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THE DERIVATION OF A MEAL:WHEY PRODUCTION FUNCTION FOR PIGS.

A Thesis presented at
Massey University College of Manawatu
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in Victoria University of Wellington.

R. J. TOWNSLEY

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CONTENTS.

C H A P T E R I

INTRODUCTION

This chapter discusses in some detail, the usefullness of knowledge about technological relationships, in the form of a production function, in management processes associated with pigmeat production in New Zealand.

1.1 The Management Process

In 1939 T.W. Schultz wrote a fundamental article[1] pointing out that the farm firm exists in a dynamic economy where production may be adjusted and co-ordinated in response to changing conditions. The motivation for change at the farm level is generally the expectation of progress in the attainment of a set of objectives held by the entrepreneur. The whole process of making adjustments and changes within the framework of the firm has become known as the "Management Process".

In the article referred to, Schultz pointed to the two main interests of Farm Management workers and Agricultural Economists, namely:

(1) a desire to provide a basis for guiding entrepreneurial decisions under dynamic conditions; or, in more up-to-date terminology, to assist farmers in carrying out the management

(1) "Theory of the Firm and Farm Management Research", T.W. Schultz, J.Farm Econ., Vol.21, 1939, p.570.

process with the aim of maximising their objective functions, and

(2) to provide results of use to policy makers in understanding the relationship between micro and macro adjustments in agriculture.

Schultz felt that Farm Management research was failing to further both of these interests and pointed to the reason as a lack of understanding of the dynamic nature of the managerial process employed by farmers. He therefore reviewed analytical tools suitable for understanding actions of the firm.

In a reply [2] J.D. Black noted that current research at that time was aimed at exploring the general shape of response surfaces of interest, and that such technological information would surely help farmers in carrying out their managerial processes.

Careful consideration of the views expressed in these two papers is useful. Schultz says that Farm Management research with the aim of helping farmers attain their objectives, cannot be fully directed towards this aim until the management process is understood. The full understanding of micro and macro adjustments in agriculture, of use to policy makers, is also dependent on knowledge of the management process.

Black, on the other hand, pointed out that if knowledge on technological relationships is necessary for the efficient functioning of the management process, then it is worthwhile doing research on this aspect of the process, even though full understanding of other factors necessary in the process is not available.

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(2) "Dr. Schultz on Farm Management Research," John D. Black, J. Farm Econ., Vol.22, 1940, p.570.

Both authors recognise the dynamic nature of the information required to assist farmers in the management process. The process itself is dynamic in nature, and its character will change with type of production, farmer education, time, etc. The viewpoints of Schultz and Black are complementary, and explai the development of research into the management process on one hand, and research into facets of agricultural production aimed directly at improving efficiency of the management process, on the other. Many examples of the complementary nature of these fields of knowledge exist. Experiments run by Heady, Catron, et al, on pork production (3) have explored the marginal rate of substitution between carbohydrates and protein with and without the use of antibiotics. Resulting knowledge of the pork production function has allowed production economics principles to be applied to the problem of computing least-cost protein-carbohydrate rations for pigs, as well as making a choice between different marketing weights under differing price situations for feeds and product.

These recommendations maximise revenue from a given litter of pigs, through the well known principle of equating marginal product value with marginal input cost. A consideration of pork production, however, leads to the conclusion that where pigs are produced on a continuous basis certain "length-of-run problems" arise. Where profit is the objective in the

(3) "New Procedures in Estimating Feed Substitution Rates and in Determining Economic Efficiency in Pork Production", by E.O. Heady, D.V. Catron, D.E. McKee, G.C. Ashton, and V.C. Speer, Research Bulletin 462, Nov. 1958, Iowa State College.

management process, the aim will be to maximise profit over time rather than maximise profit per litter of pigs. In general these aims will not lead to the same production plans.(4)

Thus, as new aspects of the management process become clear, research can be carried out to provide relevant information, and hypotheses can be formulated and tested.(5)

The development of Farm Management (of which the Management Process is the essential feature) as a discipline has been reviewed by Glenn L. Johnson.(6)

Early in the history of Farm Management it was felt that Agricultural Economics had a considerable contribution to make to Farm Management, which until then placed emphasis mainly on technical agricultural sciences. Other disciplines from both the sciences and the humanities are making much needed and important contributions to Farm Management. These include statistics, logic, sociology, home economics, psychology, philosophic value theory, as well as the physical and biological sciences.

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(4) "Results from Production Economic Analysis", Glenn L. Johnson, J. Farm Econ., Vol.37, 1955,p.206.

(5) A notable example of a major research project which made contributions both to the theory of management and empirical testing in agriculture is the Interstate Managerial Survey. The results and description of this research have been reported in various articles in the J. Farm Econ. i.e., "Progress and Problems in Decision Making Studies", Vol.37, 1955, p.1097, H.R. Jensen, C.B. Haver, et al., and in bulletins of the seven experimental stations involved,i.e., "Information Needs in Farm Management", D.W. Thomas and R.J. Amick, Purdue University Research Bulletin No.705,1960. A book has been written summarising the methodology and major findings - "A Study of Managerial Processes of Midwestern Farmers", G.L. Johnson, et al. (Eds), Iowa State Univ. Press, Ames, Iowa, 1961.

(6) "Agricultural Economics, Production Economics and the Field of Farm Management", Glenn L. Johnson, J. Farm Econ., Vol.39, 1957, p.441.

The conclusion reached after study of the literature pertaining to the field of management process, is that before doing research aimed at helping farmers attain their objectives, some knowledge of the relevant management process is necessary. As more is learnt about management processes used in the field of interest, research can be directed to areas of need. The relationship is dynamic and will continue to be so while we are faced with a dynamic economy.

With this brief background it is proposed to consider Farm Management research into pig-meat production in New Zealand, where the aim of such research is to assist farmers maximise their objective functions. The characteristics of pig-meat production in New Zealand are discussed and this leads to the broad description of features of likely management processes that exist in the industry. Avenues of Farm Management research will then be discussed with respect to these features.

1.2 Characteristics of Pigmeat Production in New Zealand

Pigmeat production in New Zealand is carried out under widely differing conditions, with a variety of breeds in use(7) and with different marketing opportunities - both during the season and between districts. The conditions of pigmeat production in New Zealand differ from those in other parts of the world because of the bulky nature of the main foodstuffs - skim milk (9% D.M.), whey (6.5% D.M.). The supply of these foods varies from almost zero in the winter months, to a peak in November, and then falls again as the dairying season advances.

(7) "Pig Production in New Zealand: History and Breeds", I.H. Owtram, N.Z.Jnl.of Agriculture, Vol.106,No.4, 15 April 1963, p.291.

The productive performance of the pig can be closely controlled (if desired) by the pig producer. The farrowing dates of sows can be controlled by hand mating. The subsequent litter may be weaned at 7-10 days with appropriate management(8) or at any time subsequent to this, commonly six or eight weeks. By mating directly after weaning sows may be farrowed twice yearly. The growth rate of a litter after weaning is determined to a large extent by both the rate of feeding and nature of the foodstuff (disease factors, breeding, housing, etc., will also play a part in growth rate of course). Pigs may be sold at almost any weight subsequent to weaning (where weaning occurs at 35-40 lb live weight). Pigs from 60-109 lb carcass weight are known as "Porkers", and from 110-140 lb carcass weight as "Baconers". Price