposition and therefore, assumed that resources would be saved only after 1969. In addition, the cost per acre saved amounted on average to £87, since it was considered that factors such as chitting, management, interest could not be meaningfully related to marginal changes in planted acreage.

These are significant differences and all the more surprising, when it is realised that Simmons used the PMB cost handbook (1972c op cit) referred to in this study. It perhaps reflects an optimism (possibly of the sort behind the simplistic approaches of other CBA work) on the part of the SPBS, without the accompaniment of necessary detail. However, a simpler approach does not necessarily lead to wrong overall results; it is useful to consider Simmons' results in a form which is comparable to those of this present study.

Simmons' study aimed to establish the overall return to all of the SPBS's activities: he made assumptions as to future benefit, considered other crops, and derived benefit (on similar assumptions) from the commercial success of potato varieties other than Pentland Crown and Pentland Dell.[1] However, the substantial part of realised returns

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[1] This mainly takes into account the success of Red Craigs Royal. Simmons estimates a yield advantage for the variety over British Queen and Dunbar Rover, to derive cost savings associated with freed acreage of around £(1954)5 per acre (op cit: p.27). However, there are no grounds for assuming that a yield advantage would lead to reduced acreages in early crops, or for observing that Craigs Royal benefit came from replacing those varieties, see above (Section 9.10).

(that is returns other than future ones) came from those two varieties. To make his results comparable, therefore, they have been adjusted to consider only the realised returns of Pentland Crown and Pentland Dell. Also Simmons took R & D costs for 1951 to the 1970s: his estimates have been reworked to include only the period 1951 to 1962, that comparable to the assumptions used to derive separate rates of return for Pentland Crown and Pentland Dell in this present study.

TABLE 9.14

Simmons' results reworked to be comparable with those derived in the present study

	1951-62	1963-72	1965-72
Investment cost	0.39		
Net benefit		1.799	0.724
Rate of return (external)		461%	190%
(internal)		36%	22%
Benefit-cost ratio		4.6	1.9
Adjusted b-c ratio		4.0	0.16

SPBS's R & D costs estimated by Simmons were apportioned between potatoes and other activities by taking the average staff ratio for 1951-62. All figures were discounted from 1951 at 5%, and values adjusted to 1971£s.

The cost assumption approach most comparable to the Simmons' one, is that used to derive the rates of return for Pentland Crown and Pentland Dell specifically; that is, the relevant R & D costs are SPBS are those incurred during the development periods of the varieties. Thus, taking the net benefit derived in those instances and comparing it with the reworked (on Simmons' assumptions of benefit) results, gives the estimates in table 9.14 above. The estimates for 1963-72 are those derived according to Simmons' principles; those for 1965-72 are estimates based upon this present study's principles: in both instances, the rates of return and benefit cost ratios are derived by comparing them against Simmons' investment costs.

An interesting feature is how an adjustment of the benefit cost ratio, as suggested by Wise (above, Section 9.12), acts to make the Simmons' ratio appear relatively more favourable in relation to the one for this study. This is because Simmons assumes that there are no extra resource costs for Pentland Crown and Pentland Dell, other than those associated with investment cost. Wise's suggestion probably has an inherent bias in favour of simplistic approachs to CBA.

9.15 The significance of rates of return: some qualifications to the results

Although the rate of return to investment in Potato R & D at the SPBS might not stand up to comparison with returns obtained elswhere, as the SPBS might have expected, the results are still good. Although Pentland Dell produces a negative return, the indication is that had not is 'blight immunity' broken down, the returns to plant breeding would have been very high indeed. The return from Pentland Crown is very high, but this must off-set the costs associated with Pentland Dell, when the return to 'both varieties' is considered. Nevertheless, this overall return is respectable considering the very long time scales involved, the inclusion of all potato R & D costs to 1960, and the short time allowed to benefits, 1965 to 1972. The significance of the results seem then, that in terms of resource cost, the value of commercial success, if it is substantive, is likely to be high for society. However, there are two questions for the decision maker. He must know how this success compares with that of other investments, and what the chances are of such success repeating itself. Taking the last point first.

The high rates of return estimated generally for R & D investment might be indicative of what is a weakness of retrospective studies. This is that they concentrate upon R & D investment which is known to have been commercially successful. Given the use that CBA makes of market values, it is to be expected that commercial success would translate into socio-economic success. In their survey of technical change, Kennedy and Thirlwell (op cit) point out that whereas most R & D is likely to generate no usable information at all, when it does, the results are often spectacular. To measure such achievement and then hold the results up as indicative of future social utility might be misleading, since there might be no guarantee of success repeating itself.

The SPBS has recently introduced a number of promising varieties, however, most of these come from the same research system which produced Pentland Crown and Pentland Dell. Many changes have occurred in the breeding programme in recent years, and it seems that with the appointment of Dr. Simmons as Director in the 1960s, philosophy changed towards a more target orientated R & D. These changes have yet to produce varietal successes unassociated with the system that produced the older varieties. This study has emphasised the long time span involved in R & D programmes, it might be many years before success does repeat itself.

Ideally, rates of return enable a decision-maker to rank in order of preference the investment projects he can undertake: then, subject perhaps to various constraints, he can descend his list until investment funds are exhausted. If the rates of return reflect the whole truth about resource cost, and efficiency is the first priority of government, then the selection process could be reduced in theory, to a simple mathematical routine.

However, socio-economic problems often confuse the normative significance of the efficiency criteria, so that assessment and selection is not straightforward. A major problem of comparability is consistency of CBA approach, how the assumptions and methods of CBA have been used to derive rates of return so that results differ. It is likely that much has to be agreed about the present state of the 'art' of CBA before, in the words of Wise, the "existing techniques of CBA (can) be used for the fine-tuning of R & D allocations" (op cit: p.259).[1]

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[1] He states "In the course of time, with a purposeful effort on methodology, generally agreed procedures may emerge, but there is much to be done before this happens. One serious lack is a body of adequate historical cost-benefit analyses: there is the classic study of Griliches and a few others but this is a slender basis for synthesising a coherent system" (p.260).

CHAPTER TEN

Government potato policy objectives and the regulation of the potato market

Introduction

It was indicated in Section 2.8 that rate of return CBA can usefully be complemented with a broader type of CBA which aims to consider other, non-efficiency objectives which might be important to a public decision maker. A brief account of the Treasury's study of forestry, Section 3.8, indicated what kind of issues might be considered.

Broadly there are two areas of interest which might usefully be considered by the present study: a specific one to the potato industry, and more generally, that of matters which are of relevance to general government economic policy. This last area of interest is considered below in the following chapter.

This chapter will consider the former, the objectives of government and its agencies in intervening and managing the potato market. The substitution of Pentland Crown and Pentland Dell for Majestic might have affected the management of the market, and thereby had a result which has been at variance with government policy. Also, there is the associated question of how market management has affected the way in which society has been affected by the new varieties. The answer to this might in some way qualify the rate of return estimates.

This chapter falls broadly into two parts. The first concerns a statement of policy objectives, and the theoretical effects of the instruments used to influence trading conditions in the potato market. Secondly, the concern is to describe what trading conditions have actually been like, and consider this in relation to the substitution of Majestic by Pentland Crown and Pentland Dell.

10.1 Government potato policy objectives

Government policy has had four main aims with regard to potatoes. The first has been the efficient production and marketing of types and quality of potatoes that users and consumers have required. Second, potato surpluses should be produced at the lowest prices possible which is consistent with a fair return to growers, and third, in a manner that assures a reasonable degree of price stability for producers, users and consumers. Fourth, that the United Kingdom (UK) should be self-sufficient in maincrop potatoes and products made from them, but that this aim should be based upon a competitive industry capable of withstanding fair competition.

The MAFF has stated that these aims are in the national interest and that their validity would stand in "any circumstances" (MAFF et al, 1973 op cit). However, the self-sufficiency aim puts potatoes apart from other crops, and in some respects, this objective might seem to make the goal of low prices for consumers subsidiary.

Generally, agricultural policy up until the 1970's has involved opening domestic food markets to world competition so that consumers have had the benefit of low prices (see Appendix 5). This probably had important distributional results, in that the burden of supporting farm incomes was shifted to some extent, from the consumer to the Exchequer. Given that the UK has had, and has operated successfully, a progressive taxation system, it is likely that farm incomes, in being bolstered by subsidies, have been supported to a minimum degree by low-income families (who probably pay relatively little taxation). Otherwise, these families might have had to pay higher food prices, possibly with cuts in their purchase of the more costly food items (ones which might have associated with them relatively high nutritional levels). However, in the instance of potatoes competition from overseas suppliers has been severely limited by the government's self-sufficiency objective.

10.2 Potato import controls

A total ban is at most times in force on the importation of main-crop potatoes (it is lifted only in years of exceptional shortage: government might also impose a ban on exports, if shortages seem likely to occur). The effect upon domestic prices of this measure can be illustrated with reference to figure 10.1).

It is assumed that the world price for potatoes, P_w, is less than the domestic price, P_d, that would prevail without imports.[1] If, given competition from imports, domestic price fell to world levels, more potatoes would be sold (given the attraction of low prices to consumers) but domestic growers would produce less. That is, an extra quantity Q_2Q_3. will be supplied, but only OQ_1 would be produced by domestic growers. There might also be a loss in foreign exchange approximately equal to the shaded area, figure 10.1; although this might be off-set to some extent, if freed potato resources were used to produce exports or save imports.

If this is true, it seems that potatoes might have been over-valued, in efficiency terms, by an amount P_d-P_w (given that P_w reflects a competitively determined pattern of resource cost). That is consumers are over-paying, in terms of utility they derive, for the potatoes they get; given that the conditions of existing supply and demand would, under competition, determine equilibrium price at P_w. This also means that the size of the potato growing industry is larger than it would need to be if government were to only consider efficiency as an objective: thus, the resource cost required to produce output Q_1Q_2,

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[1] World prices have been generally below British levels (for a figurative illustration of prices in the EEC, see Appendix 17). However, it does not necessarily follow that imported potatoes would be significantly lower in price in the British market, since the costs of transportation has to be considered. Even so, it has been suggested that if import controls were absent over a long period, then the Netherlands might establish a market in Britain and gear part of its potato industry to that end (EDCA, 1972 op cit).

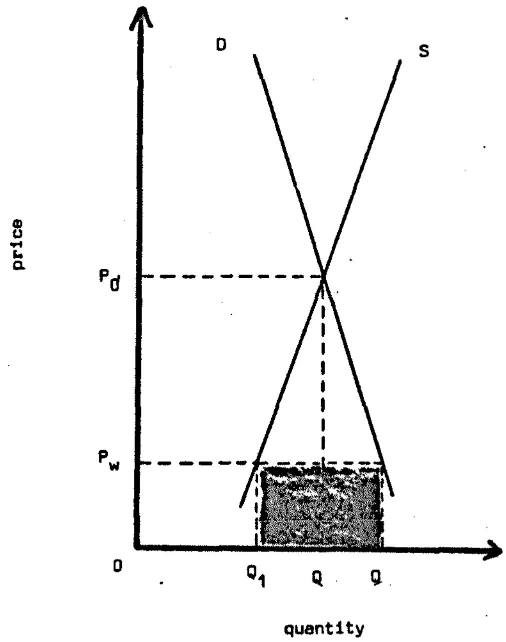

Figure 10.1 The consequences of import restrictions

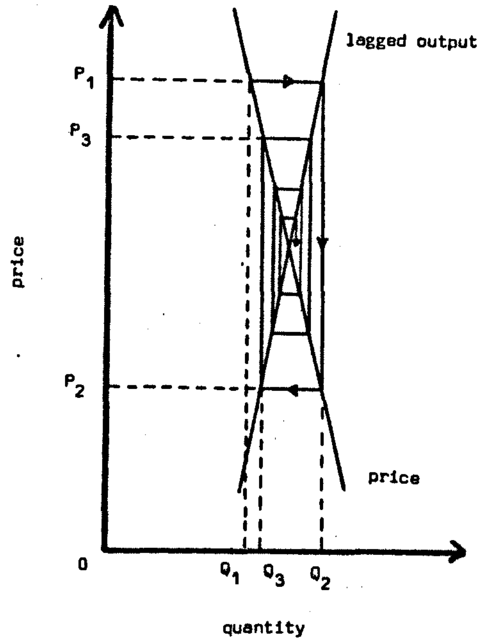

Figure 10.2 Cobweb price-output interactions: converging cobweb

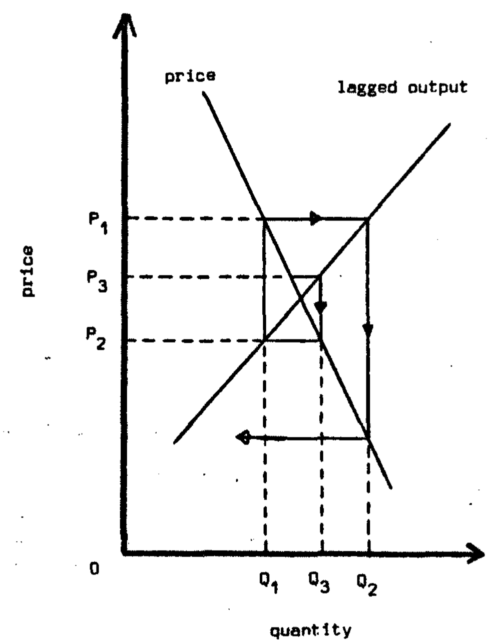

Figure 10.3 Cobweb price-output interactions: diverging cobweb

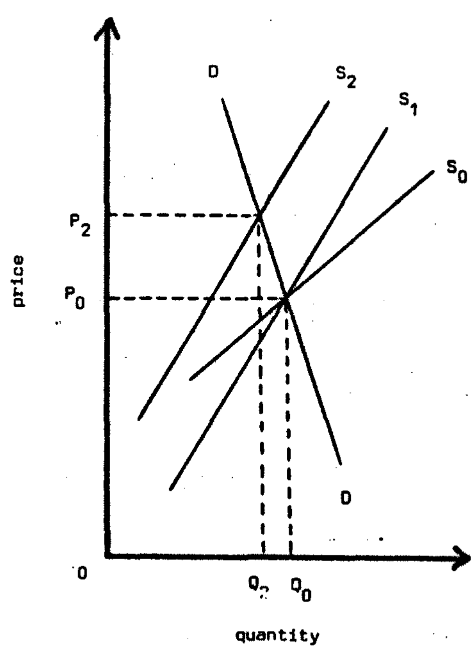

Figure 10.4 The effect of acreage regulation

figure 10.1, is the efficiency cost of the self-sufficiency objective.[1]

10.3 The self-sufficiency objective and the problem of instability of potato output

It might seem then that making potatoes an exception to the cheap food policy and instead have self-sufficiency is to ignore the possibility of achieving "the lowest prices possible". However, potatoes produce their own special problems for government administrators.[2]

These are mostly associated with a problem of output instability. Yield is greatly influenced by weather (particularly at planting time, when delays can seriously affect output), so that one year of poor crop yields and low national output with very high market prices, can be followed by another of good yields, surplus trading conditions and very low prices. The uncertainty of such a sequence of years can make itself felt, through growers' incomes, on future planting decisions, which then are liable to make trading conditions even worse.

This is explained diagrammatically by the cobweb theorem of price and output interactions (first described in an analysis of corn and pig price-output cycles in the USA, see Ezekiel, 1938). It is necessary to assume the market takes place at discrete time intervals defined by crop seasons; so that output does not react to price directly, but only after a time lag. Each farmer plans his output on the expectation that its price will be similar to the one for his previous output.

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[1] Thus, the pattern of resource use in potato production not only reflects consumer preference but also a non-efficiency government objective. This means that some part of the benefit, as measured in this study in terms of resource cost, is likely to be a reduction in resources put aside for self-sufficiency. This does not, of course, alter the value of the benefit, (resources are still saved), it merely implies that without government intervention, the rate of return might have been smaller because the size of the potato industry would tend to be smaller.

[2] William Beveridge has been quoted as saying: "this puckish vegetable ... as a producer of problems for Food Controllers, the potato has no rival in the vegetable or the animal world" (Winnifrith, 1962, p.68).

In figures 10.2 and 10.3, the lagged output curve related next season's output to current price, and the price curve relates current price to current output. For figure 10.2, assume that low yields have resulted in a small output, Q_1, and high price, P_1. Encouraged by high prices (and high incomes, given inelastic demand) farmers then plant a larger acreage for the following season. Ceteris paribus, this leads to a large output, Q_2, which results in a low price, P_2. This disheartens farmers, and persuades them to plant a smaller acreage for the following year, which leads to another high price, P_3, and so on.

The extent of the cobweb problem over time, depends upon the slopes of the curves. If the price curve is less steep (the demand curve not so inelastic) than the lagged output curve (supply curve), the system of price-output interactions will tend to converge to equilibrium, and the problem will work itself out. This is the case for figure 10.1: the direction of the interactions is indicated by the arrows. If the price curve is steeper, which is likely with potatoes, given its very low demand elasticity, then the system might explode, as the arrows indicate in figure 10.1.[1] However, because crop yield is so uncertain, it is likely that lagged output would not be so predictable in practice, and system oscillations might predominate.

If potato prices and outputs are examined in Britain since 1955 up to 1972, it is seen that despite the presence of the PMB and import controls, there has existed a clear tendency to oscillation, and in fact, a cobweb pattern is discernible. This is shown diagrammatically in Appendix 18. There is some evidence for cobweb patterns in potato markets in the USA (Gray et al, 1954).

The self-sufficiency objective would not of itself solve the

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[1] The price elasticity of demand, averaged during the period, 1966 to end-1972, (-)0.08 for the UK as a whole: this compares, over the same period, to (-)0.79, (-)0.73 and (-)1.45, for bread, root vegetables (excluding carrots) and canned peas respectively (MAFF, 1973a: table 14).

tendency of the domestic output to vary between years, but if, as happens, prices (and so growers'incomes) are guaranteed at high enough levels, then enough farmers will plant potatoes to ensure that shortages (and the associated very high prices) will be avoided.[1] Of course, for most years this means a moderate surplus is likely.[2]

Thus, there is a price effect that consumers will benefit from. The high prices associated with shortages should be avoided. To lower income groups, very high prices, in a single year could be more serious than prices moderately higher in most years because of no cheap food policy. However, the target of a moderate surplus for most years might itself tend to lower prices in normal years, but not very much if the government acts to maintain market prices at a reasonable level for growers.

The government can act by determining the levels of guarantee prices, but more importantly, indirectly, by influencing (through negotiation) the PMB.

10.4 The PMB

After a period of direct government control of the potato industry during the war and post-war years, the PMB was re-instituted in 1955, under the terms of the Potato Marketing Scheme (MAFF & DAFS, 1962).[3]

[1] Growers' prices have to be high enough to return an income comparable to that which would be returned on alternative enterprise. This was apparently successfully done up to 1972: thereafter, some exceptional conditions in the world agricultural markets raised cereal prices to high levels, and afterwards, British membership of the EEC has ensured that cereal returns would remain at high levels; this has tended to make potatoes seem much less profitable than previously, and guaranteed prices have been looking on the low side in recent years - if plantings are to be maintained. Of course, there will always be a demand for potatoes for rotational purposes at relatively low prices.

[2] Since 1969, Ministers after consultations with PMB and NFU officials, have set targets designed to produce a surplus of around 200,000 tons (CEA, 1975)

[3] It has been suggested that import controls were a reward, a kind of quid pro quo for growers' co-operation in the marketing scheme; see Donaldson et al, (1969).

Its membership was fixed at 33, 25 of whom were to be potato growers, another 4 special members; all to be elected by potato growers. Another 4 members were to be appointees of the MAFF, and Secretaries of State for Scotland and Wales. Statutory provision allowed ministers to set up a consumer committee, its purpose to consider the effects of the workings of the Potato Marketing Scheme, and report its findings to ministers (this has occurred twice since 1955).

The PMB is empowered to directly intervene in the potato market by regulating output, price and quality. This it has done by controlling planted acreage, buying in the market, and policing quality standards (there has been of course, a more indirect influence, that through its supply of information, propaganda, services, negotiations with government departments, and so on). Consider now how the PMB has worked in principle.

10.5 Control of size of potato output

Maincrop potato growers of more than one acre are required under the provisions of the Potato Marketing Scheme to register with the PMB, and pay it a subscription (known as the levy) on a per acre planted basis. Upon registration, growers are awarded an allowance of basic acreage, based upon individual growers plantings over a previous period. During years for which it is apparent to the PMB that planted acreage has a tendency to exceed that required to meet the nation's needs, growers are restricted from planting their full allowance of basic acreage, by the imposition of a quota.

Quotas are not assessed individually, but applied blanket-fashion; so that if for one year the PMB announces a 90% quota, then all registered growers will be required to grow only 90% of their allowed basic acreage. The acreage that the PMB plans for, is determined annually in negotiations with the MAFF and NFU. Growers may, however, plant in excess of both the basic and the quota, if they are willing to pay a higher levy (which has been for many years, £25 per acre, instead of the normal payment, currently, £4.20).

Theoretically, acreage restrictions of this sort should have two main effects upon the supply of potatoes. These can be shown diagrammatically, figure 10.4. Growers might find that they have less scope for adjusting the annual size of their plantings, so that the supply curve for the industry becomes less elastic: the original curve, S_0, becomes steeper at S_1. This dampens the effect of cobweb tendencies, perhaps slowing down the tendency to explosion.

Secondly, acreage restrictions might be fixed to hold planted acreage below levels which might have prevailed under uncontrolled conditions. This is illustrated in figure 10.4 by a shift of the supply curve to the left, so that it becomes similar to S_2. This effect will make surplus seasons less likely. It would be achieved by lower quotas, or perhaps more permanently, by a rearrangement of the basic acreage. Of course, restriction of output will tend to affect price; the supply curve, S_2, associated with a smaller output, Q_2, and higher price, P_2, than curve, S_{01}, which is associated with Q_0 and P_0, see figure 10.4.

The importance to growers' income of inelasticity was noted above (Section 3.7), in respect to the general problem of introducing output increasing innovation, where general productivity is rising and farming is competitive. The control of output does soften the impact of this kind of technical change. If higher crop yielding potato varieties increase the supply potential of the industry, then all the PMB has to do, is impose quotas which take this into account. Prices will be maintained, and growers will continue to receive reasonable incomes.

10.6 Market price support operations

The market price support operations of the PMB are based upon the guaranteed price level. Buying programmes are begun when it seems to the PMB, that going market prices are likely to average out at below the guaranteed price. The PMB has described this function as a kind of buyer of the last resort: that is, growers are guaranteed a market for potatoes which might not otherwise find a market (PMB, 1970a). Growers are allowed to opt out of PMB contracts if market prices improve (or alternative markets offer themselves), and the PMB itself can release stocks directly into the market.

The theoretical effects of market support are shown in figures 10.5 and 10.6. An effective support price operation creates a demand curvey which is perfectly elastic for all potatoes in excess of a given quantity. Thus, in the figures, the demand curve, DD_0, is adjusted to DD_1, at quantity, Q_s, the amount allowed to consumers, given a support price, P_s.

The important feature of market support operations is that they create a floor price, beyond which growers might reasonably expect market prices not to fall. Thus, cobweb tendencies are dampened (see the direction of arrows in the figures): this effect will tend to be more marked if the support price is greater than what would normally have been the equilibrium price, P_0 in the figures. The cobweb is less pronounced in figure 10.6 than 10.5.

There is a danger, however, that given a rise in grower confidence associated with the reduction in price uncertainty, output potential might be increased. Growers will strive to maximise crop yields, or simply plant more acreage (perhaps evading acreage restrictions). Thus, the supply curve might, over time, tend to move towards the right. The extent to which this occurs will depend upon the actions of the PMB.

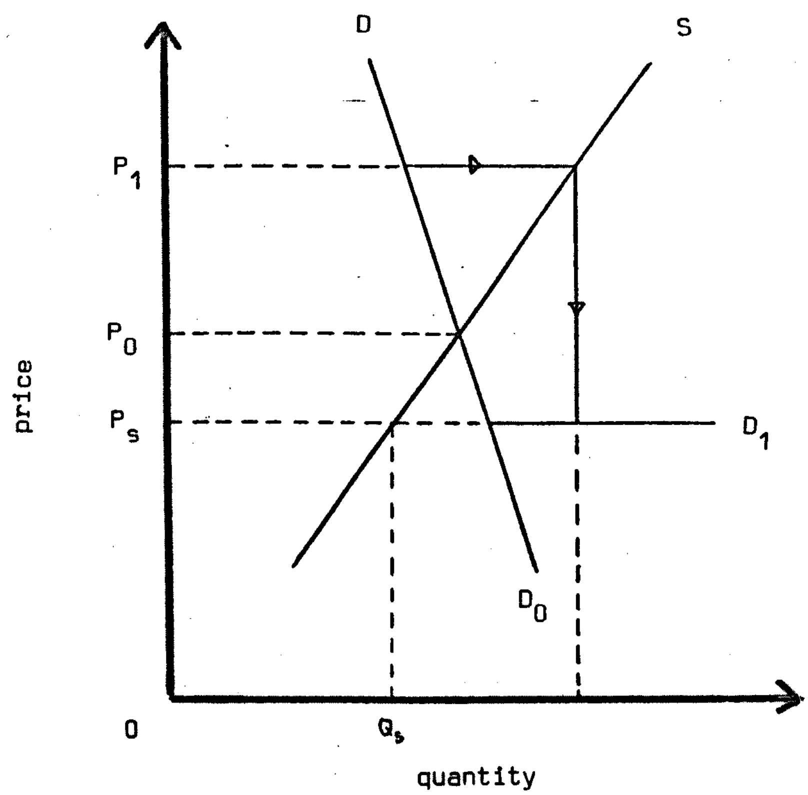

Figure 10.5 Price support at a level below equilibrium price

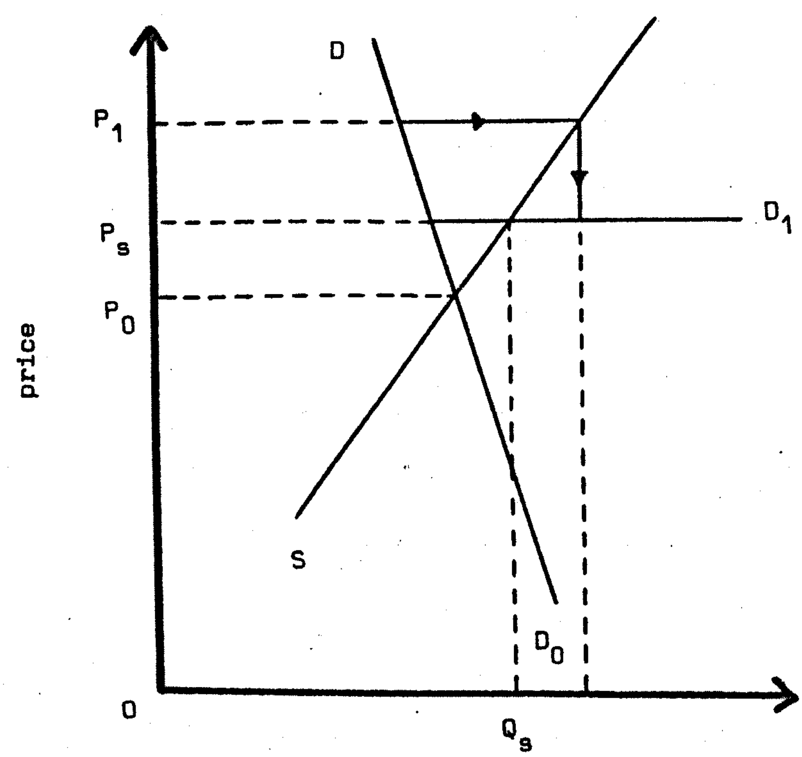

Figure 10.6 Price support at a level above equilibrium price

If quality standards are enforced (not just in general terms, but specifically, in relation to the samples bought in market operations), and acreage restrictions continually reviewed and adjusted, the danger might prove unreal.

When support buying was first introduced in 1958, it was welcomed then by some critics of PMB, as likely to act as an incentive to ensure stricter acreage control than had previously been applied. This was because it was thought that support buying would prove too costly for the PMB to tolerate a situation of chronic over-supply. Since most of the PMB's income was made up with growers' levies, it seemed that growers' themselves might be asked to meet a larger share of surpluses' costs (Allen, 1959).

However, the government has seemed unwilling to see the PMB get into financial trouble and has been prepared to meet most of the high costs associated with support buying. A detailed account of how support buying might work, with its impact upon market prices, is given for the 1959/60 crop season, in Sykes and Hardaker (1962).

10.7 Control of marketed quality

The PMB has attempted to control and standardise the quality of potatoes going for human consumption, by the specification of suitable quality grades. In codifying quality standards, the PMB is enabling the market to recognise differences and upon that basis, establish price differentials.[1] The need to achieve a "good quality produce" was recognised at the PMB's re-institution (see PMB, 1955); descriptions of grades are given in PMB's annual reports (see for instance, PMB, 1973a: Appendix A).

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[1] At the present time, the PMB specifies only one quality standard in addition to the minimum. It is a recommended standard only, and if it is to act as a measure likely to improve the choice of quality available to consumers the potato trade must be willing to market potatoes at this grade in sufficient numbers and in consistent supply to enable consumers to generally recognise the quality, and turn to it, should the minimum standard not satisfy their needs.

The most important feature is the specification of minimum standards, which are required for all samples marketed for human consumption, and must hold true at every stage of the distributive system. Offenders are liable to fines or expulsion from registration (this includes merchants and wholesalers, who similarly to growers, must register with the PMB). The potato industry is policed by a PMB appointed inspectorate.

Currently, the minimum standards should mean that not more than 8% of any quantity of potatoes sold for human consumption should be subject to the following considerations. That potatoes should not be wrongly sized: potatoes are graded for size, and are out-graded if they do not pass through a $3\frac{1}{4}$ by $3\frac{1}{4}$ in. griddle mesh, or, alternatively pass through one of $1.^{5}/8$ by $1.^{5}/8$ in. Potatoes should also be rejected if more than half the tuber surface is affected by common scab, if tubers appear diseased (or rotten), misshapen (or affected by secondary growth* effects), cracked or damaged (so that normal peeling is impossible), bruised internally, affected by greening,* and damaged by frost and pests (see PMB, ibid).

An effective minimum quality control tends to lower the total quantity of potatoes which is made available to final consumers, and is therefore, likely to raise price (providing of course, that the rejected potatoes would otherwise have been marketed). In fact, until 1968, the PMB exerted control over the rate that potatoes were coming on to the market by varying the potato size permitted for sale for human consumption. This practice was termed as 'varying the riddle', and was abandoned because it involved a wastage of sound potatoes (recently, however, temporary adjustments to riddle size were introduced when it seemed that potatoes might become under-supplied).

10.8 Potato maincrop trading conditions

The general success of the PMB can be gauged from an impression of the trading situation for maincrop potatoes shown in table 10.1. The figures for maincrop and human consumption are for the months of August to end-May, and thus omit to a large extent the effects of early crop production (there are likely to be overlaps of the main and early crop markets in August and May). The uses for potatoes not shown in the table include those of exports, unrecorded sales, and stockfeed not covered by PMB schemes. Generally, these uses account for only a small proportion of the maincrop output.

It is seen from the table that the tonnage required for human consumption has been fairly stable compared to the annual changes that occur in output. Where there is a wide divergence between the two, the result is a surplus. The other categories of usage do not appear to be meaningfully related to surplus outputs. In fact, in the heavy surplus years of the early 1970s, the category 'wastage' (made up of outgrades, shrinkage loss and wastage in store, stockfeed outside the PMB's schemes, and so on: see PMB/A op cit, notes to table 11A) is at its lowest ever.

Such a possibility would inflate the 'surplus' category. This category is made up of potatoes contracted to the PMB and still remain unsold at end-season, and so qualify for 'compensation' payment. Up to end-1968, estimates were made and included for those potatoes assumed diverted from human consumption by the practice of varying the riddle (Section 10.7). Some of the surplus potatoes are diverted for stockfeed under the PMB schemes, dehydration, export, and in at least one instance, for use in a product designed for famine relief (the size of alternative markets to human consumption is very small, see Appendix 19).

TABLE 10.5

Potato market trading conditions 1955 - 1972

	Maincrop total tonnage (a)		Human consumption (b)		Surplus (c)		Seed (d)	Quota (e)	Wastage (f)	
1955/56	4141		3864		39	(1)	844	100%	921	(22)
56/57	5032	+22	3780	-2	1095	(26)	768	100%	595	(12)
57/58	3957	-21	3942	+4	0	-	759	100%	401	(10)
58/59	3962	-	3730	-5	0	-	756	100%	529	(13)
59/60	5081	+28	3611	-3	862	(23)	773	100%	454	(9)
60/61	4982	-2	3836	+6	808	(20)	664	100%	614	(12)
61/62	4378	-12	3888	+1	75	(2)	704	90%	657	(15)
62/63	4805	+11	3967	+2	20	-	728	100%	1020	(21)
63/64	4616	-4	3933	-1	67	(2)	714	100%	834	(18)
64/65	4931	+7	3908	-1	675	(16)	702	100%	520	(11)
65/66	5582	+13	4021	+3	905	(20)	650	100%	630	(11)
66/67	4872	-15	4036	-	0	-	688	100%	662	(14)
67/68	5390	+11	3990	-1	781	(18)	666	100%	468	(9)
68/69	4941	-8	4093	+3	203	(5)	597	100%	719	(15)
69/70	4403	-11	3901	-5	0	-	645	85%	445	(10)
70/71	5446	+24	3867	-1	1336	(38)	613	95%	367	(7)
71/72	5351	-2	3864	-	1206	(34)	574	87½%	373	(7)

Notes: All tonnage figures expresses as '000s.

± Figures in columns (a) and (b) denote percentage changes from pervious seasons

Figures in parentheses in column (c) express surplus and in (f) wastage percentages of maincrop output.

Source: PMB/A

The main uses for, and costs of surpluses, 1965 to 1971, are summarised in table 10.2. It is seen that the proportion of surplus potatoes used for stockfeed is large; for two out of the five surplus seasons shown, it exceeded that proportion of surplus which qualified for compensation payment, see rows (b) and (c). The costs associated with surpluses are also large. For example, the average annual value of tonnage sold for human consumption (tonnage times average market price) between 1965 and 1971 was around £79m: this compares to the average annual surplus cost of about £7.8m, or 10% of the value of the crop.[1]

TABLE 10.2

Maincrop potato market support ('000 tons, 1971 £s)

	1965	1966	1967	1968	1969	1970	1971
Total surplus	905	-	781	203	-	1336	1206
Stockfeed	435	-	249	136	-	620	559
Compensation	95	-	337	22	-	716	647
Export (a)	45	-	-	-	-	-	-
Riddle effect	330	-	195	45	-	-	-
Total cost market support (£)	11300	-	10000	2300	-	19700	17400
Total cost government (5) (b)	9000	500	8400	2300	600	18600	16500
Value of stock feed (c)	2900	-	1500	800	-	3700	3400
Value of compensation (d)	1800	-	6200	410	-	11200	9700

Notes: (a) Potatoes dispatched by the PMB to the Continent for dehydration purposes.

(b) Includes a cost to government of administering potato guarantee arrangements which include a contribution of around £0.5m.

(c) Assuming a price for potatoes of £6.

(d) Assuming compensation paid at average market price for year shown.

Sources: PMB/A, CCGB, 1972 op cit.

Of the seventeen years shown in table 10.1 thirteen were ones of surplus, and three of these were seasons when surpluses were in excess of a million tons (which represents about a quarter of human consumption). Nine are in excess of the target surpluses fixed in 1969.

Only once prior to 1969 did the PMB make use of its quota measures to restrict plantings, this was during 1961/62 after two seasons of heavy surpluses. A quota was imposed again in 1969, and thereafter maintained, see table 10.1. Yet during the early 1970s the PMB was faced with two of the largest surpluses ever recorded; and criticism that it had been reluctant to impose realistic quotas (see for example, Amey, 1972a).

[1] The financial arrangements used to cover costs associated with surpluses are summarised in Appendix 20).

Nevertheless, the imposition and maintenance of the 1969 quota restrictions did bring about a significant change in the size of main-crop plantings, see table 10.3. The five year annual average for 1972 is more than 54,000 acres below that for 1968. This is a decline which more than accounts for the increase in general crop yields brought about by the widespread adoption of the SPBS's new varieties, and was necessary to allow for the contribution to higher average gross yields brought about by husbandry improvements generally.

TABLE 10.3

The decline in British planted maincrop acreage

Year	Maincrop Plantings (a)	5 year moving average (b)
1965	516,820	4[illegible]7,896
1966	473,040	501,290
1967	508,530	504,926
1968	489,180	501,322
1969	423,380	482,190
1970	465,440	471,914
1971	442,230	465,752
1972	413,290	446,704

Source: PMB/A

Indeed, the restriction of acreage was sufficient to probably have an important effect upon the structure and, therefore, the efficiency of the potato growing industry.

10.9 Structural problems associated with acreage quota imposition after 1969

Prior to the imposition of quotas in 1969, there existed a marked tendency for potato growing units to increase in size, see table 10.4. The total number of registered growers had declined substantially. Those who had planted less than ten acres were the ones most affected: as a group, they declined in terms of a proportion of all growers, and of total planted acreage, see table.

TABLE 10.4

The structure of the potato growing industry

Acreage size group	Number of Registered Growers 1959	1962	1965	1968	1971
Below 10	58738 (77%)	51993 (74%)	32376 (55%)	24779 (50%)	22289 (51%)
10-19.99	9350 (12)	8337 (12)	8274 (14)	7479 (15)	6459 (15)
20-29.99	3454 (5)	3264 (5)	3392 (6)	2599 (5)	3020 (7)
30-39.99	1714 (2)	1624 (2)	1890 (3)	1786 (4)	1526 (3)
40-74.99	2083 (3)	2072 (3)	2067 (4)	2392 (5)	2091 (5)
75 and over	919 (1)	925 (1)	1090 (2)	1116 (2)	998 (2)
TOTAL	76258	70665	58761	49425	43990

Acreage size group	Acreage planted 1959	1962	1965	1968	1971
Below 10	160266 (24%)	135593 (22%)	115646 (18%)	93414 (15%)	89990 (17%)
10-19.99	124995 (19)	112773 (18)	111231 (17)	100722 (17)	89762 (16)
20-29.99	81723 (12)	77775 (13)	79741 (13)	75258 (12)	72498 (13)
30-39.99	57571 (9)	54948 (9)	63475 (10)	60002 (10)	52073 ((10)
30-74.99	107914 (16)	107759 (18)	122841 (19)	124964 (21)	109715 (20)
75 and over	125358 (19)	126049 (20)	144284 (23)	148929 (25)	130772 (24)
TOTAL	657827	614897	637218	603289	544810

Note: Figures in parentheses signify categories' totals as percentages of the whole.

Source: PMB/A

Large-scale growers, that is, those who had planted forty acres and over, increased as a group their proportion of the number of registered growers, and share of planted acreage. It is possible that the figures in the table might understate the importance of large growers (and may, therefore, hide change), since acreage expansion often takes the form of rented acreage, and this is not reflected in the table.

An EDCA report (1973) has suggested that the relationship between production unit size and productivity (as defined by gross output per unit of all inputs) is a positive one. This is because conomies of scale allow a full use of machinery and central facilities.

The rate of structural change which the table implies for the period prior to 1968 is surprising since in theory, the basic acreage method of allocation might be expected to restrict flexibility (for instance, see the examination of quota restrictions in OECD, 1973). In fact, in percentage terms, the rate of change in the size of production units between 1965 and 1968, is similar to those for wheat and barley, two crops unconstrained by acreage restrictions (MAFF et al, 1970: Table III).

After the imposition of quotas in 1969, the trend to larger units stopped, and may have gone into reverse, see the 1971 figures in table 10.4. As a proportion of the total, numbers of small growers and potato growing units increased, whilst those of large growers and units decreased. Some large-scale producers have charged that marketing arrangements have not allowed them to expand. For example, Amey has suggested that the more successful growers in eastern England have been prevented from expanding their plantings only by acreage quotas (1972b).

It seems that the problem facing the PMB, and perhaps the reason behind any reluctance it might have felt in imposing quotas, is one of a choice of compromise between allocative efficiency and distributional justice. The existing method of quota implementation probably favours a status quo distribution of growers and acreage, to the cost of those who want to expand their acreages and outputs.[1] It is likely that such a situation is likely to increase the pressure for maximising crop yields and quantity marketed. A tendency for production units to substitute other factors of production for one that has been restricted is a well documented phenomenon in economic literature (see Lancaster, 1969: Chapter 4), and has been observed for potatoes in the instance of land, in American studies (see Gray, et al, op cit).

10.10 The implications of the commercial success of Pentland Crown and Pentland Dell for the achievement of the aims of government policy

It has been necessary to explain the workings of the PMB and some of the problems it has faced, to understand how Pentland Crown and Pentland Dell might have affected the achievement of the government policy aims outlined at the beginning of this chapter.[2] The first objective of government potato policy was the achievement of efficient production and efficient marketing of the type and quality of potato required by users and consumers. This is usefully categorised into two parts, efficient production and efficient marketing.

(a) The objective of efficient production

Whilst growing costs per acre have been increased as a result of growing Pentland Crown and Pentland Dell instead of Majestic, the magnitude of costs saved resulting from retired acreage was such that cost per ton for human consumption would have been reduced in 1969 and thereafter, see Section 8.7.

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[1] The PMB has proposed alternative solutions for acreage allocation (PMB, 1972). One of which was to control output by the prohibition of high yielding varieties. This would mean that Pentland Crown and Pentland Dell would not be grown.

[2] A full critique of the workings of the PMB is not relevant here, only those facets of its activities which have some bearing upon how the new varieties have affected the situation with regard to issues of importance for this present study.

As indicated in the previous section, acreage restrictions probably involved a loss of flexibility, and, therefore, perhaps a loss of efficiency.[1] The contribution of the new varieties to this state of affairs is uncertain. It is unlikely to amount to any significant cost estimate, which would go any way to off-set the above cost advantages.

(b) <u>The objective of efficient marketing of the type and quality of potato required by users and consumers</u>

There are two parts to this policy aim, the costs of marketing, and whether the potato trade and consumers have received the potatoes they wanted. The implications of differences in quality of yield between the new varieties and Majestic for costs was examined in Sections 7.8 to 7.10. There, it was considered likely that costs had been increased overall. However, it is likely that with spraing troubles excepted, Pentland Dell with its uniform and attractive samples will facilitate quality grading and marketing.

The second part of the policy aim involves asking the question of whether Pentland Crown and Pentland Dell were wanted by the potato trade and consumer; did they in displacing Majestic, improve the welfare of users and consumers. Two economists writing in the agricultural press state that welfare was not enhanced, to the contrary:

> "...(Pentland Crown) has a very high yield but is of poor quality, difficult to store and is not appealing to the taste of the consumer. It is easy to grow in almost any conditions and provides a higher return per acre than the lower yielding but higher quality potatoes because the PMB's policy ensures a market." (Haynes and Howarth, 1972).

The last part of these comments implies something additional to the simple possibility that Pentland Crown might not be liked by consumers, in that somehow, husbandry practices and the workings of the PMB have combined to make the new varieties commercially attractive, and so presumably, consumers have, to some extent, been forced to accept

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[1] Of course, this will only last as long as more growers wish to plant potatoes than the available acreage allows. This situation certainly lasted up to 1972.

them.[1] It is a contention which has received wide support in the potato trade.

The issues surrounding these allegations are complex, and because they involve the new varieties, a full examination is required by this present study. This is done in Chapter 12. Two important parts of the potato industry which had not entered directly into the debate associated with quality questions, are the processing and catering sectors.[2] The needs of these can be considered here.

(c) <u>The usefulness of the new varieties for processing uses</u>

The growth of the different sectors of the potato processing industry during the 1960s and early 1970s, is shown summarised in Appendix 21. The fastest growing processing activity has been that of frozen and parfried chips. The crisp and dehydration sectors have also significantly expanded the tonnage of potatoes used by them annually, but in terms of percentage share of all potatoes processed, they have given ground to the frozen chip sector.

Much secrecy surrounds the activities of the processing industry, but a rough indication of varietal use is provided by estimates given in Appendix 21. Pentland Crown and Pentland Dell have both been used extensively by frozen chip and dehydration manufacturers. It is difficult to judge if their existence has made any impact upon processing

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[1] There are generally elements of 'force' in what are essentially cost innovations but which have consequences for consumer quality: in the sense that the innovations are producer induced, and then the onus is on consumers to recognise quality implications and if necessary, refuse the product for alternatives. However, consumer sovereignty assumes that consumers are aware of change, and do have the choice to refuse product change. The implication of the above allegation is that consumers do not have that choice.

[2] A description of the sectors of the potato industry, based upon the type of potato product sold, is given in Appendix 19.

that would not have existed if Majestic had still been widely grown. Conversations with company representatives during 1970 and 1971 suggested that Pentland Crown was only acceptable to processsors because it was popular with growers. The variety seemed to have no particular advantage for processing.

Whether they would have thought this if they had had to use Majestic on a large scale, is another matter (frozen chipping and dehydration have grown to their present sizes largely during the period of the SPBS innovation). It has been suggested in the agricultural press that the potato industry generally (including processors) is confused about the kind of potato required (Gardener, 1971).[1]

(d) The usefulness of the new varieties for catering purposes

It is possible that around 20% of potatoes used for human consumption, is channelled into catering establishments (EDCA, 1972 op cit). The importance of catering to potatoes is examined in Gibbons (1970), and more generally, in Hunt and Jamison (1967). A wide range of concerns and customer is involved: for example, from state-sponsored institutions, of which school canteens are probably the largest consumer, to hotels and fish and chip shops, probably the largest private consumer. However, little is known about the industry's requirements, still less about the importance of specific potato varieties.

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1 Probably of more importance to processers than variety as such is price. Particularly in the dehydration sector, where price competition from imports is strong, despite the availability of subsidies, (see PMB, 1974b op cit: Table 2). If PMB market support operations have significantly affected the prices of potatoes available to this processing activity, then the sector might have been held back in its expansion at a time critical to future development (note the concern expressed in this respect in the report by the CCGB, op cit). The EDCA had observed during the 1960s that it was likely the sector's domestic market would be subject to substantial competition from imports by 1972/73, if the price advantage of the raw product used in the manufacture of imports was not off-set (1968 op cit). Recent statistics suggest that this has happened: during 1973/74 the raw potato equivalent used for imports of dehydration products, was nearly half the domestic total, (see PMB, 1974b: ibid).

Simpson has suggested that caterers are more knowledgeable than domestic consumers about varietal cooking suitability, but that given the relatively high price for King Edward, they were generally "reduced to using the rather flavourless Majestic" (p.19). Just how Pentland Crown and Pentland Dell might have affected the Catering Industry is difficult to tell. What fragmentary evidence there is suggests that establishments generally take what potatoes are generally available, an important consideration being price (Simpson 1968; Gibbons 1965). It was suggested to the author by a PMB regional officer that Majestic persisted as a popular variety in the face of competition from the new varieties in south-western England, because of its keeping quality and its importance to the tourist and holiday trade (written communication).

However, taking catering as a whole, the displacement of Majestic has not resulted in any obvious effect. Similarly for processing, the consequences of Pentland Crown and Pentland Dell being available instead of Majestic, has had no obvious overall effect. Thus, the policy objective probably has not been affected with respect to these two sectors of the potato industry.

(e) <u>The objective of price stabilisation</u>

The success of the PMB in stabilising prices depends, of course, upon its ability to bring supply into equilibrium with demand. In Section 10.8 it was noted that the PMB had been subject to criticism that it had not brought in adequate quotas to deal with a problem of chronic over-supply, so that in the early 1970s some very large surpluses were recorded.

The PMB attributed these surpluses to the effects of the new varieties, including those of Pentland Crown and Pentland Dell, in raising the general level of crop yields to where they were in "advance of statistical trends" (PMB, 1972d: p.56). If this is correct then it implies that the new varieties have made the PMB's task of achieving price stabilisation more difficult.[1]

Certainly, the pressures upon the PMB to maintain prices were made worse prior to the imposition of quotas.[2] However, the effects of the quotas were such as to retire a large amount of acreage from maincrop potato production, far in excess of that which could be attributable to Pentland Crown and Pentland Dell. The average annual estimate, 1969 to 1972, of freed acreage attributable to Pentland Crown and Pentland Dell together, is about 20,000 acres, which is 38% of the annual fall in maincrop acreage noted in Section 10.8, after the imposition of quotas. In addition, the PMB seemed aware of what the impact of the new varieties would be upon crop yields (PMB, 1968b: pp.4-5).

Given these considerations, and the probability that weather conditions were generally favourable in the early 1970s to high yields, then it seems likely that the large surpluses would have occurred anyway, if the new varieties had not existed.

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[1] It also implies that acreage restrictions, begun in 1969, have not taken full account of the new varieties' extra output, and that therefore, the full extent of potential cost savings associated with retired acreage has not been realised. In addition, it suggests that costs were incurred in market support and surplus disposal after 1969, and, therefore, the rate of return which included costs associated with surpluses, Section 9.7, is an under-estimate of the real situation.

[2] That is, the extra output potential of the new varieties contributed to surplus conditions. However, in 1968, they probably turned a near deficit trading situation into a surplus: thus, relatively high prices might have been prevented (Section 8.4), which in annual terms stabilised prices. It is questionable if the PMB would regard this as advantageous, since the Board seems rarely, if ever, to have advocated the use of imports to bring down prices in a deficit year. The aim of self-sufficiency is of course, to ensure price stabilisation. However, the reluctance to bring in imports indicates that, paradoxically, self-sufficiency is a less flexible policy aim than price stabilisation. It is probably felt by the PMB that prices in surplus seasons (which are the norm given the self-sufficiency aim) are unreasonably low, and so the grower is entitled to the reward of higher prices in deficit seasons.

However, the new varieties could have made a contribution to more volatile trading conditions in two other ways. If planted acreage has varied less annually then crop yields then the smaller acreage brought about by the need to off-set the new varieties' yield advantage, might have meant that an increased proportion of total output has been made dependent upon the generally more volatile yield, and less upon plantings. Secondly, trading conditions might have been made more volatile if the new varieties' annual yields have been more volatile than Majestic's would have been.

The evidence is mixed. It is not clear if planted acreage does deviate more strongly than crop yields (see table A22.1, Appendix 22), and on the second point, whilst it is possible that Pentland Dell's output might be more volatile than Majestic's, this is not clear in connection with Pentland Crown (cf. table A22.2, ibid).[1]

It is likely however that overall, the new varieties by displacing Majestic, have brought some extra pressure to bear upon the ability of the PMB to stabilise trading conditions and prices, if only because of the increased tendency to over-supply prior to acreage adjustment in 1969.

(f) The objectives of lowest reasonable prices consistent with a reasonable return to growers, and self-sufficiency

That the displacement of Majestic might have made it more difficult for the PMB to maintain prices, means of course, that the Board has found it difficult to maintain reasonable incomes for growers. In

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1 There is additional evidence which suggests that Pentland Crown is a more reliable yielder across a range of conditions: for instance, note the positive rating for the variety in the growers' survey for weather (Section 7.5), and the possibility that it reacts less adversely to drought (Lapwood et al, 1971).

addition, if total output has been made more dependent upon crop yield, it is necessary that the strategic reserve of resources available to ensure self-sufficiency take a greater proportion of all resources.

Since, although the resource savings properties of the new varieties will have meant that the resource cost of producing potatoes will have fallen, and that, therefore, the resource cost of self-sufficiency will have fallen with it; a more volatile output situation requires that the resources reserved for self-sufficiency must fall less proportionally than those employed for meeting normal demand.

However, the overall effect of cost savings is likely to contribute to a more efficient industry, and, therefore, the attainment of the lowest reasonable prices consistent with a reasonable return to growers, providing growers' representatives are successful in keeping guarantee prices at reasonable levels, so that if surplus conditions are more likely, then returns remain unaffected.

The achievement of the lowest reasonable prices (and indeed, aim of self-sufficiency to ensure ample supplies of potatoes upon a consistent basis) as a policy objective, possibly reflects the concern of government generally with the distribution of income. The potato is a relatively inespensive food item, which holds a prominent place in the national diet; particularly, in the instance of low income families.

10.11 The significance of the effects of the new varieties in terms of policy objectives, for the rate of return results

The importance of the implications of the new varieties for policy objectives for the social decision maker, will depend upon the circumstances of the planning environment at the time of the decision. For instance, although the type and quality of a variety's output might not be that required by users or consumers, an investment could be considered worthwhile if government policy has given an emphasis upon efficiency and the saving of resource costs.

Generally, the policy aims do seem to place an emphasis upon efficiency, and, therefore, the rate of return results would be very pertinent to a social investment decision.

However, the issues considered thus far are not the only ones with which government policy may be concerned. There are others more general in concept and, hence, of relevance to overall government policy (rather than specifically relevant to potatoes), but which may still enter investment decision making as considerations.

CHAPTER ELEVEN

General policy considerations of possible importance to social investment decision making

11.1 Introduction to chapter

Since this study must keep to manageable proportions there is not sufficient space to refer to every factor that might be of interest to decision making associated with publically sponsored investment. There are five categories of subject area, however, which probably warrant attention. It is not possible to evaluate them in detail, but because they are issues which seem important to public debate at the present time of writing and to some extent have relevance to plant breeding, they ought to be considered in a CBA. The subject categories are for the convenience of this study termed - government spending, regional policy, balance of payments and long term considerations.

11.2 Government spending

The financial cost of Pentland Crown and Pentland Dell in terms of their contributions to the total costs of surplus disposal and market support, was noted at about £4.24m (table 8.19). Around £3.91m of this was financed out of government sources of income.[1] The size of annual government contributions to surplus disposal is shown in table 10.2: the contribution to these totals caused by the new varieties is inferred in the same manner as for their contributions to total surplus costs, see Section 8.4.

However, the SPBS innovation has probably had some beneficial effect for government founding as well. Potatoes are a relatively high

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[1] Thus the main burden of surplus financing is felt by taxpayers. These are not necessarily potato consumers, given the progressive tax system, and tendency for high income groups to consume less potatoes.

cost crop, and since it is possible that freed resources will find employment in crops such as spring wheat and barley and since both are relatively low cost enterprises, it is likely that government departments will need to make fewer subsidy payments.

The consequences of a reduced potato acreage for subsidies are difficult to determine; for example, there does not appear to be a definite relationship between fixed capital equipment (including some machinery costs) and planted acreage of different crops. It is known, however, that fertiliser costs per acre for potatoes are about twice those for spring wheat and barley (cf. Nix, 1972, op cit) and so it might be assumed that freed potato acreage might result in the saving of around half the subsidization of fertiliser associated with that land.

No record exists for payments made on fertilisers bound for potato acreages. It can be approximated however, by taking the total public expenditure upon fertilisers (H.M.G. White Paper, 1973) and apportioning it according to acreage shares taken by different crops. Since potatoes are hungry plants, the share apportioned to the crop might reasonably be doubled. This total is then multiplied by freed potato acreage, expressed as a proportion of the total potato acreage (plus, freed acreage), to obtain an estimate of saved subsidy payments; around £0.3m might have been saved annually for the four years 1969 to 1972. Since potato land used for other crops might have less than half the fertiliser applications associated with potatoes, the actual savings might be about £0.25m. With the costs of surpluses, this leaves a net financial loss to government of around £3.844m.

11.3 Regional policy considerations

The most important aspect of regional policy is probably the goal of full employment. Reduced potato acreages (because the crop is relatively labour intensive) will contribute to the trend of a lower use of labour input in arable agriculture; but as far as the contribution of the Pentland Crown and Pentland Dell innovation is concerned, the effect is likely to be marginal. And given that unemployment levels have been relatively low in the main arable areas, labour savings in potato production are likely to be swallowed up by the needs of alternative crops. The effects therefore, in terms of wages and mobility (and thus, such matters as work satisfaction, removal and so on) might have been unimportant. Nonetheless, there might be exceptions associated with employment opportunities for casual labour and in areas outside the most prosperous arable areas.

Few crops offer opportunities for casual labour employment as do potatoes and it is likely that if growers reduce their requirement with planted acreage, alternative opportunities might be difficult to find. The effect is uncertain, since casual labour in the most prosperous arable areas, where most of the maincrop potato acreage is located, is in short supply, particularly for the potato harvest (Section 6.7). Hence, alternative employment has probably been available.

In the poorer arable, or mixed farming regions, however, the scope for alternative employment is likely to be limited. To an extent where, a reduction in family income from reduced casual employment opportunities, might make migration to urban areas significantly more financially attractive. This raises the possibility of 'second round effects', upon regional incomes and employment generally: reduced spending power might work through a local multiplier effect to contract employment opportunities elsewhere in a region. Indeed, if this leads to migration, there will tend to be undesirable effects for the urban areas (depending upon the state of the national economy).

The Treasury's forestry study gave prominence to development area policies and job creation, since forestry is an economic activity likely to take place in areas of poor farming conditions (Section 3.8). This is not true of potatoes generally, but the important certified seed industry is centred in development areas, and so some consideration should be paid to the effects of the commercial success of Pentland Crown and Pentland Dell upon that industry.

11.4 <u>The Scottish certified seed potato industry</u>

The certified seed producing regions are situated away from the main potato growing regions of eastern England, in areas of Scotland, northern England, the Isle of Man, and Ireland, where climatic factors are unfavourable for the spread of virus disease. The certified seed industry in Scotland is the largest supplier of seed to British growers and it is this part of the seed industry that this study will consider. To examine the whole would involve a subject too complex for the time available here. The sources of certified seed and extent of planted acreages by region, are shown in Appendix 14.

The period of Pentland Crown's and Pentland Dell's commercial success partly corresponded with a time of declining fortunes for the Scottish certified seed industry. The acreage certified for seed (inspected and certified by officials of the DAFS, under the Seed Potato Certification Scheme: for a description of the scheme, see Produce Studies, op cit), has declined markedly. A five year annual average of plantings to 1965 was approximately 75,000 acres, and by 1972 this had changed to around 51,000 a fall of 24,000 acres. This trend appears to have resulted from a fall in the demand for certified seed from ware growers.

It seems likely that the certified seed industry has to some extent brought about a fall in demand on its own account, by allowing a poor quality image to become associated with its samples and thereby given an incentive to the ware growers to produce his own seed. The prominence of own-grown seed was noted above (Section 7.11). An examination of the problems which have faced the certified seed industry during the 1960s is given in Hay (op cit), and more recently, Produce Studies (op cit).

The introduction of the SPBS's new varieties might well have made an impact upon the fortunes of the industry, since the seed requirements of the new varieties have been different to those of Majestic (ibid) and the smaller ware acreage probably led to a fall in demand. The importance of Pentland Crown's propensity to allow a greater use of own-grown seed has sometimes been stressed as a factor in the certified seed industry's decline (see Cullen, 1970, for example).

The impact of the new varieties can be assessed if the estimated seed requirements of the new varieties, 1965 to 1972, are compared to those that would have existed if Majestic had not been substituted. The requirements in the two situations have previously been estimated with regard to seed costs (Section 8.5a, 8.6): the estimated plantings of certified seed in the two may be divided by the assumed general certified seed to ware acreage ratio, 1:6.2, to derive totals indicative of changes in certified seed acreage.

In table 11.1, columns (a) show estimates of the difference in terms of ware acreage planted with certified seed in the observed new varieties situation to that which might have existed if only Majestic had been used. Columns (b) show these differences divided by 6.2, the consequences for certified seed acreage. Sections I and II of the table depict changes with respect to actual planted acreage, and freed acreage respectively.

It is seen that Pentland Crown has indeed, brought about a signigicant fall in certified seed acreage, particularly after quota imposition in 1969. The average annual fall, 1969 to 1972, was about 1,788 acres, or 7% of the annual decline in total acreage noted in table 11.1.

TABLE 11.1

The impact of the SPBS innovation on the certified seed acreage

	(a) Ware Acreage		(b) Certified Seed Acreage	
	Pentland Crown	Pentland Dell	Pentland Crown	Pentland Dell
(I)				
1965	- 2553	859	- 412	139
1966	- 8807	- 1241	- 1420	- 200
1967	- 9840	- 4052	- 1587	- 654
1968	- 9792	17472	- 1579	2818
1969	8667	10220	1378	1648
1970	- 5503	17289	- 888	2789
1971	-12718	18167	- 2051	2930
1972	- 388	19569	- 63	3159
		TOTAL	- 6622	12629
(II)				
1969	- 4640	- 2506	- 748	- 404
1970	- 5996	- 1684	- 967	- 272
1971	-13557	- 5142	- 2187	- 829
1972	-10074	- 2964	- 1625	- 478
		TOTAL	- 5527	-1983
		OVERALL TOTAL	-12149	10646

The opposite is true for Pentland Dell, however, since this variety's average annual contribution, 1969 to 1972, was a positive one of about 2,136 acres. Taken together, the varieties increase seed acreages, 1969 to 1972, on average by 348 acres.

The impression given by these figures is that the certified seed industry was not, on the whole, made worse off. This is strengthened, when it is realised that the generally high certified seed prices of Pentland Crown and the propensity for Pentland Dell to produce suitable tubers for the 'tops trade' (Section 7.11), might possibly have brought a larger income for the industry than Majestic would have done.

On the other hand, the growing costs associated with the new varieties might have been greater for the certified seed industry than if only Majestic had been grown. Too little is known about the new varieties effect upon certified seed production costs (for example, the effects of crop yield and quality) to be certain about the full effects. It is possible that Pentland Crown in particular, has brought a share of problems to the industry associated with tuber damage and storage. However, it seems reasonable to conclude that the SPBS innovation has not seriously affected the industry, so that distributional or regional considerations have been affected.

One important point remains to be made generally about the nature of resource cost in development areas. The possibility that resources used in certified seed production might not easily find alternative employment, suggests that the costs reflected in certified seed price might overstate the opportunity cost of certified seed. Thus, the certified seed costs included in the rate of return arithmetic might have been too high and consequently, the returns to the new varieties too conservative.

This possibility applies most strongly to labour. The Tresury study suggested that of a hundred jobs lost in a development area in Scotland only 15 might be compensated locally, another 30 be found elsewhere, and the rest unemployed (H.M. Treasury, op cit). This seems to indicate a low alternative value of labour. If it were about half the market value, then upon the basis of the 1970 PMB cost survey data, and the assumption that certified seed prices reflected costs, seed prices might be 10% too high.

11.5 <u>Balance of payments</u>

The importance of potato self-sufficiency has been noted, Section 10.3: besides this aim, a general need to limit agriculturally based imports has received prominence in government policy (see EDCA, 1968, op cit: the validity of such prominence will not be discussed,[1] but suffice to note that it rests mainly upon a requirement that the balance of payments remains strong and associated strategic reasons). The SPBS innovation will have had favourable effects for both. By freeing potato resources self-sufficiency becomes less resource costing and land is released for import saving (shortage of good arable is the main limitation upon increasing output potential: ibid).

There might have been other consequences, less important but worthy of note. These include the varieties' contributions to surpluses and associated disposal of potatoes for stock-feed, with perhaps less need for cereals. Also, the general price effect in 1968 might have provided an advantage to the dehydration industry at a critical time, in meeting competition from overseas. Certified seed exports might have been stimulated. For example, Pentland Dell in 1972/73 and 1973/74 accounted for around 9% of seed recorded for export by the DAFS, that is, fifth in varietal importance.[2]

The import saving factor was incorporated in the rate of return arithmetic, in the Treasury's forestry study: this used a 20% notional premium for forestry output as indicative of benefit to the balance of payments (Section 3.8). Using this in this present study for the alternative outputs, of wheat and barley, which were made possible by freed acreage, the following rates of return are derived.

These may be compared to those rates listed in table 9.5. Notional values were attached to cereal market prices and rotational

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[1] The theoretical background to import savings is given by Ritson (1970).

[2] The amount involved is small (% of 45,700 tons). Pentland Dell appears to sell well to countries where Majestic is imported: they may, therefore be competitors. Countries that seem to plant Pentland Dell are Spain, South Africa, Italy, Poland, Israel, Portugal, Brazil and the Canary Islands. Pentland Crown does not seem to be popular.

values. It will be seen that for Pentland Crown, the rate at the 5% discount factor, has been increased by approximately 100% and more. Only small increases occur with the 10% discount factor, however.[1]

TABLE 11.2

The impact of balance of payments considerations upon the rate of return

	Pentland Crown	Pentland Dell	Both	Pentland Crown	Pentland Dell	Both
	Wheat			Barley		
Discount Rate						
5%	920%	- 389%	49%	1008%	- 358%	60%
10%	376%	- 230%	6%	415%	- 215%	7%

11.6 Long term considerations

The short term consequences of reduced rotations for crop yield were noted above (Section 9.2). It should be noted, however, that the effects over time might be very uncertain (ARC, 1970). This applies to the trend of an increasing specialisation of agricultural output itself. From several viewpoints specialisation may not be without social costs, which might over the long period cancel the benefits. For example, the dependence of arable and livestock farming upon each other becomes weaker as the two activities are more heavily concentrated in areas away from each other. Thus, the arable regions come to depend upon increasing applications of artificial fertilisers, straw-burning and are unable to dispose of surplus potatoes. The livestock areas find a worsening problem with animal sewage and scarce feeding-stuffs. In both instances, there may be associated problems of pollution and costs to river authorities: for example see Riley, (1969).

Specialisation may also adversely affect environmental and sociological factors (such as flora and fauna, landscape and village

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[1] The propriety of including what is a collective, non-efficiency goal in the rate of return arithmetic is uncertain, see Section 2.8.

communities). To non-farming consumers of the countryside these matters are of the greatest concern and although nebulus and ignored by conventional CBA, perhaps they should be noted as relevant to social planning decisions. Certainly investment decisions concerned with agricultural research should be subject to investigations of environmental-economic reactions in physical (as opposed to agricultural consumer value) terms (for a general reference on this point see Coddington et al, 1971). To date, it appears that the overwhelming stress in countryside management is given to agricultural crop yields in the short term (for a general discussion of public policy and its relation to the countryside considerations, see Bowers, 1972 op cit).

The implication of these long-term considerations noted above, is that the effects of agricultural R & D upon environmental factors are not necessarily socially benign. Given the nature of much of the evidence, however, it is only possible to state that a concentration upon production factors in agricultural R & D has dangers which are probably not fully understood.

CHAPTER TWELVE

The identification of relationships between factors which combine to affect consumer quality with regard to the commercial success of Pentland Crown and Pentland Dell, and some observations as to their significance

12.1 Introduction to chapter

In Chapter 10 it was stated that certain parties had alleged that Pentland Crown and Pentland Dell were not of the type and quality required by consumers. It was possible, therefore, that the commercial success of the new varieties had not been compatible with the policy objective, the achievement of efficient marketing of the type and quality of potato required by users and consumers (see Section 10.10b).

This possibility is to be considered in this chapter. Of course, the concern of this present study is not strictly whether the new varieties have been wanted or not, but one which is consistent with the with and without criterion; whether in displacing Majestic, Pentland Crown and Pentland Dell have changed the type and quality of potatoes used by consumers, and if so, was the change consistent with an improvement in social welfare.[1]

The fact that this question has been raised at all, might seem surprising. Since if the competitive conditions, upon which the significance of a rate of return analysis is based, and the key assumption that consumers are sovereign hold (Section 2.3); as hold they must to a sufficient extent if a CBA is to measure social efficiency,

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[1] It was stated at the outset that some locally important, though minor varieties, have probably been displaced by the new varieties, (Section 1.4). Unfortunately, the resources available for this study do not permit a consideration of what this has meant for consumer quality.

then it is to be expected that consumers would not have chosen varieties in preference to Majestic, if the latter were more suited to their requirements.[1]

It could be assumed that this is possible if the cost savings identified as associated with the displacement of Majestic by the new varieties, had been enough to be reflected in prices, to an extent where prices had been reduced enough to off-set, in the minds of consumers, any disutility associated with lower quality. Here, a situation would exist where the new varieties have been acceptable to consumers, but that the quality of those varieties is not preferred to that of Majestic.

However, it was indicated above (Section 8.7), that the cost savings associated with the displacement of Majestic have not been significant enough to be reflected in final prices. Thus, the question of why consumers should want to take the new varieties instead of Majestic remains. There are two broad answers; that consumers generally, have not thought quality differences to be significant, or are generally apathetic about the changes, and secondly, consumers have had no alternative but to accept the displacement of Majestic. The answer is unlikely to be simple, since varietal potato quality is heterogeneous and differences might not be obvious even to the most well informed observer.

These questions of consumer motivation could be side-stepped by this study, however, if it were possible to identify and measure disutility directly, by asking potato consumers, in a survey, what they would be willing to pay to avoid having the new varieties, and have Majestic instead. If the value of disutility should prove to be positive, then this could be compared to the value of resource costs

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[1] The question of the sufficiency of the market model, and how it might be considered with regard to CBA, is raised below, Section 13.3.

saved.[1] If, according to the Hicks-Kaldor criterion (Sections 2.7 and 3.5) the latter is greater than the former, then the investment may be considered worthwhile; particularly so, if the difference when expressed as a rate of return is higher than other rates of return which could be expected on alternative investment opportunities.

However, for reasons which will become apparent below, it was not feasible to survey consumer opinion in a way which would be meaningful in terms of varietal quality effects.[2] Instead, it was necessary to examine the grounds for the quality allegations, as they were relevant to the new varieties and Majestic. It was necessary to judge how logically sound they were in relation to available evidence; what might have been expected, given the institutional nature and workings of the potato industry, and what is known about varietal quality.

12.2 John Sainsbury's Limited complaint to the Consumers' Committee for Great Britain, concerning the workings of the Potato Marketing Scheme, and subsequent conclusions

Allegations that Pentland Crown and Pentland Dell might be associated with poor quality potatoes were originally contained in evidence lodged with the CCGB, to support John Sainsbury's Limited (JSL) complaint that the interests of the potato buying public had not been

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[1] Of course, this disutility will partly be based upon what might be properly termed resource costs: most notably, labour time spent upon the preparation of meals (which could, perhaps, be valued at the market price for domestic labour: see Sunday Times, 1971). Indeed, if the ratesof return derived in Chapter 9, which were based upon agricultural resource costs, are not to be under-estimates of the whole resource cost implications to society, then they should include such costs.

[2] A survey of consumer opinion was conducted for this present study. The purpose of it, however, was to obtain general information which would provide a check on information about consumer behaviour which was already available, since much of this information was controversial. Details of this survey and its results are given in Appendix 23.

generally favoured by the workings of the Potato Marketing Scheme. The complaint received the support of the Produce Packing and Marketing Association (PPMA), a trade association which represents about 90% of the companies engaged in pre-packing potatoes, which also supplied evidence to the Committee, see CCGB (op cit).

The evidence supplied by the PPMA and JSL contended that the PMB's market support operations worked to make high quality potatoes financially unattractive to produce, because growers had found it easy to supply in bulk, low quality produce. This had been brought about by a situation facilitated by the introduction of low quality but high yielding varieties encouraged by a high floor price associated with support buying, and lax enforcement of the minimum quality standards (CCGB, op cit).

Specifically, JSL and the PPMA claimed that they were unable to obtain the potatoes required on a consistent basis, for the pre-packed trade. The complaint, subsequent work of the Committee, and publication of its report stirred up further criticism from retail and wholesale interests (Rose, 1972).

Much of the comment was centred around whether or not consumers were generally dissatisfied with the quality of potatoes they purchased. Attached to JSL's complaint was evidence in the form of results from a Gallup poll, commissioned by the company to ascertain the state of consumer opinion. The main feature was that out of a random sample of 1239 housewives, only 27% stated they had no complaints about the quality of potatoes they had last bought.

This implies a consumer dissatisfaction with quality more general than would have been the case if only consumers of pre-packed potatoes had been affected by poor quality. However, it is possible that this market has been more affected by quality than others.[1]

Pre-packing became important during the 1960s: in 1961/62 about 8% of potatoes bound for human consumption have been estimated as pre-packed, a total which grew to around 19% for 1969/70 (Produce Studies, op cit), but afterwards fell to approximately 12%. This has probably failed expectations. For example, it was notedin 1961 that around 50% of potatoes going for human consumption would be pre-packed in a "near future" (Hessayon and Fenemore, op cit). It might be that the attraction of other potato products has proved too strong. Particularly, that of processed products: the convenience factors are likely to appeal to a similar kind of consumer, and processed potato products have become more popular in recent years. However, some evidence suggests that the nature of pre-packs might be associated in the minds of consumers with quality defects, such as rotting and damage (Simpson op cit: Gibbons, 1965 op cit).

The condition of the potatoes which are bagged is very important. From survey reports generally it seems that a high number of potatoes which are marketed are damaged, effects often making themselves felt through rotting much later on. Once packed, individual potatoes cannot easily be removed. This is a reason why the loose potatoes offered at a greengrocer seem more attractive to many consumers (even when offered at the same price): survey evidence suggests that only a third of consumers would prefer pre-packed potatoes (Simpson ibid: Gibbons ibid).[2]

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[1] For a description of the markets and their commercial importance, see Appendix 19.

[2] A poor quality image might affect potato outlets: particularly the sales of general stores, which are the type of outlet most associated with pre-packed potatoes. Evidence indicates that once trade is lost it is not easy to regain (Gibbons, 1970 op cit). It is not surprising therefore, that general store retailers like JSL have been vocal about potato quality.

The results of JSL's Gallup poll indicated that the main causes of general consumer dissatisfaction were associated with tuber marks and damage: other causes were greening, softness of tuber, poor flavour and colour after cooking (a copy of the poll's results is given in Appendix 24). These results are broadly in line with those obtained from other surveys of consumer opinion.

Reference to some of this work was given in the report of the CCGB, and they are noted in Appendix 23, below. Since the JSL's poll two other surveys, one commissioned by the PMB, the other conducted by the Consumer Association, have had their results published. The former suggested that consumers had been satisfied with the potatoes they had bought, whilst the latter, confirmed the results and conclusions of previous work. This might seem strange since both surveys were conducted at about the same time: however, the differences between the one conducted by the PMB and others, appear to be ones which result from differences in object, methodology and presentation.[1]

This general evidence for poor potato quality does not link the displacement of Majestic by Pentland Crown and Pentland Dell. The recent surveys have uncovered nothing which directly links dissatisfaction with the new varieties, and surveys carried out prior to the late 1960s, are irrelevant since the new varieties had not become widely available in the shops. This last point suggests, indeed, that a level of general dissatisfaction had existed prior to the new varieties' commercial success (although, of course, it might have been made worse).

However, the CCGB in its conclusions, and later, the MAFF in its conclusions after an investigation into the workings of the marketing

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[1] The survey of consumer opinion carried out for the present study confirmed a general dissatisfaction amongst consumers with the potatoes they bought; the survey was carried out at about the same time as the PMB and CA ones. Some notes on the PMB and CA surveys are contained in Appendix 23.

arrangements for potatoes (below), did link the growing of 'new high yielding varieties' to an unsatisfactory quality situation.

In 1972 the CCGB reported its conclusions on the effect of the Potato Marketing Scheme upon consumers. It stated that "in certain respects" consumers were "being less than well served" and that the Scheme was probably a contributable factor. It recommended a review of the 'Guarantee and Marketing Arrangements for Potatoes'. This was undertaken by the agricultural departments and resulted in a consultative paper "to serve as a discussion between agricultural departments, and the organizations concerned with the future of the potato industry" (MAFF et al, 1973 op cit). This paper's general conclusion was that on balance it seemed desirable to give "greater weight to market forces" (para. 69)[1]

The paper seemed to accept the contention that the commercial success of the new varieties was greater than freer market conditions might allow: that somehow the new varieties might not be conducive to the improvement of general market quality, and that the planted acreage of the new varieties was larger than the needs of the market required. Officials who worked in association to produce the paper were contacted for the purposes of this study, to see if they could be more explicit on points of relevance to the SPBS innovation. One observation is worth quoting in full:

> "Witnesses suggested to us that in order to maximise their returns some growers grew for quantity rather than with the needs of the market in mind. This is not to say that grown properly the higher yielding varieties of potatoes are not wanted by the housewife, but by growing to maximise yield, faults do occur which may not be so apparent in other varieties. I think the working party (which produced the paper) felt that introducing arrangements which would allow

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[1] Such developments seemed shelved until more is established about what kind of common organisation will be required in the enlarged EEC. The Treaty of Accession allows a continuation of national policies in the meantime. One observer has noted that Europeans generally favour a freer market system (ACMS 1973), however the PMB has stated that the British system is envied by continental growers, and that there is no suggestion that the PMB will be wound up (Howells, 1973).

market forces greater weight so that producers have a much greater incentive than at present to grow with the needs of the market in mind, might result in a small swing away from higher yielding varieties"

(MAFF written communication)

12.3 <u>The implications of the MAFF observations for the effects of Pentland Crown and Pentland Dell upon quality</u>

The gist of the MAFF observations is that at least in part, present marketing arrangements have not functioned in concord with the policy aim of efficient marketing of potatoes of the type and quality required by users and consumers, and that the new high yielding varieties, namely Pentland Crown and Pentland Dell, have been associated with this situation. The observations imply that the new varieties might be linked with poor quality in three ways.

The first is that the new varieties are grown with the maximisation of crop yield in mind, rather than for the needs of the market. High varietal yields are, of course, a necessary factor in the attainment of maximum crop yield. Therefore, the new varieties have probably been grown for that reason, with the implication that since the new varieties possess a significant output advantage over Majestic, they have strengthened the incentives for growers to ignore the needs of the market.

Secondly, in concentrating upon size of output, growers have handled the new varieties in such a way that quality had been poorer than it might have been, if growers had been considering the needs of the market. The question here for this present study is whether or not these faults would have occurred anyway, without the new varieties: in growing Majestic to maximise output, would these faults have still occurred.

Lastly, if freer marketing conditions are likely to remove the emphasis given to the attainment of maximum outputs, then the contention that the new varieties would be planted less, given that the faults associated with growing to maximise yield would have been removed, implies that in the present situation, the market would prefer to have varieties other than Pentland Crown and Pentland Dell. The question for this present study is whether these other varieties include Majestic. If so, then it implies that the quality of Majestic is more preferable to consumers than that of the new varieties, and that therefore, the displacement of Majestic has resulted in a quality loss.

Thus, to summarise, the quality implications are that the new varieties might have restricted the availability of quality potatoes (reducing the scope for quality markets); have faults associated with the way they are grown and handled, and be preferred less (even if produced with the needs of consumers in mind) than Majestic. To consider the strength of these possibilities it is necessary, since the workings of the Potato Marketing Scheme are central, to consider what should happen when varietal innovation occurs without market regulations and with perfect expression of consumer sovereignty.

12.4 The determination of output quality with varietal innovation in conditions of perfect competition

For the purposes of exposition it is convenient to assume that only two potato varieties exist side-by-side, in a perfect market. One is a high quality, the other, an ordinary quality variety.

Under the conditions of perfect competition, consumer sovereignty ensures that the quantity and quality of potatoes required by consumers is achieved, subject to the conditions of supply. If, in equilibrium, production costs associated with a high quality potato are higher than those for an ordinary one, then the price of the former will be so much higher (not more so, for else growers would be earning abnormal profits).

If a new variety is introduced to the market, which is a perfect substitute for the ordinary quality variety except that it yields more per acre, then growers will want to grow the new variety since it offers an opportunity to earn high returns from a larger output. This will result in an over-supply of ordinary quality, and price will fall to an extent where, in equilibrium, the extra returns associated with the sale of a larger output per acre are off-set by lower returns from a reduced price (this occurs in a similar manner so described for the effects of an output increasing innovation in agriculture generally, (Section 3.7)).

The extent to which plantings of the quality variety are affected depends upon the cross elasticities* of demand and supply (potentially, market interactions are very complicated and uncertain, hence a need generally for partial equilibrium assumptions in market economics, see Lipsey, 1963). The important feature to note is that the price differential between the ordinary and quality variety will tend to widen, as the price of the former declines. This will encourage consumers to see the advantages of higher quality in a less favourable light: if the quality factors involved do not seem worth the price differential, then consumers are likely to buy more of the ordinary quality variety.

It is likely, therefore, that marketed quantities of ordinary quality will have been increased by the innovation at the expense of those of high quality. However, this situation will have been brought about by the decisions of consumers themselves, based upon their valuation of quality factors. However, it might be that the new variety has a potential for its potatoes to be dressed to a high standard, and therefore, one would expect growers to have an advantage of a higher output of good quality at the higher prices of the quality market. This possibility rests upon the strength of the potential. All potato crops, no matter how bad the harvested quality, have a potential for dressing to high quality.

What matters is the degree of harvested quality, since labour cost at grading, inconvenience, handling and storage problems all increase with poor quality.[1] Another factor is how the new variety might be received by the potato trade. If varietal attributes favour grading for certain kinds of product, for instance, tubers give uniform and attractive samples which keep well, then the trade might offer premiums for pre-packing.

The stronger the market price for quality, the lower the extra costs and inconvenience associated with producing quality, on the one hand, in relation to the market price, costs and convenience of ordinary produce on the other, the more likely will growers favour production for quality and the new varieties get used for quality markets.

12.5 The influence of the PMB, upon the determination of output quality

The purpose and workings of the PMB were described in Chapter 10. It was noted there that the contract price generally applied in the Broad's market support operations, is based upon guarantee price. This, therefore, is effectively a floor price beyond which, in surplus seasons, growers' prices generally do not fall. This applies to all qualities of potatoes, but is likely to be of most value to growers who tend to produce indifferent quality.

Since in unsupported conditions, it is likely that the market for indifferent quality would be less sure, given that the potatoes most likely to be sold for human consumption would be the ones of the

[1] Grading to a higher quality does not necessarily involve a grower in more waste, since rejected potatoes might still be suitable for sale at the minimum quality standards, and wastage rates are therefore similar to those which would have come about given minimum quality standards.

best quality. In this situation it is likely that quality prices would fall less than those for indifferent produce. However, the market guarantee at a price which is not too different from the market average over all years (see table 7.7), has ensured that producers of indifferent quality have been able to secure near average prices. It seems certain that the effect of a floor price is to narrow the price differential that might otherwise exist between quality standards.[1]

In addition, other factors associated with the workings of the PMB might combine to form conditions which are more favourable to producers of indifferent quality, than to those of higher quality. These are ones to do with the enforcement of the minimum quality regulations; and acreage control.

The proportion of the total amount of potatoes marketed which is likely to be checked by the PMB inspectorate is small, and the discipline meted out to transgressors has often been minimal.[2] The problem intensified during surplus seasons, when much of the inspectorate's time is taken up with market support buying. Extra inspectors were appointed in 1972. However, there is some evidence to suggest

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1 The CCGB recommended "the fixing of a lower buying-in price when market support has to be given. This would widen the gap between the rewards to the quality producer on the one hand and to the less good producer, on the other. (This would be a matter for Ministers, not the Board)" op cit: p.9. It is not suggested that floor prices are unreasonable in principle, or that the guaranteed prices have been generaly unreasonably high. The point is that the PMB buying-in prices have not acted to make indifferent quality seem less financially attractive than the marketing of good quality potatoes.

2 The CCGB gave the following for inspections in 1970/71: "At farms, 3,759 involving 28,963 tons of potatoes; at merchants' premises, 6,941 involving 41,408 tons of potatoes; at retailers' premises 2,145; at pre-packers and fish friers 149; and at school canteens 248." (op cit: p.4). This is a small proportion of the tonnage destined for human consumption, which approaches four million tons. Of sanctions used to enforce standards, the CCGB observed, "In practice it is often impossible to establish a case against him (a producer of sub-standard potatoes). If the potatoes are found on the farm, he has not yet marketed them and, if they are found elsewhere, the Board may not yet be able to prove that they came from him". It adds that whilst the licenses of merchants who deal in sub-standard potatoes can be withdrawn, it has rarely, if ever been done (ibid).

that the quality standards were still inadequately enforced. For in the autumn of 1973, the CA found that when it bought samples of pre-packed and loose potatoes, at a number of locations and shop outlet, only 25% and 33% respectively, were consistent with the minimum ware standard. The CA stated that most of the faults must have been present when the potatoes were graded at the farm (CA, 1974). The easier growers find it to market potatoes of indifferent quality, then the sharper is the incentive to maximise output and ignore the needs of the market.[1]

Acreage regulation is likely to increase pressures to maximise output per acre, since the imposition of quotas limits the expansion of output from planting more land. The generally observed tendency for producers to substitute other factors of production of an input in short supply was noted with respect to acreage in Section 10.9.

Some large growers have alleged that a combination of quota and guaranteed prices at reasonable levels, has allowed marginal growers to plant on poor land, experience high production costs and market sub-standard potatoes, and still make a good profit (Scorer, 1972). Certainly, the imposition of quotas in 1969 seemd to bring a halt to

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[1] The PMB seemed to accept in part, that the quality specifications laid down in its regulations, had not been entirely successful. In 1972, perhaps in reaction to the publication of the CCGB's report, the PMB brought in changes not only in the inspectorate, but in its specifications. The aim was to prevent a preponderance of single faults in samples: also, common scab was included as a consideration at the minimum ware standard (it had previously only featured in the recommended grades); the minimum riddle size was increased from $1\frac{1}{2}$in. to $1\frac{5}{8}$in., and a top riddle size introduced for the first time, of 3in.
Other reforms at this time included the first general attempt at consumer education with respect to varietal name and qualities, with the publication of a recognition chart. The compulsory labelling of all potato samples with the original source of supply, so that complaints could be relayed back (this reform had long been called for), and subsidy facilities were introduced to encourage growers to transport surplus potatoes to animal rearing areas for use as stockfeed.
The changes received a mixed reception in the potato industry; for example, a survey of grower opinion indicated that 61% were doubtful about the potential effectiveness of the measures for consumer quality (Arable Farmer, 1972).

structural change, which had favoured large-scale growers, who might be expected to be amongst some of the most quality conscious producers (the ones most favourable placed to invest in sophisticated storage systems, and employ skilled labour).

These factors associated with the workings of the PMB are likely to work against incentives which encourage growers to produce the qualities which might be required by the needs of the market. However, whilst there is evidence to suggest that quality has been generally indifferent (as supplied by surveys), there is little which directly implicates the PMB. The case against the Broad seems to be that it has erred by default, that poor quality exists when the PMB is charged with the encouragement of the improvement of the marketed potato product (see PMB, 1955).

However, there is some evidence that PMB market support operations have resulted in the marketing (and selling to the Broad) of poor quality potatoes, in the annual estimates of 'wastage', shown in column (f), table 10.1. Besides published accounts of oral allegations from trading participants, surveys, the only other evidence that market arrangements might have resulted in a lowering of quality lies in the 'wastage' figures, and how these have varied in relation to total production between the years, see column (f), table 10.1. In surplus years one might expect crop wastage to increase, both absolutely because total crop production would be at high levels, and as a proportion of the total crop production since customers might be in a more powerful position to demand quality.

But both absolute and proportion totals are relatively low for surplus seasons. The lowest of all, occur in the years of largest-ever surpluses, 1970/71 and 1971/72. There appear to be no increases in other categories of potato use, and it seems necessary, therefore, to conclude that a proportion of the national crop that would in an average season be waste, is sold to the PMB in surplus seasons. In the two years noted, the proportion of total production recorded as waste is 7%, which is 6% below the average figure recorded for 1955/56 to 1971/72.[1]

It seems reasonable to think that market regulations have worked to the disadvantage of quality producers and, therefore, has encouraged growers to ignore the needs of the market. Nevertheless, it is possible that the needs of the market do not call for the existence of quality markets, and that the commercial importance of quality has been exaggerated by PMB detractors.

12.6 The importance of quality markets to the potato trade

Traditionally, potatoes might not have been considered a quality item, because they have been regarded as the cheap (perhaps, the filler) food mainstay of the British diet. Potato custom at retail is constant and, therefore, suggests that factors other than differences in quality might be important to consumers. Gibbons found that shoppers generally selected their potato outlet for reasons associated with convenience (proximity and delivery service), and regularly shopped at one place (1965 op cit: p.136). The general impression is that potato trading is generally stable, right through the distribution system back to the farmer.

This has perhaps, given grounds for the PMB to state that consumers, merchants and retailers have,basically, seemed willing to

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[1] The ACMS Ltd. has observed for 1973, that "There is a need to enforce the current grading and quality standards and to dispel any belief among growers that they can get away with marketing lower quality potatoes than specified in the minimum ware standard. In this way something in the order of 5-10% of potatoes could possible be removed from the ware market". (1973 op cit: p.5)

to accept the quality offered to them, since they have the right of refusal (PMB evidence to the CCGB, 1972 op cit: p.37). Elsewhere the PMB has alleged that the potato trade generally has proved itself unwilling to meet the premiums necessary for quality graded samples, to cover the high costs to farmers of extra grading (Hampson, 1972a). And indeed, attempts at the establishment of quality markets based on premiums have failed.[1] In addition, the PMB attempts to encourage grading at levels above the minimum ware standard, by the specification of standards in its annual reports, seem to have lacked general support from growers and the trade (these were the 'standard' and 'table' grades, see PMB, 1971 op cit: and were recently replaced by a single 'premium' grade, PMB, 1973a op cit: Appendix A).

The lack of support for potatoes graded to the PMB's recommended standards brings one back again to the allegations of the pre-pack interests, that although they are willint to pay the premiums required, retailers such as JSL, have found it impossible to get consistent and continuing supplies graded to the recommended standards. The reason being that growers have found it too easy to market indifferent quality and still make a good profit (evidence to the CCGB, op cit).

However, it is likely that the nature of the distributive system generally, its structure and practices, is not conducive to the establishment of new quality markets. The system is generally made up with small traders, who take supplies as offered, usually from a single source, and lack the facilities to handle several quality grades

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1 Two such attempts were those of the Pre-packers' Development Association (which aimed to found a national standard of premium quality for pre-packed potatoes) and the PMB's voluntary labelling scheme, in 1960 and 1962-1963 respectively. In the former instance, the Association besides blaming the trade also criticised the PMB and growers (see Gibbons, 1965 op cit).

(or sort the potatoes themselves).[1] These factors tend to favour inertia and conservatism with regard to market changes. It has been observed that merchants generally might be uninterested in market research and improving consumer quality (see EDCA, 1972 op cit).

Other factors might also be important for quality differentiation. The chaim of distribution from grower to final consumer is long, usually involving a number of functions, the most costly of which is probably transportation. This tends to result in a large mark-up of retail price over that of farm-gate: for example, the average mark-up of London retail prices for white-skinned potatoes, on three dates in 1970-1971, was about 162% (Appendix 15). This tends to dilute the effects of price differentials based upon different quality standards.

Generally, distributors attempt to keep to constant absolute mark-ups, irrespective of the size of price changes passed to and fro along the chain of distribution: a common aim is to stabilise prices over the longest prior possible, sometimes across a range of vegetable type (the profits of some off-setting losses in others), so that smooth trading and easier book-leeping are facilitated. Attempts at quality differentiation might be seen as unnecessary complications, likely to favour the larger general trading groups.[2]

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[1] The large number of merchants might be expected to facilitate quality choice. However, the regularity of custom throughout the distributive system acts against it; rural merchants tend to have a local monopoly where outputs are accepted regardless of type and passed on to merchants whose function is haulage, to wholesalers in urban areas, who might also have a local monopoly. A full account of the potato distributive system is given in Gibbons (1970 op cit): indications of distributive behaviour with regard to retailers in Research Services (op cit), and more specifically, with regard to Leeds and Nottingham, in Simpson (op cit) and Gibbons (1965 op cit). A general examination of the way the distributive system works for vegetables generally, is Ellis et al, (1967).

[2] The nature of the distributive system for agricultural commodities generally has given cause for concern with regard to quality (MAFF, 1972a). And that part with respect to potatoes particularly so, the EDCA observed that the potato industry would be hard put to withstand quality competition from EEC trading partners, if freer marketing conditions were introduced (1972 op cit).

The large retail multiples (particularly those which are based upon supermarket trading: where potatoes are generally stocked to complete the 'family range' offered to consumers, and convenience factors are important for staff handling costs) have generally relied upon pre-packed potatoes, and vary their prices in a way which is more responsive to trading conditions (Gibbons, 1970 op cit). They have tended to by-pass the traditional distributive system for potatoes, to ignore the urban wholesaler, and go directly to farm co-operatives.

This development has been in accord with that of the establishment of central grading stations (generally, by grower co-operatives). These permit the pooling of outputs, the provision of common facilities, and the development of alternative markets to those offered by the more traditional rural merchant. They offer to the trader who wants good quality, a chance to obtain potatoes on a more consistent basis, since unsuitable potatoes might be sufficient in number for them to be graded for other markets at the station. However, the proportion of potatoes bound for human consumption handled by stations and grower co-operatives has remained small: probably about 10% of the total in 1972 (Hill, 1972: Symon, 1972).

This low proportion might reflect the possibility that growers have lacked the incentive to combine to form co-operatives, and grade their outputs collectively for high quality. It has been observed that the main advantage of stations has stemmed not from the 'top-end' of the market, but from the facility provided for out-grades, usually for stock-feed but sometimes for processing, for which there might otherwise have been no alternative market (Briggs and Umpleby op cit).

This situation is consistent with the pre-pack allegations that the workings of the PMB have been such as to blunt the development of quality markets, and, therefore, to hold up the reform of the distributive system for potatoes. The role of the new varieties in this is that their increased output potential over Majestic, has made the incentive to supply quality on a consistent basis less important, relatively less profitable.

It might seem that the increased output potential also applies to quality samples, since a large crop yield is likely to lead to a larger marketable yield. This would seem to apply especially to Pentland Dell, which tends to naturally produce good looking tubers of uniform size, suitable for quality prepacks. Nevertheless, since growers generally were almost certainly producing for maximum outputs with Majestic, the psychological impact of the new varieties was probably in terms of crop yield size, rather than quality grading potentialities, which without generally established quality markets, would seem less obvious.

But precisely because growers had been generally concerned with size of crop yield in the pre-new varieties situation it seems that the overall impact of the new varieties upon the establishment of quality markets would have been marginal, therefore. The combination of the workings of the PMB with the commercial success of the new varieties is likely to have been more important for consumer quality with regard to that at or about the minimum ware standard. First, however, it is necessary to consider the impact of the new varieties upon the quality market which has been long established generally, that for King Edward VII potatoes.

The PMB has expressed concern that growers had found this variety (and the minor one, Golden Wonder[1]) less profitable to grow relative to

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[1] Golden Wonder has a quality reputation in some Scottish markets equivalent to King Edward elsewhere. It generally attracts a price premium. However, it takes only a very small part of the Scottish maincrop, generally less than 5%.

the success of the new higher yielding varieties (1972a). This is to be expected initially, but thereafter competitive forces should have resulted in a fall in King Edward's planted acreage until its prices rose sufficiently to off-set the revenue advantages of the higher yielding varieties (Section 12.4). The extent of the acreage decline would depend upon the strength of consumer preference for King Edward's quality.

12.7 The impact of the commercial success of the new varieties upon King Edward VII

In terms of its proportionate share of the national maincrop, figures 1.1 and 1.2, there seems to have been little effect for plantings of King Edward (or Golden Wonder).[1] This is in spite of what appears to be a significant narrowing of the price differential between white-skinned and red-skinned (mostly King Edward VIIs) potatoes during the 1960s and early 1970s, in the London market.

Using a list of prices published by the PMB (contained in evidence to the CCGB, op cit): a comparison of a three year annual average to end-1971, to that for the period to end-1965, the price of red-skinned potatoes rose about 18% but fell in real terms by 11% (1971 £s). For white-skinned varieties, price rose 25% and fell 6% in real terms (1971 £s). That is, the price differential narrowed in real terms by around 23% between 1965 and 1971.[2] The prices from which these were estimated are given in Appendix 15.

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[1] This is also true in terms of its proportionate share of the national tonnage. For example, the slight reduction in the variety's share of acreage in the mid-1960s (from which the variety soon recovered, figure 1.1) was paralleled by a slight fall in its share of national tonnage: the commercial importance of King Edward is greater by about 1-2 percentage points than is indicated by planted acreage.

[2] In terms of average grower prices, over five years to 1972, allowing for a mark-up of 160%, the average yield advantage has been such, over five years to 1972, that the retail prices for potatoes of alternative varieties would have had to increase by 2p/lb to off-set the extra revenue per acre associated with growing Pentland Crown and Pentland Dell instead of Majestic. This includes differences in costs per acre.

Part of the reason is probably a result of an improvement in King Edward's profitability brought about by an apparent increased yield potential which occurred in the mid-1960s, see figure 7.1 and that the markets for King Edward and white-skinned varieties are fairly independent of each other.[1] Even with these qualifications, it seems that the movement of relative prices has been such during the commercial success of the new varieties to suggest that competitive forces in determining the balance between high output varieties of ordinary quality on the one hand, and lower output but higher quality varieties on the other, work imperfectly.

It is possible that given marketing arrangements have favoured growers of maximum outputs, then growers of King Edward might have been reduced in the past to a rump, concentrated in areas where husbandry and marketing conditions are especially favourable for King Edward. That, therefore, substantial changes in relative profitabilities are required before significant changes occur in acreage plantings. Written communications with regional officers of the PMB and ADAS suggested that some regions were particularly geared to King Edward. It seems that substantial shifts in crop profitabilities did not occur with regard to those of King Edward, and the impact of the new varieties has been minimal.

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[1] The increase in yields is probably associated with the displacement of seed stocks with that free from paracrinkle virus. This was discovered in 1930 to be present in the total stock of King Edward's seed. Virus free tested seed was first introduced in 1959, and resulted in higher yields but with a preponderance of small-sized tubers (Hirst et al, op cit). In the results of the survey conducted for this present study, it was possible to discern the presence of a dichotomy in the preferences of King Edward consumers and others (Section 12.9). Also, a part of the potato industry might be particularly geared to the production of King Edward, and therefore, the market might not be very responsive to changes in the white-skinned market.

12.8 Faults in the quality of Pentland Crown and Pentland Dell arising from the way the varieties were grown and handled, and influence of the workings of the PMB

It was noted in the results of the growers' survey (Section 7.5), and the commercial trials (Section 7.8) that Pentland Dell probably has a superior quality for grading than Majestic: this is less clear for Pentland Crown, but generally the variety seems superior to Majestic. However, early difficulties might have been associated with Pentland Dell's susceptibility to spraing and tuber blight. Also, growers generally seem to have experienced difficulty with Pentland Crown in storage. In this instance, it seems that high yields encouraged growers to take risks with quality; Pentland Crown probably requires careful handling if its full quality potential is to be realised (Section 7.9).

These considerations should be largely irrelevant for consumer quality, since an adequate enforcement of (and grower attention to) PMB grading standards should remove poor quality potatoes from marketed samples. However, as indicated in Section 12.5, there are grounds for believing that many samples have not been graded up to the minimum ware standard. In addition, where grading is correctly conducted, there is always an increased possibility that more damaged potatoes will get through grading inspections (with disease spreading later in the tubers) if damage is generally at higher levels in a given crop.

Pentland Crown's relatively poor storage propensity is likely to be of most importance for quality towards the end of the maincrop season. If this is so, then it might have been a factor associated with an observed fall in consumption levels. It appears that consumers are well aware that quality deteriorates towards end-season generally (PMB, 1974a op cit) and, therefore, consumers could have been conscious of quality changes associated with the displacement of Majestic at this time.

Table 12.1 gives estimates of monthly potato consumption (excluding meals outside the home[1]) on a lbs. per head of population per annum basis, for the period 1960 to end-1972. Effectively, the maincrop season is over by May, and begins again in late August; thus the consumption totals for May to end-August are not given, since these would be likely to reflect mainly early crop* marketing conditions.

TABLE 12.1 Monthly Consumption of Potatoes

	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Total	3 year av.
1960	192	295	214	209	217	212	210	199	207	203
1961	194	207	215	210	218	231	231	195	213	205
1962	189	204	211	204	213	235	240	195	211	210
1963	203	213	215	208	206	200	211	207	208	211
1964	201	213	218	201	202	206	201	191	204	208
1965	206	223	224	205	208	210	206	195	210	207
1966	205	223	220	203	202	209	202	194	207	207
1967	202	224	223	198	210	207	200	194	207	208
1968	205	234	222	198	205	213	212	205	212	209
1969	205	233	217	186	195	203	201	185	203	207
1970	205	242	213	185	190	190	186	181	199	200
1971	205	241	213	185	181	191	185	183	198	200
1972	209	254	220	187	201	208	202	193	209	202

Source: MAFF, 1973b

The feature to note is the fall in annual consumption in the late 1960s and early 1970s below previous levels;[2] this resulted largely

[1] Monthly estimates are also published by the PMB as well as by the MAFF (which are used in table 12.1). The PMB's figures are calculated from merchants' returns, and so include sales to caterers, but exclude potatoes which do not go through the conventional marketing channels. The MAFF estimates are used here because they permit a clearer presentation of consumption when it occurs: a lag is probably associated with the PMB figures. However, both sets of estimates show very similar annual trends.

[2] A change also appears to have taken place around 1963/64: this also coincided with changes in varietal growing patterns. A period when King Edward VII stopped increasing its share of planted acreage at the expense of Majestic: seemingly after the advantage of the introduction of its paracrinkle virus free seed in the early 19s0s, figure 1.1. Recently, consumption levels have risen markedly. It is felt in the trade that this is a result of rising food prices generally (see Bullen, 1974): that consumers have been forced to switch to relatively cheap food categories for some meals.

from lower consumption totals in the late season months, and be associated with reduced storage quality. However, other factors might also have been important, most notably mild winter weather which could have lessened the need for warm meals, with which potatoes are used. If this were so, however, one would expect the consumption of some other foods to have been affected.

There was a slow-down in the sale of processed foods about this time (see Richardson, 1971), and this was, in part, blamed upon the weather. Other foods, such as canned peas, and other root vegetables, do not seem to have been subject to any notable changes in consumption however (see MAFF 1973a, op cit: Table 10).

If it is possible that quality of the potatoes available to consumers has been affected to an extent where consumption was affected, then it is probable that dissatisfaction with the quality of potatoes bought would have been widespread.

This is because of the nature of the importance of potatoes in the national diet. Cohen has suggested that the public think in terms of food category, rather than in terms of individual items: for instance, 'green vegetables' rather than a cabbage (1949). Potatoes might hold a unique role in traditional British meals in this respect, since they probably represent a category in themselves. If this is so, it is not surprising that there seems to be no evidence, in a British context to show conclusively which foods are generally substitutes for potatoes.[1] This implies that consumers, when faced with changes in the quality offered to them, are unlikely to buy significantly less with poor quality, since it is not obvious to them what might be used instead with traditional meals.

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[1] Gibbons produced results from his Nottingham survey, which suggested that a small number of housewives might turn to bread, vegetables, rice and macaroni (1965 op cit: table 47). American work has suggested that sweet corn, frozen peas and rice might be alternatives (Hee, 1967).

As observed above, Section 12.2, there is no evidence to directly link the new varieties with the general level of dissatisfaction suggested by consumer surveys.[1] The case that the new varieties did influence quality at or around the minimum ware standard, must rest on the observation that growers have experienced trouble with handling and storing the new varieties, particularly Pentland Crown, that because the PMB has not enforced quality standards adequately, and given the concern of growers to maximise output, then sub-standard quality was probably marketed, to affect the general quality on offer to consumers. Thus, in terms of the second possible effect noted in Section 12.3, it is likely that faults in the growing of the new varieties did affect consumer quality.

The main causes for dissatisfaction in surveys were associated with tuber damage and disease. However, cooking troubles and taste also featured as important factors. These are important to the question of whether or not consumers might prefer one variety to another.

12.9 The significance of varietal quality for taste and cooking suitability[2]

Not much is generally known about the determinants of taste and cooking suitability under commercial conditions, it is a subject which has probably been neglected until recently, when processing interest made it more important. For instance, it has been observed that feeding practices are likely to adversely affect flavour (Gibbons, 1965

[1] There is some indication that the proportion of consumers dissatisfied with general quality has tended to increase over time, and therefore, got worse in the time of the new varieties.

[2] There are other quality factors not considered here such as nutritional content, which might differ between varieties, for instance, calorific and carbohydrate values. Nothing is known about these, and it is likely that varietal differences are insignificant to consumer preference, and potato use.

op cit: p.147), and whilst in the advisory service the consequences of fertiliser applications have been noted as important, they are little understood (Eagle, 1972).[1]

Processing interest has involved a consideration of factors important to particular cooking uses, especially with regard to frying and associated factors of dry matter content* (which influences the amount of cooking oil used) and reducing sugars* (important to the colour of the finished product). An account of what processors would prefer from varieties is given in PMB (1974b op cit), and of their interest in quality more generally in Gibbons (1965 op cit). The NIAB introduced varietal assessments for dry matter, flouriness and freedom from discolouration (see table 7.1, under 'quality') in the early 1970s largely because of the processing interest (NIAB, op cit).[2]

Differences in varietal cooking qualities and taste have been examined and noted in several sources, most notably Whitehead et al (op cit), Burton (1966) and Cox (op cit). The influence of other factors upon cooking quality and taste, such as husbandry practices, soil and weather are, of course, important, but it seems that generally the most consistent and dominant influence is variety. However, whilst varietal cooking quality might seem of obvious importance in a variety like King Edward, because this is a variety known to consumers, it is less certain that it matters in a choice for consumers between the

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1 The nature of flavour itself is not yet fully known (Burton, 1966). The industry seems to have given little attention to it; out of 231 research projects lists in the PMB survey of potato R & D in the UK, only one seemed explicitly given over to flavour (PMB 1970b).

2 However, it does not yet appear to have become important to growers in their varietal choices generally. For the growers survey, the NFU thought that these considerations were unimportant, since growers would plant varieties which the market had accepted anyway. The only variety which processors specifically demand is Record, for crisp manufacture.

white-skinned varieties, Pentland Crown and Pentland Dell, and Majestic. The choice of varieties presented to consumers at greengrocers is generally one between the price premium demanding King Edward on the one hand, and other varieties, often unlabelled or simply marked 'whites' (Gibbons, 1965 op cit: CA, op cit).[1]

From the results of the survey of consumer opinion for this present study (Appendix 23), it seemed possible that consumers are broadly of two kinds with respect to the type of potato bought and varietal awareness. Respondents who stated that they purchased King Edward, Golden Wonder and Kerr's Pink (both of these latter two varieties seem to be associated with good quality in Scotland) were more likely in their answers to state that their motivation for buying their potatoes had been preference or quality: the percentage of these respondents saw 68%, as against 32% who gave convenience factors as important to their choice.

Of respondents who stated that they purchased 'whites', Majestic or unspecified varieties, 83% bought for convenience reasons, and only 11% for quality.[2] This might suggest that quality differences between white-skinned varieties could be unimportant. However, the surveys' results indicate elsewhere that this 'low preference' group is no less dissatisfied with the potatoes it has bought than is the 'high preference' group: (in fact, the percentages are 55% and 42% respectively).

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[1] Potatoes are not easily recognised, for example, King Edward is often labelled 'reds' but its skin is only part-coloured and after a period of storage may not have any colour at all (there is a red-skinned variant, Red King Edward; this is not widely sold however). Instances of incorrect labelling may occur; for example, during March 1973, the author visited 12 shops in Glasgow, and found 14 instances of what appeared to be incorrect labelling, out of 21 selections.

[2] This seems to be supportive evidence that the markets for King Edward, and the new varieties, are broadly independent, and why, therefore, they did not have a significant impact upon plantings of the older variety (Section 12.7).

A factor of some influence is that although consumers might be aware that differences exist in the quality of the types of potato they buy and use, they are unable to relate these differences on a consistent basis to variety. Survey evidence indicates that consumer knowledge of varietal name (Gibbons, 1965 op cit; PMB, 1974a op cit). It is to be supposed, therefore, that they know even less of the consequences of varietal choice for taste and cooking suitability.

The situation with regard to presentation of potatoes at retail has probably contributed to this state of affairs. PMB inspections in 1973 revealed that only 4% of potato samples had varietal names attached to them (1974d). Labelling is not compulsory of course, however, the PMB has since 1972 encouraged growers to mark samples with names when source of supply is recorded (the PMB has made rubber stamps free on request).

To some extent the reaction to the PMB to calls for varietal labelling has been ambivalent. For example, it has stated the view that to consumers with "average taste buds" and to "cooks of average talent" a potato is "just a potato" (PMB, 1973b).[1] However, in 1972 the PMB published a varietal recognition chart, which described the main potato varieties likely to be available to consumers, and contained assessments of their relative cooking suitability for the

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[1] The author encountered divided opinion within the ranks of the PMB on the question of varietal importance for quality. Regional opinion suggested that differences in varietal adoption patterns between different areas of the country, reflected consumer preference for the varieties concerned, Appendix 13. At head office, officials suggested that varietal attributes were relatively unimportant, in comparison with regional differences in husbandry and weather. Compulsory labelling at retail was, therefore, impractical, since associating varietal propensities with cooking suitabilities would expose retailers to prosecution under the Trades Description Act. The popularity of King Edward was 'traditional', its continuing success depending upon the buying habits of housewives.

elderly

main ways of cooking potatoes (PMB, 1975a). This has led to an increased demand for compulsory labelling.[1]

These assessments allow a consideration of the relative merits of the new varieties compared to Majestic. Once done, if these are associated with observed differences in cooking habits, it might be possible to infer if the displacement of Majestic could have had any effect upon consumer quality.

12.10 Differences in varietal cooking suitabilities and taste: the possibility of whether consumers have been affected by the displacement of Majestic

Chart assessments of varietal cooking suitability was based upon a consensus of opinion from PMB home economists. The PMB has stated that they show "good average evaluations" which provide a "first class guide" (1973b), and elsehwere, "experience has shown in the Board's Experimental Kitchen, some varieties are better than others for some purposes" (1975a op cit). The assessments are given in table 12.2 below.

The supriority of King Edward is evident. Desiree, a new red-skinned variety introduced in the 1960s which may prove a strong competitor for King Edward, is also given a generally high rating: so too, are Maris Piper[2] and Golden Wonder. The low ratings for all the

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[1] Gibbons observed that this demand has grown out of a "new stream of interest" generally with food quality (1965 op cit). At about that time the Observer newspaper commenting on the publication of a report of the Food Standards Committee (which generally recommended labelling), stated: "tickets ought to inform the housewife whether she is buying King Edward or Home Guard potatoes" (1964). This call was repeated in the report of the CCGB (op cit). More recently, the PMB noted that "the most common complaint still voiced by the housewives who attend the Board's cooker demonstrations is that variety names are rarely shown in the shops" (1976: p.5).

[2] Increased consumer awareness might favour a shift from Pentland Crown and Pentland Dell to Maris Piper in the white-skinned market, given the newer variety's high assessments. The yield advantage of the former varieties may be small (Section 9.9) and growers will, therefore, not resist strongly the shift in consumer preferences. The future returns to the SPBS investment seem dependent upon the size of Maris Piper's success (ibid).

maincrop varieties for salad use is a reflection of the texture of maincrop varieties, which is too mealy for salads (early crop varieties tend to have a waxy texture, and are therefore better).

TABLE 12.2 PMB cooking usage assessments

Variety	Boiled	Mashed	Jacket Baked	Roast with meat	Chipped and Saute	Salad Aug. to Dec.	Salad Jan. & after
Desiree	4	4	4	5	5	1	1
Golden Wonder	4	4	5	4	1	1	1
Redskin	3	4	3	1	1	1	1
Kerrs Pink	3	3	3	3	3	1	1
King Edward VII	5	5	5	4	4	1	1
Majestic	3	3	3	1	5	1	1
Maris Piper	4	4	4	4	5	3	2
Pentland Crown	3	3	4	3	3	3	1
Pentland Dell	3	3	4	3	3	3	1
Pentland Hawk	5	5	5	1	1	1	2
Pentland Ivory	4	4	4	3	4	3	2

Notes: Key - 1 - not recommended
2 - can be used for this purpose
3 - good
4 - very good
5 - excellent

Source: PMB 1975a op cit

Majestic receives good ratings for boiling, mashing and baking, excellent for chipping and saute (in fact, better than King Edward), and is not recommended for roast and salad uses. Pentland Crown and Pentland Dell have identical ratings which when compared to Majestic, show differences in roast, chipping and salad use. The new varieties are judged superior, see table 12.2.

A comparison of Majestic's ratings with those of Pentland Crown and Pentland Dell (both the newer varieties' ratings are identical) indicate differences in four of the seven categories. The SPBS's varieties are rated very good for baking (their only exceptional rating), good for roast and salad use: whereas Majestic registers good, excellent (better than King Edward) and not recommended, for baking, roast and salad use respectively.

Pentland Ivory, derived from a Pentland Dell - Pentland Crown hybridisation, is rated very good for all cooking purposes, except roast and salad use. In all, it does better than its parents. It is observed on the chart that the variety has a mealy texture.[1]

Other observations on the chart noted that Desiree, King Edward and Maris Piper rarely discoloured upon cooking, whereas Majestic had a tendency to do so. Majestic's good keeping quality is noted. Pentland Crown and Pentland Dell were noted for their close texture.

Nothing was stated explicitly about differences in maincrop varietal flavour. This reflects traditional attitudes that maincrop flavour is of no commercial importance, see below (Section 12.12). Texture is probably of some importance to taste (Burton, op cit), but the chart does not point this out to consumers.

The PMB have, in addition to the chart, published further advice on what varieties to use for different cooking purposes. This consists of a collection of recipes and associated recommended varieties: Pentland Crown and Pentland Dell are omitted altogether for boiling, mashing and roast (1974d). They are only recommended for baking[2], frying and sauted uses.

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[1] And might therefore, if consumers were aware of it, be a competitor for Golden Wonder in Scotland, since this is the main quality feature of this variety.

[2] Probably because of their tuber size. It was observed in Section 7.9 that Pentland Crown might have a tendency to get large tubers. The PMB perhaps sensitive to the allegation from JSL that it encouraged the marketing of potatoes the size of "old boots" (Rose op cit), introduced a top riddle size of 3in. in 1972. However, there is some evidence to indicate that consumers cannot get tubers large enough for baking (Gibbons, 1965 op cit: Simpson, op cit: The Observer, 1973). In 1973, in response to requests from caterers the PMB introduced a 'bakers grade' for use by that trade.

Without labelling, however, it is difficult for consumers to use this information to make a rational choice of variety. And it seems likely that if the new varieties had aversely affected consumers' cooking, by displacing Majestic as the dominant white-skinned variety, then consumers aware of the varietal change, would have tended to vary their cooking habits. The results of two surveys of cooking habits, conducted in 1961 (Pickard & Cori, 1964) and 1972-1973 (PMB, 1974a op cit), indicate that changes did probably occur during the 1960s, see table 12.3. The results are not strictly comparable since slightly different questions were asked, see the table column headings.

TABLE 12.3 Methods of Cooking Potatoes

	1961 (1516) % of meals before 7 p.m.	1972 (1786) % share of last 10 serving occasions
Boiled	27	29
Mashed	37	26
Chipped	17	18
Roast (with meat)	13	18
Jacket baked	n.a.	2
Other	12	7
Not stated	-	

Sources: Pickard and Cori, 1964: Section III
PMB, 1974a: op cit, Table 27

Whilst Majestic was rated excellent for chipping purposes in the PMB assessments, Pentland Crown and Pentland Dell were rated at only good, but no impact was made upon the use of this cooking method in the 1960s as a result of the displacement of Majestic, see the table. Roasting became a more popular cooking method, and for this method the PMB rated the new varieties good, and Majestic not at all. Thus, it is possible that the new varieties might have made this method of cooking potatoes more popular, or were contributable factors.[1]

[1] The excellent ratings given to Maris Piper and Desiree, make these varieties more important for chipping. However, at the time of the 1972 cooking habits survey these varieties probably had not had time to influence consumer actions to any general degree.

The largest change in cooking methods occurred in mashing. Burton has stated that traditionally consumers have preferred a potato flesh texture which upon boiling breaks down into a dry crumbly mash (op cit). If this is so then the difference in texture between Pentland Crown and Pentland Dell on the one hand, and Majestic on the other, might have been important. The NIAB assessed Majestic highly for flouriness (table 7.1). However, the PMB chart whilst noting the close texture of the new varieties, rates the three varieties equally for mashing (although the recommendations for the recipes ignores the new varieties for mash).

The increased use of potatoes for roast and decline in the popularity of mashed potatoes have probably influenced each other. It is difficult though, to link the change in cooking methods with the new varieties' displacement of Majestic, even though the varietal substitution seems consistent with the cooking change. There could be other reasons, the most likely for example, a change in eating habits associated with a general trend of increased meat eating (MAFF, 1973b op cit), so that roasted meat meals have become more popular.

It seems clear, however, that differences in cooking suitability have existed to an extent where the displacement of Majestic would have changed consumer quality. It is possible, given the above evidence, that this change affected cooking methods. The advantage of the new varieties for roasting over Majestic, is probably the most important factor, since this is consistent with the largest increase in popularity associated with any cooking method. The new varieties might have contributed to a decline in the popularity of mashing, but this is not certain, and, therefore, overall the effect of the new varieties upon cooking quality has probably been to improve it, compared to the situation where only Majestic would have been offered to consumers as the leading white-skinned variety.

The original allegations against Pentland Crown noted in Section 10.10b stated that the variety was "unappealing to the tastes of the consumer". Whilst this might be essentially so, in the sense that its flavour might have nothing to distinguish it,[1] there is no available evidence to suggest that Majestic is superior.

12.11 Summary and conclusions of this chapter

The question raised at the beginning of this chapter was whether the commercial success of the new varieties had been consistent with the government policy aim of the achievement of efficient marketing of the type and quality of potato required by consumers (Section 12.1). Or more generally to acertain if by displacing Majestic, the new varieties had changed the quality of potatoes generally available to consumers, and if so, with what consequences for welfare, and the interpretation of the rate of return results.

The nature of the allegations were considered first (Section 12.2), they were founded upon the quality interests of the pre-pack product sectors of the potato trade. The quality effects of the new varieties were associated with the workings of the PMB, and linked with general consumer dissatisfaction (uncovered by surveys of consumer opinion). The association was largely confirmed by the investigations and conclusions of the CCGB and MAFF reports.

Three possibilities were raised with regard to how the new varieties might have affected consumer quality (Section 12.3). These were (1) that the new varieties had in combination with the workings of the PMB blunted the incentives for growers to produce high quality:

[1] The only evidence in this context was an observation of the Henry Doubleday Research Association on the results of a survey it conducted amongst its members to ascertain varietal qualities; Pentland Crown was rated tasteless except after Christmas, when flavour was considered to improve slowly with storage (Mills, 1969). Majestic was not rated.

(2) in being grown to maximise output, the new varieties had produced quality faults, and (3) consumers would have preferred Majestic.

Theoretically, varietal choice and associated qualities, are determined by the inter-play of supply and demand upon price (12.4). However, the price for minimum quality has been established at levels where a reasonable income is received by the intervention of the PMB (Section 12.5). Other factors associated with the workings of the PMB, inadequate enforcement of minimum quality standards, and the method of acreage regulation, also play their part. So that quality incentives are probably blunted, and growers concentrate upon maximising outputs without proper regard to the needs of the market. There is evidence that wastage decreases in surplus seasons, when market support operations have been carried out.

However, the potential for quality markets is restricted by the traditional nature and practices of the distributive system (Section 12.6), but this state of affairs might be in part, a result of blunted incentives for quality, if new developments such as central grading stations have not been able to exploit potential quality markets based upon the pre-pack trade. It seems reasonable to suppose that the new varieties have had some effect in contributing to this situation, but only to a very small extent.

A quality market of some importance is that for King Edward (Section 12.7); there have been no obvious effects caused by the introduction of the new varieties. Thus, with regard to possibility (1) above, the general effect of the new varieties upon high quality markets has probably been only marginal.

It is likely that the new varieties have had faults in their quality, associated with growing and handling them to maximise output (Section 12.8). The important factor is the extent to which growers have been able to sell potatoes below the minimum quality standard; there is evidence that this was possible (Section 12.5). Quality might have been most affected in the latter half of the maincrop season, and this corresponds to a time when consumers bought less potatoes than in previous years. It seems that possibility (2) is probable that quality marketed at the minimum ware standard was adversely affected by the new varieties, Pentland Crown in particular.

Differences in varietal quality regarding cooking suitability and taste exist, and consumer behaviour suggests they are commercially important (Section 12.10). Cooking suitability differences exist between Majestic and the new varieties, which seem consistent with changes in consumers' cooking habits during the 1960s. It is likely that overall, the new varieties have improved cooking quality. Thus, it is unlikely that consumers would have preferred Majestic to the new varieties.

It seems that the general effects of the new varieties displacement of Majestic have produced a mixed result. The effect in terms of quality markets has probably been less significant than that in terms of quality at the minimum war standard and cooking suitability. Of these latter two concerns, the effects upon quality at the minimum ware standard are probably the more important, since survey evidence indicates that consumers have been most dissatisfied with disease and damage troubles, rather than cooking troubles. The overall effect upon general quality therefore, might have been such as to have left consumer quality worse off.

However, it is impossible to be more specific so that the consequences of these quality effects might be measured and allowed for in the rate of return results. Instead they have to be noted as general qualifications to the measured results. It is the view of the author that the quality considerations do not nullify, nor seriously off-set, the net benefit estimated in Chapter 9.

There are some points though, which whilst not of direct relevance to the investment decision of whether or not the new varieties' displacement of Majestic has been worthwhile, are of importance to the general question of whether social resources have been employed effectively. These concern the need to ensure that consumer choice and quality are facilitated, with regard to varietal choice. It is conceivable that the effects of new varieties upon quality might, in the future, be such as to result in substantial costs to consumers, if they remain unaware of varietal attributes.

12.12 The introduction of safeguards to facilitate consumer choice and quality[1]

From the research for this present study there are three considerations of importance to the improvement of facilities which ensure consumers are able to obtain the quality they require in potato varieties. These are the introduction of compulsory varietal labelling; the testing and evaluation of new varieties, under commercial conditions by consumers, and the improvement of the quality of information available to plant breeders about consumer requirements.

These suggestions might seem to imply that the industry has neglected consumers' interests, in favour of production ones: this, indeed, was part of JSL's allegations with respect to the workings of the PMB. There is some truth in this, not in the sense that the PMB, MAFF and other agencies have been overtly in favour of growers' interests,

[1] The question of how well an industry serves its consumers, the strength of competition and consumer awareness, can be answered only with a comparative analysis of a similar industry, or with reference to overseas' situations. Gibbons has reviewed what has been done in consumer and quality research in the potato industry in the USA, and concluded that there is wide scope for improvement in the UK (1965, op cit: Chapter 5).

but that given the nature of the tasks and problems it faces, ones which are essentially associated with supply, it is not surprising that considerations associated with demand might be neglected.[1]

It is a likelihood made all the more pertinent where demand seems stable and unresponsive to trading conditions, and in the instance of the PMB, membership is heavily grower orientated and funds short (so that it might be unwilling to incur additional expenses associated with market intelligence).

The research service in Britain does not generally appear to give much explicit consideration to the consumers' position. The ARC in giving policy aims behind breeding new varieties of crops omits them altogether:

> "to breed new crop plants and new varieties to provide, as far as possible, for the needs of farmers, growers and processors that might otherwise not be satisfied from other sources".
>
> (1970, op cit: p.4)

The trust is that farmers and processers will supply the varieties that best suit consumer requirements (and perhaps for cereals this might be so). According to Russell (1973, op cit) directors of R & D establishments generally either do not know who should be the beneficiary of agricultural R & D or they assume the farmer is in most instances the immediate beneficiary (p.15).

Literature concerned with potatoes and the potato industry generally suggests a trust in market forces and power of consumer

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[1] The idea that organisations work in a way reflected by the problems they face (so that quite often their operational objectives differ to ones behind the reasons for the establishment of the organisations) is one common in sociological research concerned with the behaviour of people in organisations. See for example, Perrow, 1961. There appears to be no countervailing institutional power to producer biased groups to represent consumer interests, except the provision of hearings and investigations on an ad hoc basis (which the CCGB, and a government minister might provide: these would take much of their evidence from data collected and presented by producer orientated groups).

preference, which seems difficult to justify in the light of what has been written so far. It appears to be generally felt on the farming side of the industry that potato varietal patterns broadly reflect consumer choice: this was particularly noticeable in private communications with regional PMB officials.

This seems true of plant breeders. Howard, head of the potato breeding section at the PBI has listed what he thinks might be the factors important to the commercial success of a new potato variety (1963b). It is an account which reflects many of the beliefs associated with consumer preference and needs, which are recorded in general literature about potatoes. The main feature about them is that they presume present trading conditions are determined by consumer preference.

This has dangers. For example, Record, a variety recommended by the NIAB for crisp processing, is generally considered in the potato industry to be unsuitable for direct human consumption because the colour of its tuber flesh is yellow, and British consumers are believed not to like this colour (Pickard and Cori, op cit). However, the members of the Henry Doubleday Research Association have rated maincrop potato varieties according to flavour, and Record was noted as superior to all others (the "Cox of the kitchen garden", Mills op cit).

Flavour was a factor associated with dissatisfaction in the surveys of consumer opinion: most notably in that of the CA, which produced a result where three-quarters of respondents complained of tastelessness (op cit). Plant breeders have rejected seedlings on the grounds that their flavour was not mild (Howard, 1970). This seems to have been based on the belief that because the present situation is such that consumers use maincrop varieties which are mild or insipid, generally as a neutral accompaniment to a fish or meat dish or as an inexpensive constituent to fill out a stew, soup or pie, flavour is unimportant.[1]

Very little is known about flavour; however, this need not prevent varietal assessment for this property in commercial trials. Work in psychology associated with multidimensional scaling of attitudes suggests that it is feasible to identify key features important to impressions of differences in flavour, see Shepard (1962).

There is a general lack of consumer representation in testing and trials of new varieties. Gibbons noted its absence in the work of the NIAB in recommending varieties (1965 op cit: p.107). The situation has changed little, except notably in one instance, when in 1974, the commercial trials of recently introduced varieties, included "consumer acceptability data" gathered in questionnaires from shoppers at a supermarket (PMB, 1975b: p.3).

From a study of information for this chapter, to assess the impact of Pentland Crown and Pentland Dell upon the general quality of potatoes available to the public, it seemed very little was known generally about consumer varietal quality and its importance, to an extent that such information there was, was often untrustworthy. To the author, it seems that it is necessary to constantly review and examine consumer needs on a systematic basis, by an authority independent of producer interests, so that in the long term varieties which are the most suited to consumer requirements can be produced by plant breeders. This might require modern market intelligence, such as modern business uses generally.[2]

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[1] It is certainly so for processing, where a neutral flavour is preferred, since it is also possible for companies to add flavour in the processing (private communications).

[2] Which ideally might be based on Drucker's advice, of not to think of consumers as buyers of a product, but in terms of their general behaviour, values and expectations (1968).

This is not to argue that the different parts of the potato industry should be separated from one other, but that the function of good market intelligence is to guide every part of the industry in how it might contribute to the whole and best satisfy consumer requirements, and thereby, maximise its return. Unfortunately, the pressures of the accountability arguments seem such that plant breeders will become more responsive to producer interests, and consequently more remote from the market place,[1]

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[1] The concern with accountability of social R & D was noted in Section 1.2. In their planning, agricultural departments probably put emphasis upon the welfare of individual farmers, rather than upon the welfare of final consumers (this seems to have been done with regard to the introduction of a new 'cost-benefit' system by the ARC): since in the present marketing situation growers seem likely to continue to produce for maximum output rather than with the needs of the market in mind (Section 12.5), this emphasis might result in the neglect of the market place.

CHAPTER THIRTEEN

Conclusions

13.1 The economic value of Pentland Crown and Pentland Dell in displacing Majestic: summary of conclusions

(a) Resource costs

In terms of resource costs saved, at the 5% and 10% discount rates, the investment in potato R & D at the SPBS has, in producing Pentland Crown and Pentland Dell, resulted in a favourable rate of return. Society has been made better off compared to a situation where without the new varieties, only Majestic would have been grown, Chapter 9.

Whilst it is fully realised that the quality of quantitative data was not good, and the assumptions used in measurement might be only approximations to the true situation, it is felt by the author that the cautious approach lent to measurement, and the sensitivity of the rate of return to a wide number of considerations, were such as to make it possible to attach a strong degree of confidence to this favourable outcome.

This conclusion is brought about largely by the continued commercial success of Pentland Crown. Pentland Dell's commercial success did not translate into an economic one, and the experience of this variety, indicates that the belief that it is certain plant breeding is a highly economical process because the cost is small in relation to gains (Section 1.1), might be mistaken.

How the SPBS investment compares to others is uncertain. Previous CBA studies indicate results which suggest a higher return. However, there are problems of comparability; it is likely that the simple approaches of these studies have exaggerated the return: also, nearly all of the studies are based upon American conditions. It is safer not to draw comparisons, and simply state the view that investment at the SPBS has produced socially favourable results, but that it is uncertain how this compares to the favourable results of investment elsewhere.

This favourable view is largely based upon an examination of potato production costs. There might be resource cost implications for the potato trade, consumer use, and for gardeners and associated interests. It was not possible to fully investigate these concerns, and therefore, they must be regarded as qualifications to the above conclusion. The effects upon the garden trade are completely unknown; the resource cost implications for the potato trade have probably been marginal, except with regard to quality.

It is probable that quality at or near to the minimum ware standard was made worse. This is likely to have resulted in extra labour costs associated with inspection, handling and preparation. The last of these is important to consumers. The quality implications are unlikely to have been as such as to turn the rate of return into an unfavourable one, however,

(b) R & D system spin-offs

The R & D associated with Pentland Crown and Pentland Dell produced benefits which were not included in the net benefit estimates. These included contributions to the development of future varieties (and some recently introduced ones, most obviously Pentland Ivory, Section 9.10), and to knowledge generally; particularly, with regard to genecology in relation to blight and virus investigations, Section 4.6.

The feature to note is that the new varieties were products of a system of plant breeding, which although in recent times has been modified, is essentially a continuing process built upon previous knowledge and experience, Chapter 5. Thus, in some sense there is a build-up in capital, the benefit of which is uncertain but likely to be favourable if it leads to an improved understanding necessary to the improvement of potato varieties.

(c) Incidence of investment effects

The most important general effect upon prices, and hence for final consumer prices and growers' incomes, was probably felt in 1968 through the impact that the new varieties' extra output had upon trading conditions. This was substantial enough to off-set any revenue or cost gains growers might have had from the new varieties during the period 1965-72, Chapter 8. However, the prompt action of the PMB in restricting acreage in 1969 ensured that growers would not be adversely affected thereafter.

Given the importance of other factors in determining final prices, it is uncertain as to the extent that consumers have benefited from reduced costs per ton marketed for human consumption, brought about by the new varieties. In the long term it must be assumed that consumers do benefit.

(d) Government potato policy objectives

Since costs per ton marketed for human consumption have been reduced the innovation was consistent with the government aim of efficient production. It is to be observed, however, that a loss in acreage flexibility resulted from a reduced acreage, but this is unlikely to have had a significant effect upon costs in the medium term (Section 10.10).

In terms of the policy objective of efficient marketing of the type and quality of potato required by users and consumers, the effects of the new varieties have probably been mixed. It is likely that the effect upon high quality markets has been marginal, but significant for quality generally available at or about the minimum ware standard, where effects have probably left quality at a lower standard: the cooking quality of the new varieties, however, has probably improved the quality made available to consumers. The importance to the potato trade generally about these effects is uncertain.

The development of processing does not seem to have been affected, and too little information is available to know what the consequences have been for catering concerns (Section 10.10). Possibly it is the pre-packing interests and trade which has been most adversely affected by quality faults at the mimimum ware standard (Section 12.11).

The remaining policy objectives of price stabilisation, lowest prices consistent with a reasonable return to growers, and self-sufficiency, have not been greatly affected by the displacement of Majestic. The costs of the potato industry have been reduced, and it follows therefore, that the costs of self-sufficiency would have been reduced. There is a possibility that the new varieties might have made output more volatile, and thus, increased pressures upon the PMB in its efforts to satbilise prices and maintain growers' incomes (Section 10.10).

(e) General policy considerations

It is likely that the new varieties success has involved extra government expenditure, associated with the early period when surplus disposal and market support was necessary as a result of the varieties' contributions to surplus conditions (Section 11.2). Some funds are saved if a reduced potato acreage brings about lower financial outlays associated with net savings in agricultural costs.

The regional effects of the new varieties are likely to be marginal. However, some consequences are likely to have been experienced in the certified seed potato industry. But overall this is smaller than might have been expected, since the high usage of own grown seed associated with Pentland Crown has probably been off-set by advantages for seed producers of initially high prices and the low use of own-grown seed in crops of Pentland Dell (Section 11.4).

The new varieties probably contributed significantly to the balance of payments, since their contribution to a small potato acreage, freed land for cereals which might otherwise have had to have been imported. At a 20% additional notional value for output that would have otherwise been imported, the resource rate of return would be significantly increased (Section 11.5).

The long term effects of a reduced potato acreage for rotation and health of the soil are uncertain (Section 11.6).

13.2 The significance of the conclusions: some observations

Whether or not a decision maker would accept that the commercial success of Pentland Crown and Pentland Dell was socially desirable, depends upon what emphasis he wishes to give to the separate and perhaps conflicting policy considerations involved. Thus, the degree of importance attached to different investment effects, as identified in relation to distinct concerns, is something which is properly left to the decision maker to perform. However, the analyst might usefully make some observations and give a personal view of the relative importance of the conclusions.

Pentland Dell was a bad investment. In terms of resource cost, under all assumptions, it produced a negative return; this was large enough to seriously affect adversely the size of the combined rate of return for both varieties, computed on the whole potato R & D investment cost to 1969. Yet the variety came very near to producing a positive rate of return; the fact that generally the estimates derived in Chapter 9 were so hugely negative, results from this propinquity. The blight immunity lasted long enough to allow a large number of growers to adopt the variety, so that large totals of extra growing costs were amassed, but just a season or two too short, before quota restrictions brought about large cost savings; by that time Pentland Dell's planted acreage had fallen. If the break-down in blight immunity had occurred earlier or later, then the economic value of Pentland Dell might have been significantly different, and the investment in potato breeding at the SPBS would have been seen as more socially acceptable.

Nevertheless, the commercial success of Pentland Crown was sustained, and the overall savings in resource costs sufficiently substantial to indicate that plant breeding can obtain results of sizeable economic benefit in relation to investment cost. In the author's opinion the success of Pentland Crown was large enough to make investment in plant breeding at the SPBS worthwhile, even accepting that the variety produced results which were probably inconsistent with other considerations, most notably with regard to some government potato policy objectives.

It is to be observed that this inconsistency is to be expected, or at least looked for, in the commercial success of new output increasing varieties. The essential point is that marketing arrangements should be strong and effective enough to amend the changes brought to (and pressures brought upon) the conditions of supply by varietal innovation, so that stability of trading conditions and product quality are maintained.

It is the view of the author that marketing arrangements proved sufficiently flexible to off-set the de-stabiling effects of the new varieties' increased supply potential.[1] Of course, in future cases of varietal innovation acreage might not be adjusted so quickly. In 1969, a situation of chronic over-supply was probably obvious to the PMB, since crop yields had been rising generally for some time for reasons unassociated with varietal innovation.

The extent to which the PMB is sensitive to changes in output potential is vitally important to the scale of the savings in potato costs brought about by new varieties. The economic success of the SPBS innovation was based upon the extent of the planted acreage of the new varieties, and size of the yield advantage over Majestic, the displaced variety. These factors determined the size of the retired acreage and associated savings, but the timing of acreage restrictions, and so actual realisation of savings was dependent upon the actions of the PMB. Of course, differences in the costs of growing new varieties compared to those of the ones displaced might be important, but these are unlikely to be as significant as the cost effect produced by the retirement of potato acreage.

It is likely that yield advantage is important even for varieties which do not have an overall national advantage. For instance, a variety might have a yield advantage on particular soils (like Maris Piper on eelworm infested soils), or for certain husbandry techniques (as Pentland Hawk might have in terms of yield unaffected by mechanical damage).

In the instance of the Pentland Crown innovation the effectiveness of marketing arrangements was most suspect with regard to the consequences for quality; these do not seem to have been foreseen or understood by

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1 Some observers would disagree, see Section 10.8: even the PMB blamed the very large surpluses of the early 1970s upon an increased yield potential of new varieties, Section 10.10e. Since the new varieties appear to have caused the surplus of 1968, the PMB might have introduced quotas for that year; however, the introduction of quotas in 1969 seems reasonable enough.

the PMB. The introduction of trials for recently introduced varieties under commercial conditions might in the future uncover faults associated with the growing and handling of new varieties early enough, so that advisory authorities and inspection facilities are prepared to deal with potentially unsatisfactory situations.[1]

13.3 The usefulness of CBA, its place in decision making

This study has told a great deal about varietal effects and their economic importance, particularly of the importance of yield advantage. Nevertheless, it was indicated that CBA, especially where it has followed a simple approach, without a prior and full investigation of the subject area, might omit important considerations (and associated investment effects) which could qualify the results of a rate of return analysis, (Chapter 3).

In the instance of this present study, preliminary analysis revealed the important influence of the PMB, its part in determining savings in resource cost and the possibility that its workings might have been such as to influence the way the new varieties had been marketed and handled. A CBA along the lines suggested by previous work associated with investment effects of agricultural R & D, might fail to consider these factors.[2]

Indeed, the possibility that consumers (and users) do not get the type and quality of potatoes they require suggests that the market model,

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[1] The introduction of these trials is perhaps an important spin-off from the experience of the potato industry with what was, for the maincrop potato production, a novel situation - a major varietal innovation, for modern times.

[2] As indeed, the Simmons study (1974 op cit) failed to do: costs savings associated with reduced acreage needs were estimated there to have begun in 1963, and the possibility that the new varieties might have affected consumer quality was not considered at all.

on which CBA is based, might be an insufficient representation of the behaviour of the potato market; since some of the assumptions of the model that ensure consumers are sovereign do not hold to the extent where one can be reasonably certain rate of return results are completely meaningful in terms of consumer utility.[1]

This is not to state that the market model is an unsatisfactory representation of how economic resources are allocated generally in the potato industry, but simply that there might be dangers associated with its use without adequate investigation of its assumptions and subsequent qualification. The application of CBA would seem to require a complementary behaviourial-type analysis.[2]

This is not to argue in general terms, that applications of CBA require an accompanying behaviourial analysis, but more specifically, in sectors of the economy like the potato industry, where consumers

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[1]The possibility that product quality might be adversely affected by innovation is generally a neglected subject in economics. In the popular literature much has been stated about the quality of life, how productivity gains might be achieved at the expense of product quality, but economic theory has tended to assume the possibility away (see Freeman, 1974). The notable exception, in a general sense, are the theories of Galbraith, who used quality to explain how firms might control their markets (1957), and how this behaviour is not amenable to understanding using the tools of conventional market analysis (based upon neo-classical theories) (1974 op cit), of which rate of return CBA might be thought a part (Section 2.7).

[2]This could involve a closer look at processes and relationships between groups and organisations to gain an understanding of how behaviour and performance respond to and regulate choice, to determine both the pattern and consequences of output. This might actually supply decision makers in the planning process how a rate of return might be maximised by action which is independent of the investment under consideration. For example, a simple marketing reform, like varietal labelling, might dramatically alter the consumer acceptability of a given variety, with consequences for the epxected rate of return. A behavioural approach might be open to controversy of a kind which surrounded the advocacy of the behavioural theories of the firm, against market model theories. Loasby has indicated that the two bodies of theories are not necessarily competitive, since they may be though of as paradigms, and therefore, conceptually compatible (1971).

might be limited in their power to choose between different varieties those that they prefer, it is misleading to suppose that market values can be used without qualification. Particularly, where the advice of Prest and Turvey is followed with regard to "large and unknowable" bias, that it should be ignored (Section 2.6): rather should the nature of such bias be investigated.

CBA is probably most suited to investment appraisal in agricultural subject areas where it is supported by a framework, or system of resource allocation. An appraisal of recently introduced resource allocation systems in agricultural research in the USA is given in Fishel (1971). These allow a broad consideration of a range of social issues and concerns relevant to project selection, and facilitate the establishment of aims appropriate to a formalisation of say, breeding plans.[1] A need for such systems in Britain has been indicated by Russel (1973 op cit): he points out that the tools for investment project selection at research institute level are already in existence, but that an overall system is missing.

This suggests two levels of decision making and planning, sectoral and institute (or operational). A behaviourial investigation of the subject area for potential CBAs would most properly be conducted at the sectoral level. The organisation responsible for planning and analysis at this level might seek information from several alternative sources of advice, and have independent machinery to test that advice: the quality of data might thereby be improved for CBA at institute level.[2]

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[1] The systems are similar in concept to PPB and PERT planning techniques* These aim at the explicit identification of objectives and required resourc

[2] This is in keeping with criticism of the Maplin London airport CBA conclusions and decisions. A panel of economists, an engineer and a 'CBA practitioner' has suggested that government should use several alternative sources of information, and independent arrangements to check its quality; otherwise, sectional interests are likely to prevail and the public interest be ignored (IEA, op cit).

The main purpose of sectoral decision making would be to decide upon generally agreed principles and procedures for CBA.

Of course, institutes would have to be involved in sectoral decision making, for they would need to supply information concerning the quality of R & D resources, the chances of success and risk, and the special requirements such as legal constraints on what funds can be used for.

The ARC has indicated that it intends to use improved systematic approaches to R & D management. In 1974 a pilot project costing scheme was terminated at the National Institute of Agricultural Engineering, Scotland, and it is hoped that lessons from this will be used to construct a "CBA on a national basis" (NIAES, written communication). The attitudes of the authorities concerned with this project as such as to suggest that social benefit is too difficult to measure. Instead the concern appears to be that of the individual farmer: the CBA involves the placing of a financial value on increased output, lower labour requirements or "other benefit arising".

Nevertheless, the author believes that social benefit, even in the case of a difficult subject area like potatoes where marketing conditions are complex, can be both identified and measured. Overall, it is the main contribution of this thesis that CBA can be a useful means of doing this: that providing the limitations of analysis are recognised explicitly, then CBA provides a most useful method for systematically assessing the economic value of agricultural R & D, particularly plant breeding. It is recognised that this present study produced estimates of benefit which are only rough approximations: however, this is a fault which can be removed with the right institutional background, further research and investigation.

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APPENDIX 1

Glossary of terms

After-cooking blackening: A discolouration of potato tuber flesh upon cooking; the cause is a chemical complex formed between chlorogenic acid in the tuber. On cooking the cell walls break down and the iron chlorogenic acid complex is oxidized in the air, producing a blue grey pigment.

blanking: Gaps or misses in the rows of newly emerged potato plants, caused by the non-emergence of plants as a result of tuber diseases or disorders and environmental factors.

cash crop: A crop which is profitable in itself, and not simply planted to contribute to an overall farm profitability.

chitting: The practice whereby potato seed is sprouted prior to planting, in boxes or trays, under cover.

cost-effectiveness exercises: An appraisal of different methods of achieving a given objective, according to costs incurred: often involving a choice of the best combination of inputs to use in producing any given level of output.

cracking: A cracking of potato tuber flesh or skin, caused by damage or secondary growth (see below)

cross-elasticity: see 'elasticity' (below)

demand curve: Demand is the quantity of a commodity that purchasers are willing to buy at a given price over a given period of time. A demand curve is a pictorial representation of a demand schedule, which shows the quantity purchasers will wish to purchase at various alternative market prices. It is drawn on the assumption that income, tastes and all other prices remain constant (see Lipsey op cit).

dry matter content: That part of the potato tuber which is not comprised of water. In terms of weight dry matter normally comprises about 18 - 28% of a fresh tuber, (see Burton op cit).

early crop potatoes: The early potato market is divided into first and second early production. There is no clear cut division between the two on a varietal basis. Some varieties which are classified by the NIAB as first earlies, such as Arran Pilot, are carried over into the second early season while some second earlies, such as Craigs Royal, may be lifted as first earlies. A distinction is often made in terms of time (e.g. Cox, 1972 op cit): thus, the first early season, when potatoes are lifted at a low crop yield but usually command a very high price per ton, usually extends from the latter part of May to the end of June, and second early production covers the period July and August. Early crop potatoes are subject to specific standards of grading as soon as lifting commences. The ware standard of grading, which is meant to apply to maincrop, comes into force in August. Early crop acreages are not subject to direct PMB acreage controls (such as of the type of quota imposition applied to maincrop: direction is given by way of information). In 1973 early crop acreage accounted for approximately 16% of the total acreage planted in Great Britain with potatoes (PMB Annual Report, 1974). Early potatoes are supposed to sell on flavour and quality, which might be correlated with freshness (EDCA, 1971 op cit).

<u>elasticity</u>: This is a concept for understanding and measuring, the responsiveness of one variable to another. It is most often used in instances of the influence of changes in price upon demand, known as 'price elasticity of demand'. This is not to be confused with 'cross elasticities of demand' which is a term used to describe the elasticity of demand for one commodity with respect to changes in the prices of other commodities. With some approximation it might be stated that the price elasticity of demand indicates by how much in percentage terms the amount purchased will change if the prices increases by 1%; a minus sign attached to the elasticity coefficient indicates that demand will decrease if price rises. More formally, elasticity can be described as follows: if the relationship between demand (Q) for a commodity and the price (P) of the commodity is known, then the prica elasticity of demand is given by:- $P/Q \cdot dQ/dP$ (see Lipsey op cit: Appendix 8).

<u>greening</u>: Tuber colour turns green with exposure to light and affected flesh becomes toxic.

<u>internal bruising</u>: A blackening or discolouration of the tuber flesh, caused by rough handling.

<u>haulm</u>: Potato plant foliage.

<u>maincrop</u>: The maincrop potato season lasts approximately from August to May. Potatoes are lifted as soon as the build-up to maximum yields permit, and might be thereafter stored for several months. In 1973

the maincrop acreage was approximately 84% of the total planted in Great Britain. See 'early crop' above.

neo-classical paradigm: A pardigm defines the type of relationships that might be investigated, and the methods and abstractions regarded as legitimate within a particular problem area, (see T.S. Kuhn 'The Structure of Scientific Revolutions'). The essence of neo-classical economics, in the words of J. K. Galbraith ('Economics and the Public Purpose'), is that individuals using income derived, in the main from their own productive activites express their desires by the way they distribute this income for the various goods and services available to them in markets (p.28). In short, market economics, sometimes called the 'marginalist' or 'subjectivist' school of economics (Sachs op cit).

pressure group: Organisations or groups which operate by mobilizing support outside the conventional political processes, while simultaneously influencing the way ministers and civil servants take decisions, and members of parliament react.

production function techniques: Techniques which seek to measure technical progress as a separate item in a comparison of inputs to output. (see Kennedy & Thirlwall op cit).

programme evaluation and review technique (PERT): In terms of general parlance this seems to be virtually interchangeable with 'planning, programming and budgeting' (PPB). They are methods of planning the undertaking of a complex operation (or series of investment projects) in a logical way by anaylysing the field of operations into component parts (or projects), and recording them in a style used to control or plan the inter-related activities, so that resources are meaningfully related to each other and to objectives.

raiser: A potato certified seed producer who receives virus tested stocks from the DAFS and multiplies it for sale to the rest of the industry.

secondary growth: Tuber growth which is arrested and then resumed; this might result in a number of effects, such as tuber cracking, cavities in the tuber flesh (hollow heart) or irregular shapes.

supply curve: This is similar in concept to the demand curve (see above).

tuber bulking: The build-up in number and weight of tubers.

APPENDIX 2

Symbols, conventions and abbreviations

Symbols and conventions:

£	=	expressed in pounds sterling
£m	=	expressed in million pounds sterling
1971£s	=	expressed in 1971 pounds sterling
-	=	negative quantity or value
'000s	=	expressed in thousands
lbs	=	expressed in pounds weight
%	=	per centum
*	=	referred to glossary

Abbreviations:

ACMS	-	Agricultural Co-operative Marketing Services Limited
ADAS	-	Agricultural Development & Advisory Service
ARC	-	Agricultural Research Council
CA	-	Consumers' Association
CCGB	-	Consumers' Committee for Great Britain
CBA	-	Cost benefit analysis
cf	-	confer = compare
CEAS	-	Centre for European Agricultural Studies
CSP	-	Council for Science Policy
DAFS	-	Department of Agriculture & Fisheries for Scotland
EDCA	-	Economic Development Committee for Agriculture
EEC	-	European Economic Community
et al	-	et alibi = and others
FN	-	Footnote
HMSO	-	Her Majesty's Stationery Office
ibid	-	ibidem = in the same place
IEA	-	Institute of Economic Affairs
IITR	-	Illinois Institute of Technological Research
IMTA	-	Institute of Municipal Treasurers & Accountants
in	-	inch
MAFF	-	Ministry of Agriculture, Fisheries & Food
NASPM	-	National Association of Seed Potato Merchants
NEDC	-	National Economic Development Council
NFU	-	National Farmers' Union
NIAB	-	National Institute of Agricultural Botany
NIAE	-	National Institute of Agricultural Engineering
NIAES	-	National Institute of Agricultural Engineering, Scotland

NRDC	-	National Research Development Corporation
OECD	-	Organization for Economic Co-operation & Development
op cit	-	opere citato = work cited
p	-	page
PBI	-	Plant Breeding Institute
PERT	-	Programme evaluation and review technique
PMB	-	Potato Marketing Board
PPB	-	Planning, programming and budgeting technique
PPMA	-	Produce Packaging & Marketing Association
R & D	-	Research and Development
SBES	-	Sutton Bridge Experimental Station
SGST	-	Select Committee on Science & Technology
SPBS	-	Scottish Plant Breeding Station
TEMF	-	Terrington Experimental Husbandry Farm
UK	-	United Kingdom
USA	-	United States of America
USDA	-	United States Department of Agriculture

APPENDIX 3

Metric conversions

One long ton	=	1.016 tonnes
One acre	=	0.404 hectares

TABLE A4.1 Varietal percentage shares of the British maincrop acreage

	King Edward & R. King		Majestic		Pentland Crown		Pentland Dell	
Year	Eng & Wales	Scot	Eng & Wales	Scot	Eng & Wales	Scot	Eng & Wales	Scot
1955	36.9	15.5	44.2	24.8				
1956	35.3	15.8	45.6	25.5				
1957	33.3	15.4	50.9	30.1				
1958	30.7	13.7	53.6	31.1				
1959	24.5	10.9	59.3	33.6				
1960	25.5	12.2	60.2	35.1				
1961	28.9	15.1	59.9	32.5				
1962	31.6	15.8	56.6	28.7				
1963	31.9	14.6	54.3	29.1				
1964	27.1	13.8	57.0	31.4				
1965	26.8	13.5	56.9	33.4	1.6	0.7	0.6	1.4
1966	25.1	10.0	54.5	27.7	3.8	2.0	3.0	4.5
1967	22.7	8.8	47.7	20.2	7.0	4.3	9.8	10.6
1968	23.2	9.6	39.3	16.3	11.3	8.4	14.1	12.4
1969	23.2	10.1	32.8	12.9	16.8	13.3	11.4	13.3
1970	21.6	11.3	26.4	9.5	25.2	15.5	9.7	16.2
1971	19.3	10.1	18.6	6.3	29.2	18.2	11.0	18.4
1972	19.9	13.7	13.0	5.5	29.7	17.7	11.3	15.6
1973	20.8	14.9	7.8	3.9	27.5	15.4	11.3	11.4
1974	19.2	14.2	5.3	3.4	25.5	10.7	11.0	10.0

Source: Calculated from PMB statistics

TABLE A4.2 Varietal Percentage Shares of the Maincrop: England and Wales

Year	Arran Consul	Arran Peak	Bintje	Desiree	Doctor Macintosh	Kerrs Pinks	Maris Piper	Record	Redskin	Pentland Ivory	Pentland Hawk
1955	0.5	2.5	0.1		4.2	0.3		3.0	3.5		
1956	0.5	2.9	0.2		4.0	0.3		1.0	3.3		
1957	0.5	2.5	0.2		4.0			0.9	3.1		
1958	0.7	2.1	0.3		3.4			1.2	3.1		
1959	0.7	2.0	0.3		3.7			1.5	3.1		
1960	0.4	1.7	0.3		3.8			1.3	2.7		
1961	0.3	1.3	0.2		3.9			1.7	2.8		
1962	0.7	0.8	0.3		2.9			1.8	2.9		
1963	0.8	0.8	0.3		2.9			2.9	2.5		
1964	1.1	0.9	0.4		3.3			4.4	2.2		
1965	0.9	0.8	0.4		3.4			3.9	1.9		
1966	0.9	0.7	0.4		2.6			4.8	1.4		
1967	0.7	0.5	0.4		1.8			4.9	1.1		
1968	0.6	0.4	0.5	1.2	1.2		0.2	5.4	0.6		
1969	0.5	0.1	0.5	2.8	1.0		0.6	7.8	0.5		
1970	0.5		0.4	4.0	0.7		2.5	6.6	0.4		
1971	0.4		0.4	5.6	0.5		6.5	5.9	0.3	0.7	
1972	0.3		0.5	6.5	0.3		6.8	6.8	0.2	2.3	
1973			0.7	7.9			9.6	7.8	0.2	4.2	0.5
1974			0.8	9.2			11.4	9.0	0.1	5.4	1.4

Source: Calculated from PMB statistics

TABLE A4.3 Varietal percentage shares of the maincrop: Scotland

Year	Arran Consul	Arran Peak	Bintje	Desiree	Doctor MacIntosh	Golden Wonder	Kerrs Pinks	Maris Piper	Record	Redskin	Pentland Ivory	Pentland Hawk
1955	0.9	0.9	0.9		1.6	7.0	30.2		1.0	11.1		
1956	0.8	0.8			1.4	5.7	30.3		0.7	13.8		
1957	1.0	0.6			1.4	4.4	28.1		0.6	14.3		
1958	1.2	0.5			1.8	3.7	26.7		1.2	16.1		
1959	1.1	0.4			2.0	2.7	27.0		1.1	20.4		
1960	1.0	0.3	0.1		1.4	3.1	22.2		1.0	20.8		
1961	0.8	0.2	0.2		1.4	4.5	21.4		1.8	19.8		
1962	0.7	0.2	0.1		1.4	5.2	20.0		3.0	21.9		
1963	0.6	0.2	0.1		1.7	5.7	18.9		4.9	20.2		
1964	0.7	0.2	0.1		2.3	4.7	15.4		7.1	20.2		
1965	0.9	0.1	0.1		1.5	4.6	14.0		5.1	21.6		
1966	0.2	0.2	0.1		0.9	5.5	12.8		6.5	25.1		
1967	0.9	0.1	0.1		0.7	5.3	11.5		8.2	25.6		
1968	0.9	0.2	0.2	0.1	0.7	5.5	9.6	0.2	9.0	22.7		
1969	0.7		0.2	0.5	0.4	4.8	7.8	1.8	12.1	17.5		
1970	0.5		0.2	0.7	0.3	3.6	6.8	5.4	10.0	15.1		
1971	0.5		0.4	1.5	0.3	3.6	5.9	8.9	6.7	12.5	2.3	
1972	0.4		0.3	2.0	0.2	4.4	5.9	11.5	7.3	9.1	7.3	
1973			0.4	3.7		3.8	5.5	15.1	9.0	6.7	3.4	2.1
1974			0.7	7.0		2.1	5.4	19.9	9.7	4.8	3.4	4.3

Source: Calculated from PMB statistics

APPENDIX 5

General agricultural policy

Until the prospect of British membership of the EEC, agricultural policy of successive governments had been based almost entirely upon objectives laid down in the Agriculture Act of Parliament, 1947. These aimed for a stable and efficient industry, with minimum prices for consumers, albeit consistent with a "proper remuneration and living conditions for farmers and workers in agriculture".

Accounts of the working of policy according to these principles are found in Metcalf (1969) and Midland Bank (1968). Broadly, the general approach has involved opening domestic agricultural markets to the world at large, to take advantage of world prices, which have usually been below those at which a large part of British agriculture could compete.

Domestic producers were kept viable with a substantial outlay of state-funded subsidies. These took two main forms. The first is associated with deficiency payments. A schedule of guaranteed prices for farmers was drawn up annually after a review of the industry by government agricultural departments and the NFU. The guarantee levels were influenced to some extent by government's desire to influence the pattern of output to suit consumer demand. If market prices in the following season averaged less than the guarantees, then deficiency payments were made to farmers. The second group of subsidies were of a more straightforward kind, and took on the form of production grants, credit facilities and tax concessions.

APPENDIX 6

An application of the Griliches' CBA model to the Pentland Crown and Pentland Dell investment

At the outset of preliminary work for this study of the SPBS's innovation, it seemed reasonable that the Griliches' approach could be applied for estimating a social rate of return to R & D expenses associated with the commercially successful potato varieties, Pentland Crown and Pentland Dell. Application appeared to be fairly straightforward, although some doubts might accompany the necessary competitive conditions.

These were associated with the observation that the PMB regulates the planted acreage and price of potatoes. Thus it was possible that the market price of potatoes might over-state the utility of potatoes to consumers. However, there were similar doubts about the price of hybrid corn, in the Griliches' study. He allowed for the intervention in the corn market by government agencies, by the substitution of a shadow price for the market one.

This he did by using a method devised by Nerlove (1956) to approximate what might be a competitively determined price from observed market price. Also, the importance of the PMB as a distorting influence might seem less, if the organization's aims of market stability and maintenance of market quality were being achieved. Since then it would be likely that the PMB acted only to ensure a market equilibrium which would be close to that prevailing over the long term, in perfectly competitive conditions.

Thus, the Griliches model was applied to derive a rate of return to investment at the SPBS. It seemed likely that the return would be high given the commercial success of the potato varieties: although not as high as that for hybrid corn, because of the relatively low potato acreage compared to that planted with corn in the USA.

The formula used by Griliches to estimate returns to hybrid corn R & D was as follows: $kPQ(1-\frac{1}{2}kn)$, where k is the percentage change in yield, P and Q are, respectively, the previous equilibrium price and quantity of corn, and n is the absolute value of the price elasticity of demand for corn.

The value of k was found in the instance of Pentland Crown and

Pentland Dell by taking the new varieties' crop yield advantage over Majestic (table 8.2), and expressing this as a percentage of Majestic's crop yield (table 8.5). The results are shown in table A6.1. The annual average value for both varieties works out at approximately 0.19, and this was used for k.

TABLE A6.1

Crop yield advantage over Majestic of Pentland Crown and Pentland Dell, expressed as a percentage of Majestic crop yield

	Pentland Crown	Pentland Dell
1965	24	27
1966	18	37
1967	20	19
1968	22	23
1969	17	13
1970	11	7
1971	20	18
1972	17	13
Annual Average	19	20

Sources: Tables 8.2, 8.5

The value of P was estimated by taking the average growers' market price for potatoes in a period just prior to that when the new varieties first appeared in the PMB acreage statistics, that is, 1960 to 1964. Prices were taken at 1971 values from table 7.7. The annual average worked out at £22.71. However, this estimate did not allow for the effects of the PMB market support operations, and so, following Griliches' procedure, the Nerlove formula was used to deflate price.

This was as follows: $dp/p_o = (dq/q)/(n + e)$, where p_o is the equilibrium price, n and e are the demand and supply elasticities, and dq is the surplus dealt with by the PMB. (See Nerlove, 1956: pp.65-66).

The MAFF has estimated the elasticity of demand for potatoes to be -0.08 (1973a op cit). However, no estimate appears to exist for supply: some American evidence suggests that 0.50 might not be too unreasonable (G.S. Shepherd, 'Agricultural Price Analysis'). Estimates of surpluses are shown in table 9.1. Again in the period, 1960-64 was chosen, and surpluses were expressed as a percentage of total tonnage (not as expressed in the table, as a percentage of human consumption). The annual average was 7.4%; this, in conjunction with the elasticity estimates, produced a figure of 0.18 by which to adjust price, which as a result become £18.62. Rounding the figure off, the value for P became £19.

The value of Q was estimated by taking Majestic's planted acreage during 1960 to 1964, and multiplying it by the variety's annual crop yield. Estimates are shown in table A6.2. The annual average quantity produced by Majestic was around 2,473,600 tons.

TABLE A6.2

Derivation of average output of Majestic 1960-1964

	Average crop yield ton/acre	Planted acreage	Estimated output ('000s)
1960	9.85	302797	2983
1961	9.40	240098	2257
1962	9.55	248942	2377
1963	8.85	248480	2199
1964	9.55	267185	2552
	Annual average		2474

Sources: Table A6.1; PMB/A

The information necessary to resolve $(1-\frac{1}{2}kn)$ is already given. An estimate of 1.0076 was obtained. It was then possible to derive an estimate for the Griliches' formula: $0.19 \times 19 \times 2473600 \times 1.0076 =$ £8.997562m. This figure, however, assumes that this might be the return if all of Majestic's acreage had been entirely taken over by the new varieties.

Thus it is necessary to adjust returns by annual estimates of the planted acreage of the new varieties (table 8.3). This is done in table A6.3. The acreage of the new varieties between 1965 and 1972 is expressed as a percentage of Majestic's annual average plantings between 1960 and 1964 and then used to multiply the figure £8.9976m, to derive returns. These are discounted at the 5% and 10% discount rates (values are shown in table 9.3).

The rate of return to investment in potato R & D over the period 1922 to 1960, is estimated at the 5% and 10% discount rates of 935% and 158% respectively, during the period 1965 to end-1972. Expressed as annual averages these are approximately 117% and 20% at the 5% and 10% discount rates respectively. R & D costs are shown in table 5.2.

TABLE A6.3

Derivation of estimates of returns

	Planted acreage of new varieties, expressed as percentage of Majestic	Estimated returns (£m)	Discounted Returns (£m) 5%	10%
1965	.04	0.360	0.044	0.006
1966	.12	1.080	0.126	0.016
1967	.32	2.879	0.320	0.040
1968	.46	4.139	0.439	0.050
1969	.33	2.969	0.300	0.033
1970	.61	5.489	0.527	0.055
1971	.67	6.028	0.555	0.054
1972	.63	5.668	0.493	0.051
		Total	2.804	0.305
		Annual average	0.350	0.038

This return does not include an allowance for any effect upon resources which might have been brought about by differences in production costs between the new and substituted varieties. Griliches allowed explicitly for extra seed costs associated with the use of hybrid seed. If cost differences are significant, then it might be expected, given competitive assumptions, that they would be reflected in the shift of the supply curve. For example, higher seed costs might to some extent off-set the lower costs per unit of output brought about by the new varieties' output advantage.

It may seem too, that the SPBS return does not allow for the utility of resources freed from potato production. This consideration is implicitly allowed for given the assumptions of perfect competition: the cost of potato resources should adequately measure their opportunity foregoine in the next best alternative uses. Thus, the value of saved potato costs, as passed on to potato consumers in lower prices, adequately reflects the utility of freed resources elsewhere.

The rates of return derived following the Griliches' model of approach are much higher than those derived in the more detailed resource cost approach followed in the text of this present study. The rates most comparable are those for 'both varieties', see table 9.12: in annual terms they are approximately 110% and 18% less at the 5% and 10% discount rates respectively.

APPENDIX 7

Varietal crop yields

TABLE A 7.1

Maincrop varietal yields (1½ in. riddle, tons per acre)

	England and Wales		Scotland only	
	Majestic	King Edward and Red King	Majestic/ others	Kerr's Pink/ Redskin
1960	9.85	9.75	10.9	10.8
1961	9.40	9.95	10.0	10.2
1962	9.55	9.85	10.6	11.1
1963	8.85	8.40	8.0	8.8
1964	9.55	8.95	9.1	9.4
1965*		11.10		
1966		10.85		
1967		11.30		
1968		9.90		
1969**		10.40		
1970		11.55		
1971		11.15		
1972		11.25		

Notes: (1) * Estimates for 1965 and thereafter shown in Table 8.1.

(2) ** After 1968 crop yields were estimated by the PMB on a random sample basis, and not as before on routine crop checks.

Source: PMB

APPENDIX 8

The SPBS

TABLE A8.1

Statement of Expenditure at the SPBS, 1954

	£	s	d
Salaries:			
Officers, including Sub-Station	£ 12,358	7	8
Secretary and Office	2,112	7	8
	£ 14,470	15	4
Superannuation Contributions	1,385	0	5
Auditor's Fee	47	5	0
Labour	3,684	6	2
National Insurance	360	15	9
Seeds and Roots	15	16	11
Manures	300	1	0
Sundry Working Expenses, including Renewals of Implements and Tools	1,495	13	4
New Equipment	551	12	10
Laboratory Expenses	163	9	3
Library Expenses	256	5	1
Rent, Rates, Taxes and Insurances	257	14	7
Printing, Telephone, Postages and Office Supplies	612	18	2
Heating, Lighting and Cleaning	1,105	1	11
Travelling Expenses	446	14	3
Property Repairs	111	8	0
Regional Trials and Potato Multiplications	179	9	10
Seafield - Draining, Manures and Cultivations	531	18	10
Edinburgh Central of Rural Economy - Contribution towards Upkeep	360	8	0
Total Ordinary Expenditure	£ 26,336	14	8
Depreciation on Temporary Buildings, Tools, etc.	78	14	9
Total Expenditure	£ 26,415	9	5

Capital Expenditure:

Seafield - Buildings under Construction and Surveyors' Fees £48,757 7 1

Sugar beet investigations £ 1,431 13 2

Source: SPBS (1954)

TABLE A 8.2

Factors important to selection in brreding at the SPBS in the 1950s

1. High yield
2. Attractive tuber shape
3. Good colour, texture and flavour of tuber flesh
4. Uniform medium sized tubers
5. Good keeping quality
6. Good grouping of tubers in drill
7. Good foliage to suppress weeds
8. Immunity to wart disease
9. Immunity from blight
10. Immunity or field immunity from mosaic viruses
11. Resistance to leaf-roll
12. Resistance to scab
13. Resistance to dry rot and other storage disease
14. Resistance to eelworm
15. Resistance to minor diseases (e.g. Black leg, skin spot)
16. Resistance to climatic extremes.

Source: Black, 1953, p.95-6

TABLE A 8.3

Potato Varieties Bred at SPBS, and Introduced to the British Market

	Year of Cross	Year of Name		Year of Cross	Year of Name
The Alness	1928	1934	Pentland Glory	1955	1963
Craigs Defiance	1933	1938	Pentland Hawk	1958	1966
Craigs Royal	1939	1947	Pentland Ivory	1959	1966
Craigs Snow-white*	1939	1947	Pentland Javelin	1959	1967
Craigs Alliance	1939	1948	Pentland Kappa*	1960	1967
Pentland Ace*	1943	1951	Pentland Lustre	1960	1968
Pentland Beauty	1946	1955	Pentland Squire	1960	1970
Pentland Crown	1951	1958	Pentland Meteor	1960	1970
Pentland Dell	1953	1960	Pentland Raven	1961	1970
Pentland Envoy	1953	1961	Pentland Marble	1961	1970
Pentland Falcon	1954	1962			

Source: Macarthur (1970)

APPENDIX 9

Price Index

The index used for this study was that of the consumer price index (CPI). Changes in the value of the pound may be defined as the inverse of changes in the levels of prices: when prices go up, the amount that can be purchased with a given sum of money declines. The CPI arises as a by-product of the compilation of national accounts. Estimates of consumer expenditure are made at current prices and are revalued at constant prices of a base year. The CPI is the ratio of these, expressed as an index. The base year in operation at the time when the CPI was taken for use in this study was 1963. A copy of the index is shown in Table A9.1.

TABLE A9.1

Central statistical office index of the internal purchasing power of the pound (1963 = 100)

1922	265	1937	314	1958	110.6
1923	279	1938	310.6	1959	109.9
1924	277			1960	108.8
1925	275	1946	183.5	1961	105.7
1926	282	1947	171.8	1962	101.8
1927	289	1948	159.5	1963	100
1928	292	1949	155.8	1964	96.9
1929	296	1950	151.5	1965	92.8
1930	307	1951	138.9	1966	89.2
1931	329	1952	131.1	1967	87.0
1932	337	1953	128.9	1968	83.3
1933	346	1954	126.6	1969	79.1
1934	344	1955	122.4	1970	75.0
1935	339	1956	117.2	1971	69.6
1936	330	1957	113.6	1972	64.7

Source: Central Statistical Office

This index can be used to derive a new index with a base year which is more appropriate to this study, that is, 1971 = 100. If the purchasing power of the pound is taken to be 100 in 1971, then its comparable purchasing power in year X would be:

100 pence times (index number in year X/index number in 1971, 69.6)

Doing this for every year with which the study is concerned produces the index shown in table A9.2

TABLE A 9.2

Index of the Internal Purchasing Power of the Pound (1971 = 100)

1922	381	1938	446	1954	182
1923	401	1939	425	1955	176
1924	398	1940	402	1956	168
1925	395	1941	379	1957	163
1926	405	1942	356	1958	159
1927	415	1943	333	1959	158
1928	420	1944	310	1960	156
1929	425	1945	287	1961	152
1930	441	1946	264	1962	146
1931	473	1947	247	1963	144
1932	484	1948	229	1964	139
1933	497	1949	224	1965	133
1934	494	1950	218	1966	129
1935	487	1951	200	1967	125
1936	474	1952	188	1968	120
1937	451	1953	185	1969	114
				1970	108
				1971	100
				1972	93

Strictly because of continual changes in the pattern of consumer's expenditure and the way in which the index is derived, the CPI does not provide a theoretically valid measure of the way prices have moved between two years, when neither of them is the base year. However, the extent to which this bias affects the CPI is not large relative to the movements in prices shown by the index.

The CPI has been estimated only for years since 1946 (as far as it has covered expenditure of all consumers, as defined for national income purposes). For the period, 1914 to 1938, the only availabl price index suitable for estimating changes in the value of the pound was the 'cost of living index' compiled monthly by the Ministry of Labour. This was designed to measure the average changes in the cost of maintaining the standard of living prevalent in working class households, 1904 to 1914.

This index has been combined with the CPI by the Central Statistical Office, as the best indication of how prices have moved since 1914 to the present. It is therefore, used to derive Table A9.2. Estimates for 1939 to include 1945, are arbitrarily taken as a graduation from the 1938 estimate to that of the 1946 one.

Explanatory notes concerning the measurement of the pound's purchasing value are published annually by the Central Statistical Office. More generally, the subject is explained in the Treasury publication, Economic Progress Report (No. 29, July, 1972).

APPENDIX 10

Potato production costs

TABLE A.1 .1

Great Britain potato production costs, maincrop 1970*
(Adjusted market values per acre)

Factor	£ Average	Range £
Seed	32.3	21.0-53.0
Fertilizer	20.4	12.0-29.0
Sprays		
i) Herbicide	2.5	0.7-3.7
ii) Pesticide	2.0	1.5-2.8
iii) Fungicide	2.7	0.7-4.8
iv) Haulms defoliant	2.1	2.1-3.8
	9.3	5.0-15.1
Total materials	62.0	
Labour		
i) Cultivations, planting, fertilising, spraying etc.	7.2	2.5-12.6
ii) Harvesting	13.0	9.6-20.3
Total labour	20.2	12.1-32.9
Machinery		
i) Tractor fuel, depreciation and repairs	8.4	4.5-11.7
ii) Special machinery	15.7	8.0-20.1
iii) General machinery	6.7	4.0-11.2
Total machinery	30.8	16.5-43.0
Chitting	4.0	3.0-7.0
Irrigation	3.5	3.0-12.5
PMB levy	3.0	
Rent and rates	9.5	5.5-17.0
Total other direct costs	20.0	
Overhead labour	5.0	0.8-7.5
General maintenance	2.5	1.0-4.5
Management and office expenses	2.0	1.0-4.0
Interest charges	5.0	
Total overheads	14.5	
Total costs to lifting	147.5	
Storage (inc. handling into store)	8.5	4.2-17.6
Grading (labour cost)	7.4	4.5-17.5
Total cost of production	163.4	89.60-260.8

Source: PMB

TABLE A10.2

Estimates of potato costings (1971£s)

	1963[1]	1964[1]	1965	1966[5]	1969[6]	1970[7]	1972[8]	1973[9]
Seed	45	35	27[(2)] 27[(4)]	25	33	35	27	23
Fertilizer	17	17	20[(2)] 15[(3)] 15[(4)]	14	16	22	20	20
Spraying	6	4	3[(3)] 5[(4)]	3	12	7	12	7
Casual Labour)			17[(2)] 21[(3)] 9[(4)]	21				
)	42	42			16	30	37	29
Res. Labour)			21[(2)] 21[(3)] 31[(4)]	23				
Machinery	12	16	17[(2)] 16[(3)] 26[(4)]	17	27	34	21	29
Chitting Irrigation	4	4			6	7	5	7
Rent	7	7	6[(2)] 8[(3)] 8[(4)]	6	11	10	10	10

Notes:
1. Raynor, 1965
2. Davison, 1967
3. Anderson, 1965
4. Mathias, 1967
5. Anderson, 1967
6. NFU
7. PMB, Table A10.1
8. NFU
9. PMB, 1973d

APPENDIX 11

Varietal descriptions

Majestic, Pentland Crown and Pentland Dell have been described in the main text. Only descriptions of Kerr's Pink, King Edward VII, Maris Piper and some other SPBS's varieties, are given here. For other descriptions of varieties, still recommended by the NIAB, such as Desiree and Record, see NIAB (1972): for descriptions of some other varieties, such as Golden Wonder and the 'Arran' series of varieties, see PMB (1965).

Kerr's Pink This variety was bred in Scotland by a private breeder, first being marketed as 'Kerr's Pink' in 1917, but had been released earlier under several local names. Tubers tend to be round, pink skinned, indented at the heel with deep eyes. The variety is susceptible to skin spot, virus and common scab. Tuber shape is sometimes irregular where conditions are conducive to secondary growth. The variety is widely used in Scotland: it is possible that its floury product on cooking has had consumer appeal in northern markets, although there does not appear to be any direct consumer evidence of this.

King Edward VII It is possible that this variety was bred by a gardener in the north of England. It was marketed under its present name in 1902. Tubers are oval shaped and have part-coloured pink skin. Red King Edward is wholly pink. The RIAB have described it as requiring very good husbandry conditions, its quality as the "highest" for the English market. It is very susceptible to blight, susceptible to wart disease.

Maris Piper This variety was bred at the PBI, and the NIAB first recommended it for general commercial use in 1966. Tubers are oval and white skinned. The variety is an early maincrop liable to give uniform samples of tubers. It is susceptible to common scab and slug damage. The NIAB has noted that the variety rarely discolours in cooking. Maris Piper is the first commercial variety to have some resistance to potato eelworm.

Descriptions of SPBS varieties

Craigs Alliance This variety was first marketed in 1950. Tubers are oval and white skinned. The NIAB recommend this variety for use as a second early variety and note that its yield is potentially of first early maturity. Yield is high at maturity except under dry conditions. Craigs Alliance is moderately resistant to tuber rots.

Craigs Royal This variety was first marketed in 1948. Tuber shape is oval with part-coloured pink skin. Red Craigs Royal is wholly pink. The NIAN recommend both varieties for their good yield and quality. Their susceptibility to common scab and tuber hair cracking is noted.

Pentland Beauty This variety was first marketed in 1956. Tubers are short oval shape and part-coloured pink. The NIAB withdrew the variety from recommendation in 1972. It had noted disadvantages associated with depth of tuber and prominent lenticals under wet conditions. It had been recommended as a second early variety, with "very good" cooking quality.

Pentland Hawk This variety was named in 1966. Tubers are oval to long-oval and white skinned. It is susceptible to spraing to a degree which is similar to Pentland Dell's reaction. The variety might withstand rough handling to an above average extent.

Pentland Ivory Named in 1966, this variety is provisionally recommended by the NIAB. Tubers are short oval shaped and white skinned. It is an early maincrop, recommended by the NIAB for both processing and domestic use. It has good resistance to virus Y and moderate resistance to tuber blight. However, the variety is very susceptible to spraing, and crops might sometimes be subject to stolon retention at maturity. Dry matter content is very high.

APPENDIX 12

The growers survey

Copy of questionnaire enclosed aside

PENTLANDFIELDS PLANT BREEDING STATION SURVEY.

This survey has been compiled by B. J. Witcher of Pentlandfields, Edinburgh, in conjunction with G. H. Umpleby of the NFU Marketing Department. Could you please fill it in and return it in the stamped addressed envelope provided.

The acreage of Pentland Crown and Dell has expanded over the last five years, largely by replacing Majestic. The survey is to find out what in the experience of the grower are the advantages and disadvantages of growing Crown and Dell relative to Majestic.

Filling in the Survey.

1. Overall Ranking: please indicate your order of preference of the factors listed, for example, write 1 for the most important, 2 for the second, and so on.
2. Crown and Dell Columns: please indicate by means of a tick if these varieties have the advantage over Majestic, or cross, if Majestic performs better. Leave blank, if little difference.
3. Comments: please enter any observation that you may have to offer concerning listed points. Estimations will be very much appreciated.

Factor	Overall	Crown	Dell	Comments
1. Less frequent replacement of seed.				
2. Lower seed rate required.				
3. Lower fertilizer application.				
4. Lower herbicide application.				
5. Lower pesticide application.				
6. Lower fungicide application.				
7. Higher yields of ware quality.				
8. Lower damage levels.				
9. Rapid tuber bulking and early maturity.				
10. Uniformity of tuber size and shape.				
11. Tolerant of wide range of soils.				
12. Tolerant of wide range of weather.				
13. Stores well.				
14. Better disease resistance.				
15. Increased reliability.				
Any other factors of importance				
16.				
17.				
18.				

Planned Acreage in	1971	1972
Crown		
Dell		
Majestic		
Other		

and acreage grown during	1970
Crown	
Dell	
Majestic	
Other	

APPENDIX 13

Regional patterns of varietal adoption

A survey of Local Opinion

A study of regional acreages statistics indicates that there are quite marked variations in the adoption patterns for Pentlands Crown and Dell. This is illustrated in Figures A13.1 and A13.2 and aside. Compared to the national acreages, some regions record faster and some slower rates of adoption; in some instances, the shape of the adoption curve was different. It was decided to survey the opinion of ADAS and PMB regional officers to discover what reasons lay behind regional variations from the national average.

Regions were chosen for analysis on the basis of the classification made by the PMB for their national survey of the maincrop in 1968, as in Figure A13.3. This made computations of regional varietal acreage easier and facilitated their geographical classification.

In the Spring of 1973 letters were sent out to ADAS and PMB regional officers, pointing out which potato varieties grown in their areas recorded above and below national acreage averages and requesting their comments and reasons. These comments are interesting and go someway in explaining what, why and where the new varieties replaced existing ones. The material upon which variations from national acreages were identified is summarised in the tables towards the end of this appendix.

The Eastern Region

The eastern region is a large exporter of potatoes, recording as it does the most acreage of maincrop. The processing and London markets are important factors influencing the overall varietal pattern. Maris Piper and King Edward are popular in this region. Maris Piper is particularly so in the Isle of Ely, where in 1972/73 around 26% of the mai crop acreage was planted in this variety (the national average was 7%). This variety owes this acreage mainly for its eelworm resistance; the eastern region has within its boundaries some of the most intensive potato land in Britain, and eelworm is a major problem.

King Edward is grown as a price premium fetching variety. It is grown on some of the best potato soils in the country and exported everywhere, from South Wales to London. Crop yields are high, and given the high consumer reputation of this variety, there appears to be no incentive to switch to other red-skinned potatoes and this accounts for the low acreage of Desiree.

Pentlands Crown and Dell and Majestic record low averages, and this appears to be associated with the regions preoccupation with the quality trade and eelworm.

<u>The East Midlands Region</u>

Pentland Crown is very popular in the east midlands. It produces excellent yields of good appearance on sand and limestone soils and is, in many instances grown as a dual purpose variety for both ware and processing (frozen chipping and dehydration). Its advantages for processing were said to include its bold, even-sized tubers, their clean appearance, particularly that resulting from its common scab resistance and a relatively high dry matter content.

The low acreage of King Edward in this region is seen as resulting from generally poor soil conditions for the variety. This was said to affect crop yields.

The West Midlands Region

Until recently the west midlands region showed a high acreage of Doctor MacIntosh. This was grown by a small number of very large growers. Apparently, it was suited to their land and yielded very well. However, these growers have since replaced the variety with the higher yielding Pentlands Crown and Dell.

Desiree records an above average popularity and seems to suit west midlands soil and weather. Much of the output is sold for pre-packing. This variety seems to have spread in this region on a reputation spread by 'word of mouth', and not through trade publicity. King Edward remains very popular in the west midlands, particularly so in Warwickshire, where some large growers specialise in it, growing for the price premium in midland and London markets.

Majestic is not popular because of its propensity to cracking and other secondary growth effects. Pentland Crown is preferred for its better quality.

Pentland Dell records below average plantings in the west midlands. This appears to be a result of its susceptibility to spraing and blight. In the late 1960s spraing was very prevalent throughout Shropshire, Staffordshire and Hertfordshire, and "some producers suffered heavy financial loss, as their crops were unsaleable" (PMB, local office, written communication). Also, late blight on crops of Dell during the 1966/67 season in Hertfordshire proved 'disastrous'. Pentland Dell's acreage fell and was replaced by Pentland Crown.

The South Eastern Region

In the south eastern region Pentland Crown records above average acreage.

This is thought due, by the PMB, to 'exceptionally high yields', an absence of tuber marks from common scab and cracking: virus Y, very troublesome in southern areas of Britain, has affected Crown's stocks only moderately, and the use of own grown seed is possible. However, Majestic has made something of a comeback in some areas. This is thought because it has better cooking qualities than Pentland Crown and many growers switched to Majestic when Pentland Dell proved susceptible to blight and spraing (which account for the low acreage of Dell in this region).

Desiree is popular and has been replacing King Edward, particularly in Essex and Kent as a variety for pre-packs in the London and south-east markets. It is considered that Desiree holds its colour better in the packs.

The Northern Region

The northern region has recorded some above average acreages for some unusual varieties, Arran Peak, Arran Consul and Redskin. Redskin was produced on a large scale, in good quality, for local markets, particularly Carlisle. However, a series of husbandry difficulties confront the variety. For example, it is difficult to store, subject to spindly tubers, blight and gangrene. It is also felt that consumers prefer other varieties. Redskin has now been largely replaced by Pentland Dell, popular for its high yields and quality.

Arran Peak was grown for its popularity amongst consumers in County Durham, but has recently been replaced by Pentland Crown and Dell, because of their high yields. Arran Consul was largely grown by local growers for the Darlington market, where it was able to command a price premium. Pentlands Crown and Dell to some extent made an impression on this trade.

Desiree was once widely grown but growers could not get a price premium in local markets, where there was only a poor demand. The variety has given some trouble with common scab. Some seed is exported to other regions. Majestic and King Edward both record acreages below average. Majestic is widely subject to cracking and the financial return is poor compared to Pentland Crown. The local demand for King Edward is poor. Local soils, particularly the grey soils, do not produce the tuber colour and crop yields are generally low.

The Yorkshire and Lancashire Region

Redskin, still grown in local pockets, was once widely grown for local markets, there is still a good demand from fish and chip shops. Pentland Crown and Dell have replaced much of the Redskin acreage, and are grown over the whole region. Quality is generally high.

Majestic is still liked by a number of growers and merchants. It grows and sells well, particularly as a late season maincrop to fish fryers. King Edward on the other hand, has never been popular with growers, since it produces poor yields of very small tubers. However, this variety sells readily in local markets. The Sheffield market prefers Desiree.

The South Western Region

Gloucestershire and north Somerset are important markets for King Edwards from the eastern counties, but local growers experience poor yields and quality with this variety. It is also very blight susceptible. Most of King Edward is grown in north Gloucestershire. In south Somerset, Cornwall and Devon, consumer preference is for white varieties, which are cheaper than King Edward. Majestic is widely grown on the Somerset sands. Pentland Dell is popular in Cornwall where it suits the summer and autumn holiday trades: it is a high yielder. On the red soils of Devon, Majestic is still retained, along with Arran Consul, for their value as late keepers.

Wales

Doctor MacIntosh was popular until its recent replacement by Pentlands Crown and Dell. King Edward is imported into the region in large quantities but is difficult to grow locally. It is susceptible to blight and tends to produce low yields of poor quality.

REGIONAL VARIATIONS IN VARIETAL MAIN CROP PERCENTAGE SHARES

Pentland Crown

	Nat. Av.	N	YL	WM	EM	E	SW	SE	W	S
1965	2	1	3	2	3	-	1	1	1	1
1966	4	4	6	3	6	1	2	3	2	2
1967	7	7	9	6	11	4	2	5	4	4
1968	11	11	12	11	17	7	4	10	4	8
1969	17	18	21	13	22	9	7	20	9	13
1970	25	29	29	24	32	16	12	30	16	15
1971	29	27	32	30	37	19	18	41	25	18
1972	30	27	34	36	35	19	22	45	33	18

Pentland Dell

	Nat. Av.	N	YL	WM	EM	E	SW	SE	W	S
1965	1	1	1	1	-	-	1	1	-	1
1966	3	5	5	4	2	1	5	4	3	4
1967	10	18	14	12	7	5	20	12	11	11
1968	14	30	20	14	11	7	27	13	19	12
1969	11	28	16	9	8	5	23	9	18	13
1970	10	22	14	8	7	5	22	7	17	16
1971	11	25	18	7	8	5	25	5	17	18
1972	11	29	30	7	9	3	21	4	13	16

Maris Piper

	Nat. Av.	N	YL	WM	EM	E	SW	SE	W	S
1970	2	2	2	2	2	4	2	-	1	5
1971	6	4	5	4	5	12	2	1	4	9
1972	7	5	5	5	7	13	3	2	5	11

Majestic

	Nat. Av.	N	YL	WM	EM	E	SW	SE	W	S
1965	57	49	71	42	60	48	70	84	69	33
1966	54	49	68	44	56	44	66	80	66	28
1967	48	41	59	41	48	40	53	71	60	20
1968	39	30	49	33	38	34	49	64	55	16
1969	33	24	42	18	30	28	50	49	47	13
1970	26	21	37	22	23	21	43	45	40	9
1971	19	13	27	14	16	13	36	34	31	6
1972	13	8	20	8	12	8	32	15	23	5

King Edward

	Nat. Av.	N	YL	WN	EN	E	SW	SE	W	S
1965	27	2	8	40	27	49	7	9	4	13
1966	25	2	6	34	24	48	5	8	4	10
1967	23	1	4	28	21	46	4	9	2	9
1968	23	1	4	29	21	47	2	8	3	10
1969	23	0	3	30	20	49	5	15	3	10
1970	22	0	3	26	18	47	5	8	2	11
1971	19	5	3	23	15	42	5	8	3	10
1972	20	4	3	21	14	46	5	3	4	13

Desiree

	Nat. Av.	N	YL	WM	EM	E	SW	SE	W	S
1969	3	2	2	7	3	1	3	3	1	0
1970	4	4	3	10	4	3	5	5	3	1
1971	6	4	4	13	6	4	7	7	6	1
1972	6	4	5	14	8	5	7	8	8	2

Source: Calculated from PMB statistics

Note: The National Average is for England and Wales

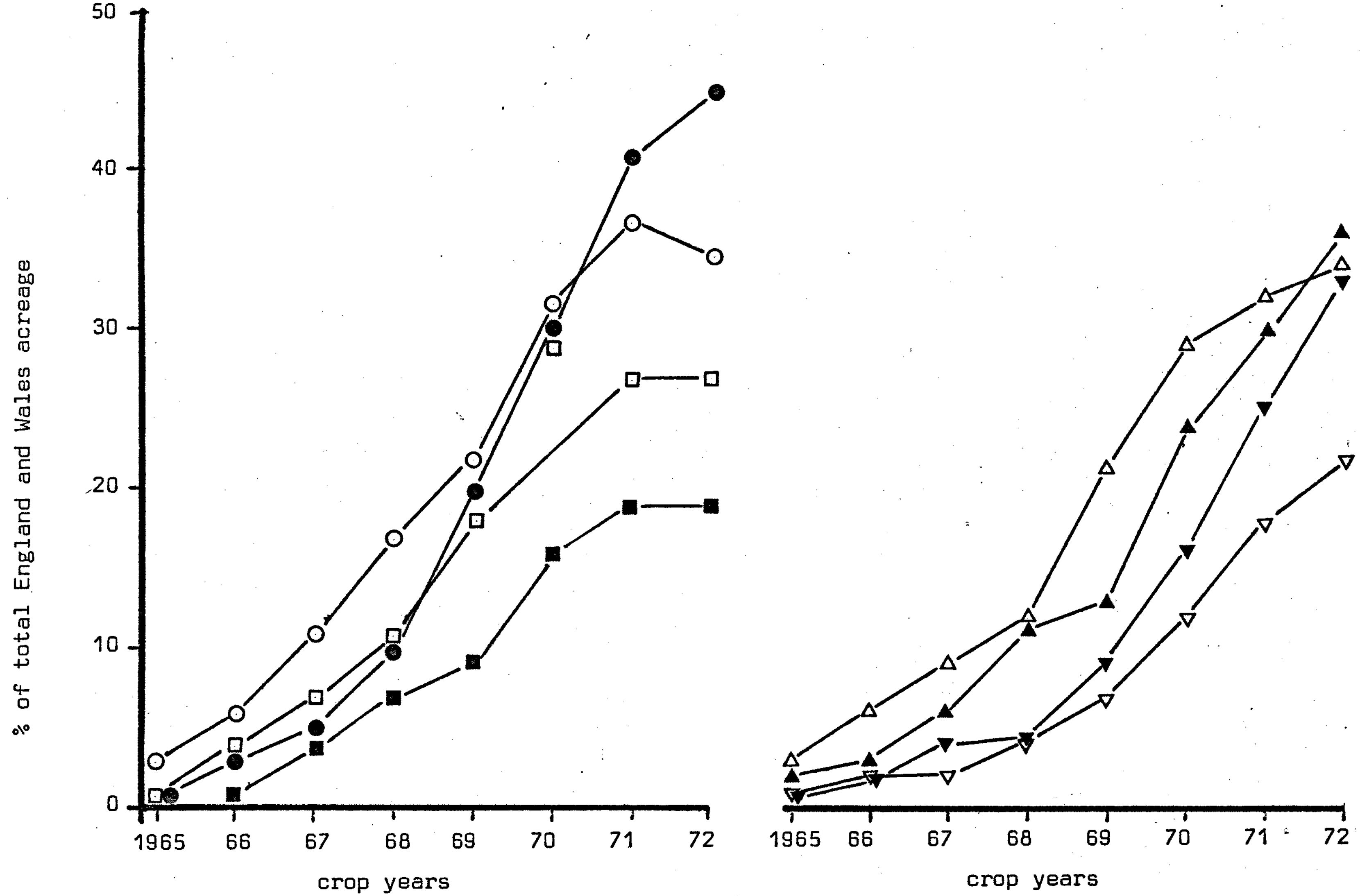

Figure A13.1 Regional variations in the adoption patterns of Pentland Crown.

Annotation: East Midlands ○ , North □ , South East ● , Eastern ■ ,
Yorkshire and Lancashire △ , West Midlands ▲ , Wales ▼ , South West ▽

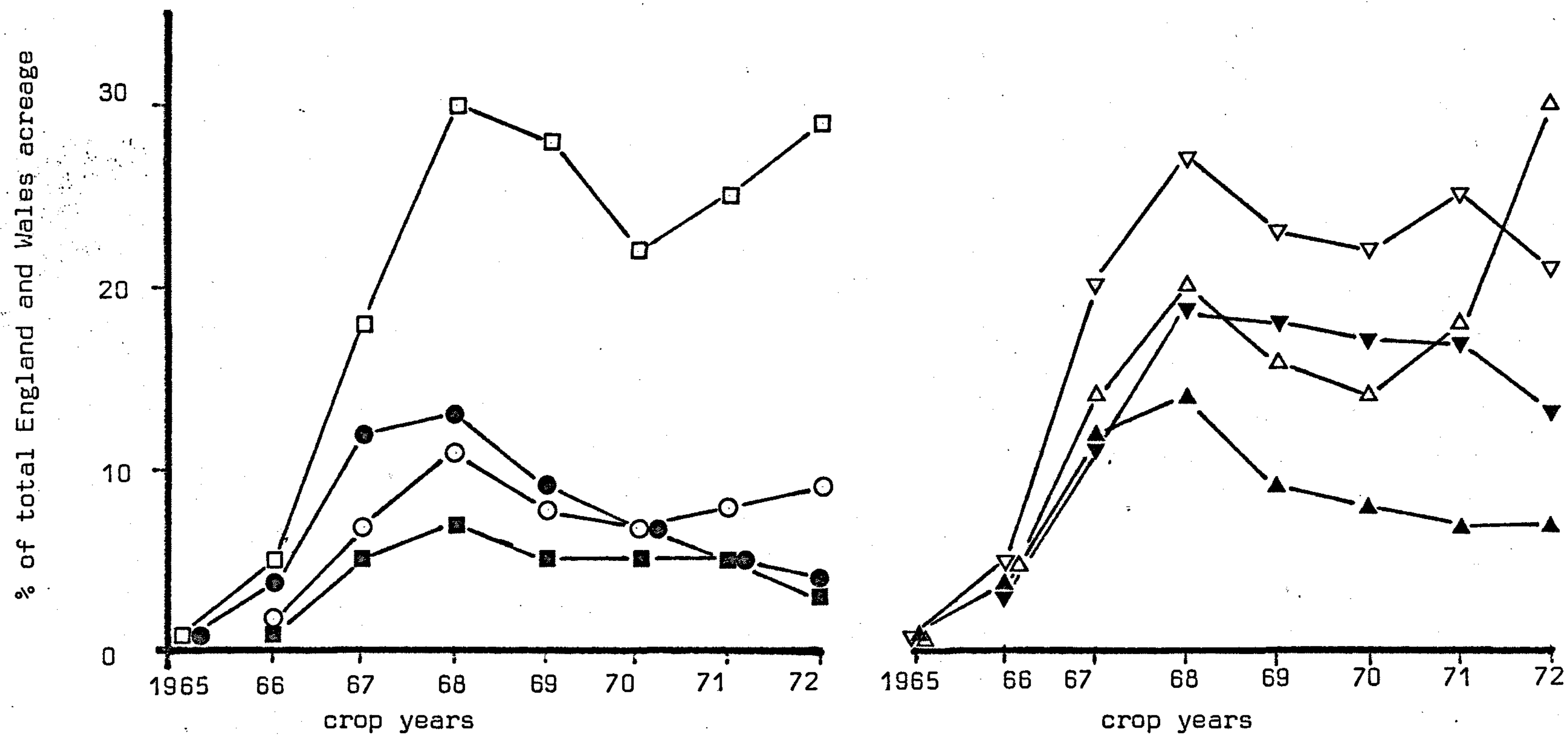

Figure A13.2 Regional variations in the adoption patterns of Pentland Dell

Annotation: East Midlands ○ , North □ , South East ● , Eastern ■ ,

Yorkshire and Lancashire △ , West Midlands ▲ , Wales ▼ , South West ▽

pesticides are applied with fungicide).

The cost is worked out upon a per acre basis, according to the principles laid down in the handbook and then multiplied by the varietal crop proportions considered to have had spray treatments (in the 1968 survey). The derivation of total spraying costs per acre are shown in table 8.11. The costs per acre associated with Pentland Crown are shown as greater by £0.079 than those suggested for Majestic: for Pentland Dell prior to end-1968, greater by £0.41, and post-1968, greater than Majestic by £0.454 per acre. These are multiplied by the new varieties planted acreage to obtain estimates of extra costs associated with growing the new varieties.

TABLE 8.11

Estimated varietal labour costs associated with spraying (£ per acre)

	Pesticide (a)	Fungicide (b)	Herbicide (c)	Haulm defoliant (d)	
Majestic	0	0.384 (.50)	0.128 (.4)	0.128 (.59)	= 0.319
Pentland Crown	0	0.384 (.68)	0.128 (.38)	0.128 (.69)	= 0.398
P.D. to end 1968	0	0.384 (.55)	0.128 (.48)	0.128 (.68)	= 0.360
P.D. post 1968	0	0.64 (.94)	0.128 (.48)	0.128 (.86)	= 0.773

PC M = .079; PD 68 M = .041; PD p68 M = .454

Notes: Figures in parentheses denote proportions of varietal acreage likely to receive applications

Calculated using table 7.10

The herbicide category is interesting, since it is possible that herbicides allow growers to minimise cultivations (Evans, 1972).[1] That it might be assumed that where herbicides are applied say, one less cultivation is required. Using the PMB handbook again, the most appropriate cultivation to be affected is ridging: it is assumed that the equipment was a mould board ridger, capable of covering ten acres

[1] There might also be advantages associated with increased crop yield and faster harvesting (Evans ibid): but these do not seem to have been measured.

APPENDIX 14

Certified seed

TABLE A14.1

1970 Crop survey distribution of "Certified Seed" used in England and Wales

Seed producing region	% of total potato crop using seed
Scottish	47
Own grown	37
Northern Ireland	7
English	5
Welsh	1
Miscellaneous	3

Source: EDCA (1972)

TABLE A14.2

Acreage certified for seed in Scotland, England and Northern Ireland ('000 acres)

Year	Scotland	England	N. Ireland
1955	76.6	10.4	27.6
1956	78.1	10.9	33.8
1957	72.7	9.4	28.0
1958	72.5	9.1	25.6
1959	75.7	10.5	28.5
1960	79.0	8.6	28.7
1961	70.5	7.1	22.7
1962	71.3	6.9	23.5
1963	75.8	8.1	29.5
1964	83.8	9.8	29.6
1965	72.8	8.7	20.3
1966	56.9	8.5	16.5
1967	59.3	9.9	20.3
1968	55.7	9.6	19.9
1969	49.3	7.7	20.1
1970	53.6	8.6	20.8
1971	50.5	9.1	17.7
1972	46.6	8.5	14.9

Source: PMB

APPENDIX 15

Retail prices for potatoes

TABLE A15.1

Retail prices 1962-71, London area

Date	Red-skinned Retail price (pence per lb)	White-skinned Retail price (pence per lb)
16. 1.62	1.87	1.46
14. 1.64	2.29	1.66
17. 3.64	1.58	1.35
12. 1.65	1.87	1.46
16. 3.65	1.46	1.25
12.10.65	1.35	1.25
18. 1.66	1.66	1.04
22. 3.66	1.77	1.25
18.10.66	1.77	1.46
17. 1.67	2.29	1.66
21. 3.67	1.87	1.56
17.10.67	1.87	1.56
16. 1.68	1.77	1.46
19. 3.68	1.77	1.46
15.10.68	1.87	1.46
14. 1.69	1.98	1.56
18. 3.69	1.98	1.56
21.10.69	2.29	1.87
20. 1.70	2.29	2.08
17. 3.70	2.71	2.29
20.10.70	2.08	1.66
19. 1.71	2.08	1.87
16. 3.71	2.25	1.50
25. 9.71	2.25	1.50

Source: PMB evidence to Consumers Committe for GB p.42

TABLE A15.2

Farm prices 1962-1971, London Area (per ton)

	Red-skinned Varieties		White-skinned Varieties	
	Annual Average	3-year moving average	Annual Average	3-year moving average
1962	17.45		13.63	
1964	17.48		13.56	
1965	14.50	17.48 (23.25)	12.32	13.17 (17.52)
1966	16.18	16.05	11.67	12.52
1967	18.76	16.48	14.87	12.95
1968	16.87	17.27	17.63	13.39
1969	19.54	18.39	15.52	14.67
1970	22.02	19.49	18.73	15.96
1971	20.47	20.68	15.15	16.47

Notes: Price data in individual years is computed from average prices on three separate occasions during early, middle and late season. No figure is given for 1963, and the average figure for 1962 is computed for mid-season only.

Figures in parenthesis show the 1965 3-year average in 1971£s.

Source: Based upon data presented in Table A15.1

TABLE A16.1 Arable Agricultural Acreage (Britain)

Year	Total Arable	Wheat	Barley	Other Cereals	Beet	Fodder	Other	Vegetables	Temporary Grass	Potatoes
1960	18051	2102	3372	1196	436	1215	519	415	6868	829
1961	17955	1827	3828	1899	427	1130	695	363	7084	703
1962	18121	2266	3986	1673	424	1077	543	385	7033	735
1963	18212	1928	4731	1415	423	959	592	396	7012	768
1964	18382	2206	5032	1226	443	892	536	378	6686	778
1965	18523	2535	5395	1105	455	842	504	370	6572	741
1966	18484	2238	6130	990	446	774	588	368	2280	669
1967	18325	2305	6027	1111	457	774	562	409	5971	708
1968	18241	2417	5933	1068	465	822	529	442	5873	691
1969	17943	2059	5962	1110	457	812	721	472	5738	614
1970	17788	2495	5542	1136	463	738	537	508	5750	669
1971	17857	2710	5654	1052	471	695	468	454	5718	634
1972	17848	2786	5653	948	468	664	481	444	5827	584

Notes: (1) 'Other' cereals includes oats, mixed corn and rye
(2) 'Potatoes' includes the early crop
(3) 'Fodder' includes beans, peas, turnips and swedes and mangolds

Source: Monthly digest of statistics

APPENDIX 17

Overseas prices

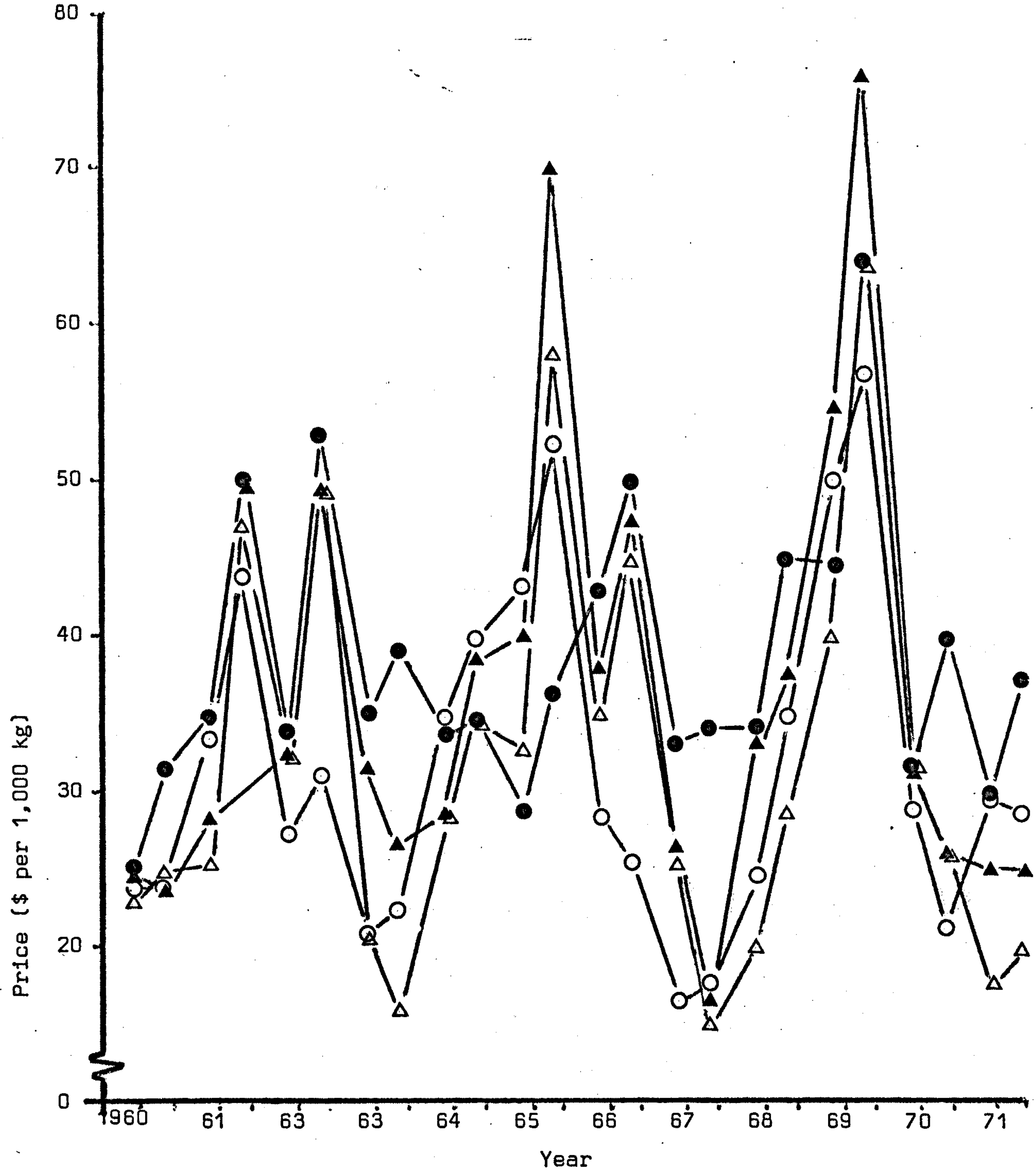

Figure A17.1   Maincrop potato prices in selected EEC countries

Annotation: Britain ● , West Germany ○ ,

Netherlands ▲ , France △

Source: After Figure 4, EDCA (1972)

APPENDIX 18

Price-output interactions

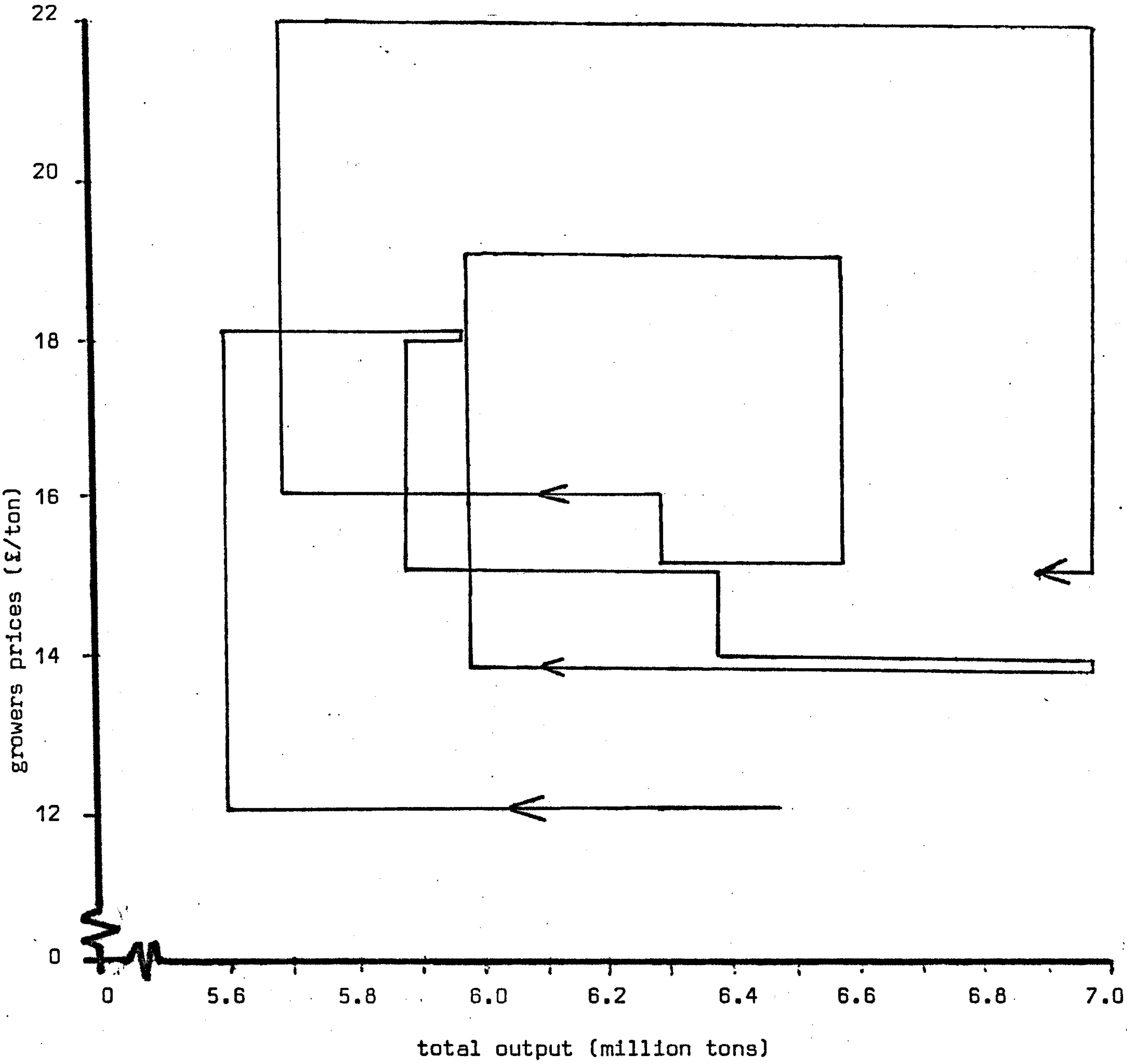

Figure A18.1 Potato grower price - output interactions, 1960 to end-1971.

Source: compiled from PMB statistics

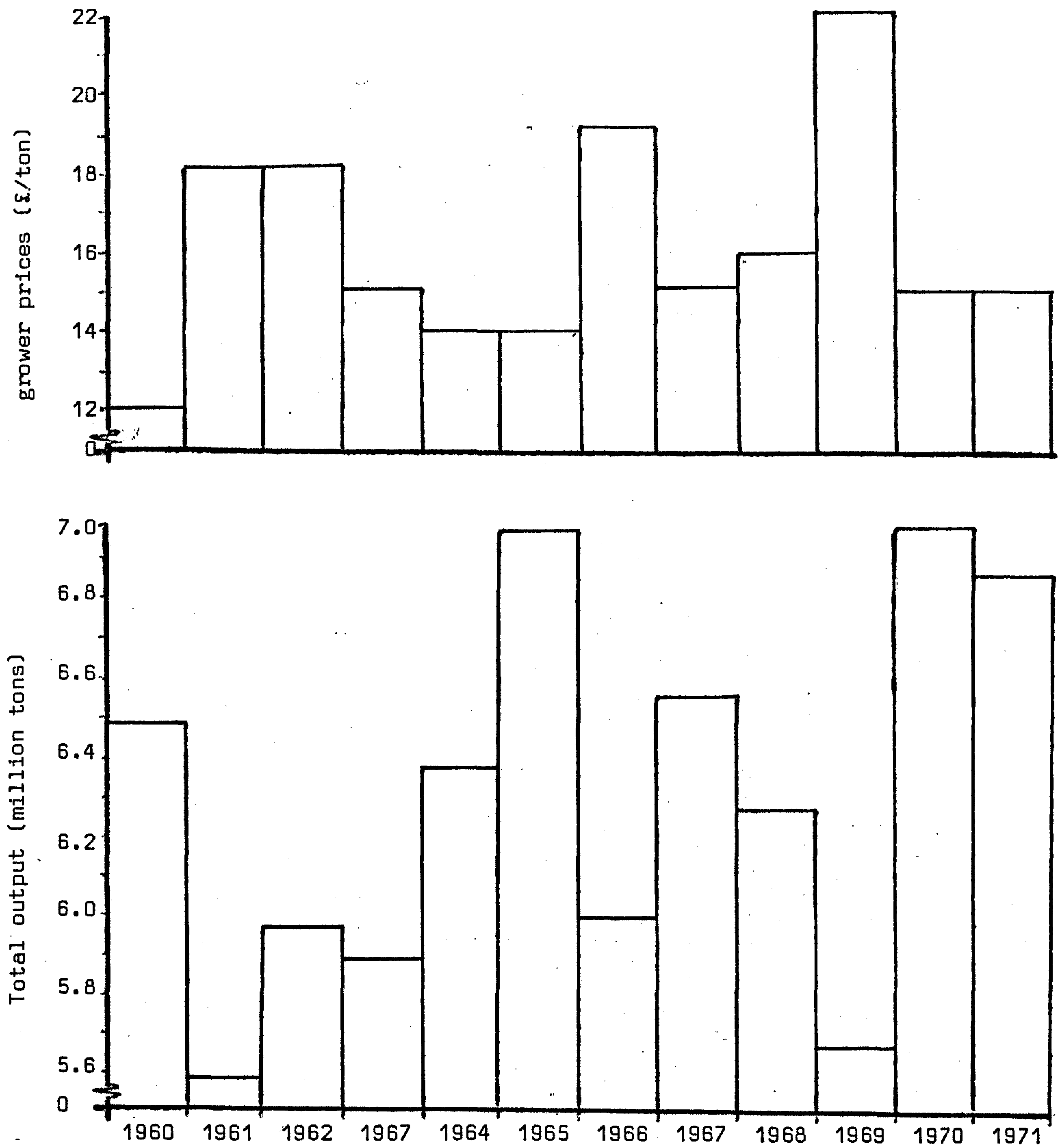

Figure AI§.2 Annual grower prices and total potato output for crop years 1960 to 1971.

Source: PMB statistics

APPENDIX 19

Potato Markets

The ware potato market

There are a number of potato markets based upon the ways potatoes are produced, presented and sold to the general public. The largest is that based upon the sale of fresh, loose potatoes, the ware market. It has been estimated that over 70% of potatoes used for human consumption in 1972/73 were ware potatoes (ACMS, 1973).

Consumers are usually able to select individual tubers and so choose in detail the standard of first order quality they require. Also, it is common practice, where loose potatoes are offered, to present a choice between two kinds of potato: based upon "whites" (usually varieties which may be of only ordinary cooking quality), and "reds" or "King Edwards" (varieties which may be of high cooking quality) (CA, 1974). The latter selections are generally priced at a premium.

The processed potato market

The second most important market in terms of size (which might indeed understant its importance, since value added per unit of weight of potato is greater than for other types of potatoes) is that of processed potato products. It has been estimated that in 1973/74 around 20% of the domestic crop was processed (PMB, 1974b). Processed potatoes are those which have been subjected to a number of activities: blending, cooking, packing and sometimes freezing. The final product may be accompanied by strong sales promotion, often using national media of communications, and quite unlike the scale of publicity given to ware potatoes (it has been estimated that for 1970, £2m was spent on dehydrated products alone; Newman, 1970).

The growing importance of processing (and expectations regarding a promising future) has had a considerable impact upon the consciousness of the potato industry with regard to cooking quality: it has made the industry aware of the importance of such factors as dry matter* and reducing sugar contents.* Both of these are important where potatoes are fried, as in crisp and chip manufacturing: the former, because it is associated with oil usage and cost; the latter, because it affects colour of the finished product: see Burton (op cit).

Some processing companies have been strict about the quality of potato that is acceptable to them; these are those involved with crisping and some kinds of canning. Usually these companies will take only certain varieties. The PMB has published quite detailed specifications with regard to both the kind of potato tuber and cooking quality required by the processing industry (see PMB, 1974b: op cit) and on occasion processors may reject whole loads which have been delivered to factories (for example if internal bruising is suspected). However, generally, it seems that in practice standards have not been so stringent, and potatoes which are generally available are taken (Elliot, 1970).

The pre-packed potato market

Third in order of size is the market for pre-packed potatoes. It has been estimated that around 12% of the potatoes that went for human consumption in 1972/73 were pre-packed (ACMS, op cit). Pre-packed potatoes are those which have been selected and packed in bags (usually polythene) prior to retail sale. This kind of potato produce has probably been more associated with the general store, particularly those of the large retail multiples such as supermarkets, than with the greengrocer type of outlet.

Presentation to the consumer is usually based upon trade or brand name. Samples are liable to contain any kind of potato or variety (including high cooking quality ones), but the emphasis is generally upon appearance, and therefore first order quality. Prices are generally higher than for ware potatoes (CA, op cit), probably to cover costs associated with sorting and bagging.

The advantages of both processed and pre-packed potatoes are ones associated with convenience. Shopping time is cut to a minimum and handling is easier: in the instance of processed products, cooking preparation is minimized. There are also advantages of this type to the general store (perhaps not so obvious for specialist vegetable outlets). Staff-time and space might be saved, self-service facilitated.

Generally it seems that less prominence is given to the sale of potatoes in general stores than in greengrocers. They are sold in the former, probably because they help complete the range of products generally necessary to an average family's weekly food requirements (Gibbons, 1970). In greengrocers, potatoes might be viewed as more a profitable line in themselves, able, as one observer has suggested, to 'carry' such business as exotic fruits (Simpson, op cit).

Bulk buying market

A fourth kind of market, which appears to have become important recently, is that which involves the sale of potatoes in large bags, 14 lbs. and over, from farms, local markets and milk-rounds. Perhaps as many as one in three consumers bought potatoes in this form at least once during 1973 (PMB, 1974a op cit). It is likely that the purchase of potatoes in bulk is associated with a desire to economise at a time of rising food prices. Unfortunately, almost nothing is known about this market.

Uses for potatoes other than for human consumption

For a general review of alternative markets to those of human consumption, see Burton (op cit: pp.302-5). Compared to other countries the UK has a very small alternative use for potatoes: mainly for stockfeeding when potatoes are in surplus and need disposal. Central grading stations have sometimes provided a continuing opportunity to provide out-grades for alternative markets, but generally, it seems growers have lacked an incentive to seek alternatives. Potato prices have been generally too high to permit the establishment of a domestic starch industry (see PMB, 1972b). The PMB has sought ways to remove surplus potatoes from the market by the investigation of the development of a dehydrated product suitable for stockfeed (PMB, 1971 op cit), and provision of subsidised arrangements to transport potatoes to animal rearing areas (PMB 1973c).

APPENDIX 20

Financial arrangements to cover costs of surplus seasons

The financial arrangements used to cover costs associated with surpluses during the late 1960s were based upon an agreement between the PMB and government in 1966. This committed the PMB to an annual payment of at least £1m, raised from growers' levies, to be put into the market support fund. The government was required to contribute funds at a rate of two to one, for any expenditure necessary to market price support operations. A sliding scale was devised to ensure that the PMB paid the whole cost of a variable basic tonnage, should the final average market price exceed the guarantee price. These arrangements were soon abandoned, however, when in 1967/68 a large surplus required that the government come to the aid of the PMB and pay an extra £1m. The cost of government support is shown in table 10.2 row (g) (for further details of surplus financing, see MAFF et al, op cit).

TABLE A21.1 Raw potatoes used for processing in Great Britain ('000s tons)

Processed product	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71	1971/72	1972/73
CANNED WHOLE	1	2	6	9	19	15	23	24
Imported raw product	(7)	(15)	(18)	(13)	(6)	(12)	(11)	(1)
Imported final product	-	(7)	(12)	(9)	(11)	(15)	(14)	(NA)
CANNED OLD/DICED, SOUPS	10	11	13	15	16	17	17	17
CHIPS, FROZEN AND PAR-FRIED	10	25	57	87	136	186	206	275
Imported final product	-	(20)	(38)	(20)	(11)	(13)	-	-
CRISPS	265	278	298	315	296	330	371	387
Imported raw product	-	(45)	(40)	(49)	(25)	(12)	(10)	(13)
Imported final product	-	-	-	-	(2)	(2)	(2)	(NA)
DEHYDRATED	34	32	39	40	80	92	80	92
Imported raw product	-	-	-	-	-	-	-	(2)
Imported final product	-	(30)	(111)	(110)	(124)	(109)	(85)	(NA)
Total Home Crop used	320	348	413	466	547	640	697	795
Total Human Consumption, GB crop	4696	4650	4650	4750	4620	4670	4720	4940
Percentage of Home Crop processed	7%	8%	9%	10%	12%	14%	15%	16%

Notes: (1) NA - not available

(2) Totals for imported final product are for the United Kingdom

(3) The following ratios are used to convert raw potato to processed product: canned 10:9 (canned content including brine), chips 20:9, crisps 4:1 and dehydrated 7:1

TABLE A21.2

Processing varieties, percentage estimated usage

Varieties	Year to 31.5.70	1971	1972
Bintze	2%	2%	1%
Home Guard	3%	3%	2%
King Edward	4%	2%	1%
Majestic	12%	13%	19%
Maris Peer	1%	2%	1%
Pentland Crown	17%	26%	29%
Pentland Dell	10%	12%	15%
Record	51%	40%	32%

Source: Private correspondence with trade sources

APPENDIX 22

Annual crop yield and acreage variations

TABLE A22.1 Annual deviations in planted maincrop acreage and crop yields from the average

Acreage planted 1965 to 1972			% deviation from average
Average acreage '000s acres		466	-
Highest	1967	509	9
Lowest	1972	413	11
Yield per acre			
Average yield per acre tons		11.0	-
Highest	1971	12.1	10
Lowest	1968	10.1	8

Source: PMB/A

TABLE A22.2 Annual deviations in varietal crop yields, England and Wales 1968 to 1972

Pentland Crown			% deviation from average
Average yield per acre tons		11.8	-
Highest	1971	12.5	6
Lowest	1969	11.1	6
Pentland Dell			
Average yield per acre tons		11.6	-
Highest	1968	12.3	9
Lowest	1969	10.6	9
Majestic			
Average yield per acre tons		10.1	-
Highest	1970	10.6	5
Lowest	1969	9.3	8

Source: table 8.1

APPENDIX 23

The consumer survey

Copy of questionnaire enclosed aside

APPENDIX 23

A survey of consumer opinion

Previous surveys of consumer opinion

Results from surveys of consumer opinion have been published in the following publications:

(1) Pickard and Cori (op cit), a national survey of 1507 housewives, which was conducted during November and December, 1961, by Produce Studies Limited for the PMB and NFU.

(2) Gibbons (1965 op cit), a survey of 199 housewives in the Nottingham area, which was conducted during November, 1962, and February to March, 1973; by Gibbons for an M.Sc. thesis at Nottingham University (he had been involved in potato trading).

(3) Simpson (op cit), a survey of potato marketing which included the attitudes of 54 households and other groups in the Leeds area: it was conducted in June, 1967, by Simpson and the marketing economics department of Leeds University.

(4) CCGB (op cit), a national survey of 1326 housewives, conducted during May, 1968, by Gallup Limited for JSL.

This publication appears to have been instrumental in leading to two other more recent studies (the results of these were unknown at the time of this present study's survey).

(5) PMB (1974a op cit), a national survey of 1631 housewives, which was conducted during September, October, 1972, and in March, 1973, by Research Bureau Limited for the PMB.

(6) CA (op cit), a national survey of 1500 association members, conducted by the CA during April and November, 1973.

Publication (1) does not present survey results in detail, but does give useful insights into the nature of consumer behaviour as it exists, and indicates how potatoes might be used by consumers. Unfortunately, no attempts were made to link varietal type with market needs and consumer dissatisfaction. Also, questions were long and elaborate, and the report gave no indication of how this style of questioning might influence results.

Publications (2) and (3) are regional in nature and did not related to the national situation, but of all the reports, their detail and observation offer the most informative insights into varietal importance and consumer opinion. They also seem the most neutral in terms of results assessment. Unfortunately, they were carried out at a time when the SPBS's varieties had not made any substantial impact upon the market.

Publication (4) was concerned only with consumer satisfactions; (5) with an emphasis upon what consumers actually purchased, as well as cooking habits, knowledge of varietal names and attitudes about quality (varietal effects were not considered, however). Superficially, the PMB publication appeared to contradict the results of the JSL survey. Upon examination, however, the results may not be so very different; that is, apparent discrepancies may be explained by the method of questioning, presentation and interpretation of results.

This is not to suggest that survey agencies are other than objective, but that if survey briefs differ, it is likely that approaches do as well. Both the JSL and PMB surveys were based upon nationally representative samples and may, therefore, be regarded as reliable indications of opinion generally, in the light of the questions posed. The JSL survey sought evidence for consumer dissatisfaction, whereas that of the PMB's aimed to "establish the true view of the consumer" (PMB op cit, p.6).

This difference in purpose appears to have influenced the surveys, so that on the one hand, an attempt was made to locate and assess the causes of dissatisfaction with quality generally available, whilst on the other, it was attempted to depict an average but more considered view of potato quality. This might explain the contrast of the simple question and spontaneous answers of the JSL survey to the more elaborate questions and prompted replies of the PMB one (these are sometimes termed 'guided' or 'focussed' interviews).

Publication (6), based upon results obtained after the PMB survey, in turn appears to contradict the latter's findings. It might be that CA members are conscientious shoppers, and liable to dissatisfaction above that of the average consumer. An observation made in the CA's report suggests how its results might differ from those of the PMB: that although the majority of members told the association about examples of unsatisfactory potatoes, only a fifth of them were surprised enough by this to be generally dissatisfied with the potatoes they bought. The CA added that people probably had "pretty low expectations".

The need for, and objectives of survey

An unfortunate feature of must of the survey evidence however, has been the extent of associated controversy. Particularly, where issues of consumer satisfactions and preference had been concerned; for example, it sometimes seemd to the author that the degree of confidence that could be attached to evidence presented by those two antagonists, JSL and the PMB, was small.

It was because of these feelings that the author decided to seek attitudes directly from consumers in the market place. Not so much to measure the consequences of the SPBS innovation upon consumers (this would have meant a rigorous investigation, which demanded financial resources quite beyond those available for this study), but as a test or check upon the trustworthiness of important contentions and material used in this chapter. It was hoped that an up-to-date and geographically widespread impression of consumer varietal knowledge, preferences and associated problems, would be obtained.

It was realised from the results of previous work that consumers were likely to know very little, explicitly, about the effects of specific varietal characters. So it was deemed necessary to ask more general questions associated with varieties, satisfactions and cooking habits. At the same time, advantage of survey facilities could be taken to check if there were potato substitutes, and opinions concerning pre-pack and processed products.

Survey methodology

(a) Survey population (coverage)

The number and category of potato consumer surveyed was to a large extent determined by circumstances, particularly availability of voluntary interview personnel. However, it proved possible to cover important centres of population representative of different types. In the terminology of the Registrar General, used in survey work by the National Food Survey Committee (see MAFF, 1973a op cit), sampling areas were obtained in the 'London conurbation' (Surbiton); two in 'provincial conurbations' (Glasgow and Liverpool), and two in 'larger towns' (Aberdeen and Swindon).

Some sampling was conducted at Louth, a small town in a rural setting, but the results seemed heavily influenced by the replies of farmers' wives and agricultural workers, and not representative of potato consumers generally. No attempt was made to sample other small towns. The composition of the population covered by the survey was 21% each for Glasgow, Aberdeen and Swindon; 20% for Surbiton and 16% for Liverpool. Thus, the survey is biased towards northern markets, where the greengrocer and King Edward VII trade is less prominent than further to the south. This might not be too important, given that the Pentland varieties are white-skinned and do not seem to be important competitors with King Edward VII.

(b) Method of sampling

Interviewers were asked to approach shoppers in central shopping areas, and themselves fill in the questionnaires. Selection of respondent was left to interviewers, and was, therefore, non-random. This method is known as 'quota sampling', and its advantages with respect to 'probability sampling' have been the subject of controversy for some years (see Moser and Kalton, 1971; p.127).

With quota sampling, it is not possible to estimate sampling errors, since the basic theoretical requirements of randomness are not fulfilled (every item in a population should have a calculable probability of its changes of selection). Statisticians have sometimes argued that quota sampling is unreliable to the extent that its results are worthless. Whereas market opinion researchers have tended to defend it for its cheapness and administrative convenience (the reason why it was adopted here).

(c) The questionnaire

A copy of the questionnaire is presented in table A25.1. This was designed in co-operation with someone with training in questionnaire design, and experience with interviewing. Wording was designed to take up a minimum of time for asking questions. To some extent the questions were open ended; interviewers were instructed to record answers verbatim, and not to prompt replies. The main purpose was to achieve consumer strength of opinion, but also gain insights into the context of the answer.

It was felt that a more formal approach to questions would act to disguise the relative importance of the most significant factors (that is, the first factors to come to the mind of consumers were assumed to be the most important for the time). This point is discussed in Moser and Kalton (op cit: pp.299-300). The value of open-ended questions is examined in Simon (1969: p.278). A problem with this approach is that associated with the summarization of data: the author had to interpret respondents replies (of course, this does prevent categorization of answers on the part of interviewers).

(d) Timing

Interviews were conducted during February, 1973; that is, towards the end of the maincrop season, but well before early crop potatoes could influence the market. It might be expected that potatoes are less fresh, and thus, of poorer quality than they would be prior to Christmas, so answers might be biased in the direction of consumer dissatisfaction. Except where requested otherwise, consumers were required to relate their answers to the whole of the 1972/73 season however (they were not told the purpose of the survey). All but one of the five interviewers were inexperienced, but it was hope that careful briefing would have reduced bias to a minimum.

Survey results

A total of 131 respondents were achieved. No count was kept of the number of people who refused to co-operate with the interviewers, but it was thought that the number was around the same as those who consented to co-operate. The results of the survey are summarised in table form below.

(a) Consumer preferences (tables A23.2)

Respondents were not very knowledgeable about the potatoes they bought: 22% did not know what kind of potatoes they had last purchased (and it is likely that some others guessed). A total of 55% respondents said they had bought a named variety, nearly always King Edward VII.

The reasons given for buying different kinds of potatoes could be grouped mainly into three; convenience, preference and quality. Convenience may be associated with proximity of supplies, limited choice available: preference implies a priority of choice, and quality might imply the best of a given choice. Of course, in practice these categories are ambiguous, but the distinction between the former and latter two has a significance to respondents' attitudes to potatoes and therefore has some significance for varietal choice.

It seemed that the respondents who knew least about the potato variety they had bought, were the ones most likely to give convnience as a factor for purchase. Also this group commonly listed 'whites' and supermarket brands as types bought. Majestic was the variety most associated with convenience factors. By contrast, preference and quality were most associated with King Edward VII and Golden Wonder (the two high second order quality varieties).

Price was mentioned by only a few respondents as a factor important to choice. There were some marked regional variations. Convenience factors were less frequent in Surbiton, where King Edward VII seemed popular; in Aberdeen convenience factors were most often mentioned, and white-skinned potatoes bought.

(b) <u>Varietal knowledge</u> (tables A23.3 and 23.4)

When asked to name potato varieties, respondents showed a distinct lack of knowledge, despite the PMB varietal recognition poster campaign, which was then at its height (posters commonly being exhibited in shops). Most respondents could name King Edward VII, but only 44% named Majestic, despite its 50 years of commercial success. Only one respondent named Pentland Crown and none, Pentland Dell, Desiree, a potato which has been introduced since the SPBS varieties, and although its acreage is still very low, was known by 2% of respondents: perhaps its red skin is both recognisable, and memorable.

Redskin, a variety long present in northern markets, appeared more generally known by southern respondents, to whom it is not readily available. Perhaps in southern markets it is confused with King Edward VII (sometimes labelled 'reds' at retail, to contrast with 'whites'). When asked to name preferred varieties, respondents chose mostly King Edward VII and Golden Wonder: reasons given were mainly cooking quality and taste.

Respondents were asked if they grew potatoes in gardens, and if so, which varieties. This question was included as a check to see if gardeners were more knowledgeable and conscious of quality in varieties. As a group they did indeed appear so, particularly of early crop varieties such as Arran Pilot, Epicure and Home Guard. The respondent who named Pentland Crown had grown it in his garden, King Edward VII was the most popular garden variety.

(c) Consumer satisfaction (table A23.6)

Respondents were divided evenly between those satisfied, and those not. The main cause for complaint was associated with first order quality, bad parts and damaged potatoes. However, cooking factors figures prominently, particularly after-cooking blackening and tuber softness or disintegration. Respondents mentioned fewer causes of satisfaction than for dissatisfaction, and interviewers noted that consumers expressed the latter with more emotion. Satisfied respondents gave cooking quality and taste as factors which most satisfied.

Levels of satisfaction varied widely with locality. Glasgow, an area which had showed a relatively high varietal knowledge and concern with preference and quality, produced dissatisfaction in 73% of respondents, the majority of complaints were concerned with cooking quality. Aberdeen, on the other hand, produced 70% of respondents as satisfied; this was the area where varietal knowledge seemed lowest, with a minimum concern with preference and quality. It is not clear what this means; for example, at Glasgow, poor quality might have made respondents there careful in their choice of potatoes, or it might be that they have higher standards and a wider choice available to them, and so are less tolerant.

(d) Cooking habits (table A23.7)

Trouble with cooking potatoes had been experienced by 36% of respondents. The main difficulty seemed associated with boiling, this affected about 67% of respondents who had had cooking problems. Sloughing and disintegration were the most mentioned factors.

Respondents generally had difficulty in suggesting varieties which would be most suitable for different cooking methods, and positive replies almost always put forward King Edward VII. Majestic was mentioned only in a few instances, and then that mostly was for baking and mash. King Edward VII was mentioned less for chipping and salad uses (although still more than any other variety). Golden Wonder was a popular choice for Glasgow respondents.

(e) Consumption of potatoes (tables A23.8, A23.9 and A23.10)

The main reasons given for respondents changes in size of potato purchases were associated with dietary reasons and family size. A total of 11% of respondents who bought less, did so because of changes in potato quality. The total percentage buying fewer potatoes was high, at 60%: only at Aberdeen did respondents feel that they purchased about the same quantity as previously.

Where respondents stated that they bought less, they were asked what, if anything, they used instead. The largest number, about 35%, felt that they probably consumed more vegetables of another sort; 29% did not know, and another 11% stated that they used no substitute. Interviewers thought that respondents had most difficulty answering this question.

When asked whether they preferred loose or pre-packed potatoes (at the same price), 74% of respondents chose the former. It appears that the advantages associated with loose potatoes were freshness, absence of rotting and ease of selection. Pre-pack were chosen for convenience factors, and cleanness. Of respondents who bought processed products, as many as 80% said that they did not prefer them to meals made from fresh potatoes: they were bought for convenience.

(f) Price and improvements in quality (table A23.11)

When asked if they were willing to pay more for an improved quality potato, 56% of respondents stated that they were. The factors that respondents would most like to see associated with an improved quality potato were freedom from damage and bad parts (the most often mentioned factor), and improved taste.[1] Cooking quality was also frequently mentioned, roughly by the same number of respondents who stated that they experienced cooking troubles. It should perhaps be noted, that respondents who were willing to pay more, were not necessarily those who were dissatisfied with quality. At Swindon and Surbiton, there was a tendency for dissatisfied respondents not to want to pay more.

General points

It cannot be claimed that the survey gave results which were accurate reflections of the opinions of all potato consumers: the number of respondents was small, and the choice of individual respondents was left (as a result of the quota sampling method) to the briefed but inexperienced interviewers. However, the author found the results of the survey informative: some insights were obtained which did not seem available from elsewhere. Where the results can be

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[1] In view of the fact that generally respondents did not seem too dissatisfied with taste, this is surprising and suggests that market acceptance does not necessarily mean that improvements should not be made.

compared to those of other survey work, they do not seem too greatly at variance.

The survey adds a degree of strength to arguments and evidence presented in the previous chapter. It seems that general consumer dissatisfaction might well exist. Also, that although consumer awareness or varietal names might be poor, consumers might not be indifferent to quality factors which are influenced by varietal type: indeed, there appears to be a popularity associated with the second order quality varieties, King Edward and Golden Wonder.[1]

Pentland Crown and Pentland Dell appeared to have made no significant impact upon the consciousness of respondents: therefore, there is nothing to directly link these varieties with dissatisfaction.

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[1] Those respondents who listed King Edward for different ways of cooking, were able to reflect in their answers, the lower propensity of the variety to chip well, as noted in the PMB wall chart.

We are carrying out a survey on consumer satisfaction with potatoes. Please would you help us by answering a few questions?

1. What kind of potatoes did you last buy? .... DK

1a. Do you know the name of the variety? .... No

2. Why did you buy that kind of potatoes?

Convenience	Quality
Variety	Preference
Habit	DK
'On offer'	
Other reason (write in)	

3. What potato variety names do you know? (tick names mentioned, but do not suggest any)

Arran Pilot	Maris Peer
Desiree	Maris Piper
Epicure	Pentland Crown
Golden Wonder	Pentland Dell
Home Guard	Pentland Ivory
King Edward	Red Craigs Royal
Kerrs Pink	Redskin
Majestic	Ulster Prince
Other varieties	

4. Do you prefer any particular variety? .... No

4a. Why do you prefer that variety?

Taste	Size
Cooking quality	Colour
Price	
Shape	
Other reason (write in)	

5. Have you ever grown potatoes in your garden? .... No
(If so, what kinds) ....

6. Thinking back to the potatoes you have been buying over the past year, have you been satisfied with them? Yes No DK

6a. If yes, was there anything you particularly liked about them?

Taste	Price
Size	Convenience
Cooking quality	
Other reasons (write in)	

6b. If no, what did you find disatisfying about them?

Taste)	After cooking	Before cooking	(Size
Size)			(Wastage/Damage
Cooking quality)			(Difficult to peel
Blackening)			(Too many eyes, bad bits
Too soft)			('Greening'
			(Dirty

7. Do you have any trouble with the potatoes you buy with regard to different cooking methods? Yes No DK

(If so, for which methods?)

Roasting	Mashed
Boiling	Jacket baked
Chips	Salad use

7a. Do you know of any varieties which are particularly suitable for different cooking methods? Such as for:

Roasting	....	Mashed	....
Boiling	....	Jacket	....
Chips	....	Salad	....

8. Do you and your family eat more or less potatoes than you used to?

	More	Less	DK	Same
Over the past year				
Over the past 5 years				
Over the past 10 years				

8a. Why do you buy more/less potatoes now?

Price
Quality
Diet
Change in family size
Other reasons (write in)
Convenience
Health reasons

8b. If you don't eat so many potatoes now, what do you (and your family) have instead as a substitute?

.... DK

9. Do you prefer loose potatoes or those sold in packs? Loose Packs

9a. Why do you prefer that kind?

Cleaner
Fresher
Convenience
Other reason (write in)

10. Do you buy processed potatoes? e.g. those in tins, instant mash, frozen etc

Yes No

Why do you buy them?

Convenience
Quality
Storage
Easier shopping
Other reasons (write in)

10b. Do you prefer them to fresh potatoes? Yes No DK

11. In general, would you be prepared to pay a higher price for potatoes if the quality was improved, or do you prefer to pay the same price for just average quality?

Prepared to pay a higher price
Prefer to pay the same

12. What would you look for in a high quality potato?

Taste
Suitability for cooking
Less wastage, bad bits, eyes etc.
Size
Other reasons (write in)

TABLE A23.1

Reasons for purchasing potatoes (last purchase only)

Kinds of potato last bought

Percentage	Variety
35	King Edward
11	Whites
10	Kerrs Pink
6	Supermarket brands
4	Majestic
4	Golden Wonder
4	New Potatoes
2	Reds
5	Other kinds
22	Don't know

Reasons for buying these varieties

Percentage	Reason for buying
36	Convenience
24	Preference
21	Quality
9	Habit
7	Limited choice on display
7	Price
1	Appearance
1	Variety
2	Don't know

Of the varieties bought for convenience

38% were Whites and Majestic
27% were Supermarket potatoes
19% were King Edwards and Golden Wonder
14% were Kerrs Pink

Of the varieties bought out of preference

81% were King Edward and Golden Wonder
11% were New Potatoes
7% were Kerrs Pinks

Of the varieties bought for quality reasons

74% were King Edward
17% were Whites and Majestic
9% were others

TABLE A 23.2

Consumer varietal knowledge

Name of Variety	Percentage of respondents naming this variety
King Edward	77%
Kerrs Pink	49%
Golden Wonder	43%
Majestic	44%
Arran Pilot	26%
Epicure	21%
Redskin	19%
Home Guard	15%
Duke of York	6%
Red Craigs Royal	3%
Red King	3%
Arran Banner	2%
Desiree	2%
Sharpes Express	2%
Other varieties	4%

9% named 'Whites as a variety
7% named 'Lincolnshires' as a variety
4% named 'Cyprus' as a variety
3% named 'Jersey' as a variety
2% named 'Ayrshires' as a variety
6% named other kinds

14% of respondents knew 1 variety by name
27% of respondents knew 2 varieties by name
27% of respondents knew 3 varieties by name
11% of respondents knew 4 varieties by name
9% of respondents knew 5 varieties by name
7% of respondents knew 6 varieties by name
5% of respondents knew more than 6 varieties

TABLE A 23.3

Preferred varieties

38% of the respondents had no preference. Of the other 62%

47% of them preferred King Edward
21% of them preferred Golden Wonder
10% of them preferred Kerrs Pink
6% of them preferred Majestic
5% of them preferred Arran Pilot
6% of them preferred Other varieties
10% of them preferred a 'type' rather than a variety

Of these

78% were preferred because of cooking quality
51% were preferred because of taste
24% were preferred because of their appearance
1% was preferred because of price

TABLE A23.4

Varieties grown in the garden

43% of the respondents had grown potatoes in their gardens

Of these -

32%	had	grown	King Edward
25%	"	"	Arran Pilot
17%	"	"	Kerrs Pink
15%	"	"	Epicure
12%	"	"	Home Guard
10%	"	"	Golden Wonder
12%	"	"	Majestic
8%	"	"	Other varieties
3%	"	"	Non-varieties*

Note: *a type rather than a variety

TABLE A'23.5

Consumer satisfaction

49% of the respondents were satisfied with the potatoes they had bought over the last year. 48% were dissatisfied, and 3% didn't know.

Of those who were satisfied:

55%	were satisfied	with the cooking quality
42%	"	" taste
26%	"	" tuber size
16%	"	" price
7%	"	for convenience reasons
3%	"	with the tuber shape
3%	"	" reduced disease marks
1%	"	for other reasons

Of those who were dissatisfied:

(34)*	72%	were dissatisfied	because	of	too many eyes/bad bits etc.
(34)	67%	"	"	"	wastage/damage
(24)	51%	"	"	"	after-cooking blackening
(19)	37%	"	"	"	softness and disintegration
(14)	31%	"	"	"	greening
(11)	22%	"	"	"	cooking quality
(10)	21%	"	"	"	the taste
(4)	7%	"	"	"	the tuber size
(2)	4%	"	"	"	dirtiness
(1)	1%	"	"	"	internal marks

Note: *as a percentage of the total of respondents

TABLE A 23.6

Cooking Methods

A. 60% of the respondents said that they had no trouble in cooking potatoes. 36% said that they did have trouble and 3% didn't know.

B. Of those experiencing trouble:

67%	said that they had trouble with	boiling
16%	" "	mash
12%	" "	Jacket baking
12%	" "	roasting
6%	" "	chips
6%	" "	salad use

C. Varieties best suited for different cooking purposes

53% of respondents didn't know which varieties were best for different cooking purposes.

Of those who said they did:

97%	named	King Edward
30%	"	Golden Wonder
15%	"	Kerrs Pink
9%	"	Majestic
6%	"	'Whites'
3%	"	Other varieties
9%	"	Other non-varieties*

D. Varieties most named for different cooking purposes were:

Boiling:	61% King Edward 17% Golden Wonder 11% Kerrs Pink 11% Others	Mash:	78% King Edward 11% Majestic 11% Others
Jacket baked:	70% King Edward 20% Majestic 10% Golden Wonder	Roast:	75% King Edward 25% Others
Chips:	33% Golden Wonder 37% King Edward 19% Kerrs Pink 9% 'Whites' 2% Others	Salad:	43% King Edward 57% Others

Percentage of responses for each cooking purpose

38% Chips; 16% Mash; 9% Jacket baked; 16% Boiling; 14% Roast; 6% Salad use.

Note: *Named by type or location rather than variety

TABLE A 23.7

Consumption of potatoes

60% of the respondents bought less potatoes than they used to buy
14% " more poratoes than they used to buy
25% " the same amount as they had always bought
1% didn't know

Of the respondents who bought less

61% did so because of diet reasons
31% " a change in family soze
11% " quality reasons
11% " health reasons
7% " convenience reasons
5% " preference reasons
5% " price reasons

Of the respondents who are buying more

63% did so because of change in family size
37% did so for other reasons

Of the respondents buying less potatoes the following substitutes were mentioned

35% said they consumed more vegetables
11% " " rice
6% " " salad
4% " " pasta products
2% " " bread
5% " " other foods
11% " " no substitute
29% didn't know

TABLE A 23.8

Pre-packed potatoes

7% of the respondents preferred loose potatoes to pre-packed ones.
24% preferred pre-packs and 2% didn't know

Of those who preferred loose potatoes

45% considered them as being fresher
20% " less likely to be rotton or soft
13% " to be more convenient
12% preferred being able to select and choose
12% considered them to be more economical
7% preferred them for other reasons

Of those who preferred pre-packs

68% considered them to be more convenient
50% considered them to be cleaner
18% preferred them for other reasons

TABLE A 23.9

Processed potatoes

61% of the respondents said that they did not buy processed potatoes.
39% said that they did buy them

Of those who did buy them

82% did so for general convenience reasons
15% did so because of convenience in shopping
15% did so because of ease in storage
18% did so for other reasons

Of the processed potato consumers

82% did not prefer them to fresh potatoes
14% did prefer them to fresh potatoes
4% didn't know

TABLE A 23.10

Factors thought desirable in a higher quality potato

72%	of respondents	wanted	less wastage from damage/bad bits/eyes
51%	"	"	improved taste
34%	"	"	improved cooking quality
22%	"	"	better sizes
7%	"	"	a more floury potato
4%	"	"	a firmer potato
3%	"	"	a cleaner potato
2%	"	"	whiter flesh
1%	"	"	improved skin colour (more red-skinned varieties)
1%	"	"	other factors

APPENDIX 24

JSL's Gallup Poll

TABLE A24.1

Consumer dissatisfaction with the quality of potatoes

(A Gallup Poll commissioned by J. Sainsbury Ltd)

Nature of dissatisfaction	Number of complaints as a percentage of housewives interviewed
Quality before cooking	
Too many eyes, bad parts etc.	31
Too many potatoes were cut or damaged	18
Green potatoes	15
Potatoes were too dirty	11
Potatoes were too big	8
Potatoes were too small	5
Quality after cooking	
Potatoes were too soft	23
Potatoes were black or discoloured	18
Poor taste	17
Potatoes were lumpy after cooking	6

Source: CCGB, 1972; p.27

APPENDIX 25

List of visits and personal communications

The following organizations were visited in the course of this study:

- The Department of Agriculture & Fisheries for Scotland, Edinburgh
- The Edinburgh School of Agriculture
- Ministry of Agriculture, Fisheries & Food, Westminster
- National Farmers' Union, Louth
- National Farmers' Union, Scotland, at Edinburgh
- National Institute of Agricultural Botany, Cambridge
- National Institute of Agricultural Engineering, Scotland
- Plant Breeding Institute, Cambridge
- Potato Marketing Board, London
- Potato Market Board, Statistics' Branch, Oxford
- Ross Foods Limited, Grimsby

Information was received from numerous individuals and organizations in the mail and over the telephone. They are too many to mention here. Some of the more important were:

American universities with departments having individuals who had been active in evaluating agricultural R & D. These included the Universities of Chicago, Iowa State, Minnesota and Yale: advice and information was forwarded from these institutions by T.W. Schultz, A. Paulsen, W. Peterson, W.L. Fishel and R.E. Evenson. Other establishments in both Britain and America also offered advice, concerning questions associated with R & D evaluation. This included the National Economic Development Office and the Ministry of Agriculture.

Information about varietal effects was gathered with the help of all the regional offices of the Agricultural Development and Advisory Service and the Potato Marketing Board. Institutions such as the Terrington and Arthur Rickman Experimental Husbandry Farms, Rothamsted Experimental Station, Sutton Bridge Experimental Station, Food Research Institute and the National Association of Seed Potato Merchants, provided published information and accounts of information known to them.

Information regarding the potato industry more generally was collected from opinion at meetings and conferences. Other than the Potato Marketing Board and the Ministry of Agriculture, written communications were conducted with John Sainsbury Limited and the Consumers' Association.

My sincere thanks to all who showed interest and were able to provide information.

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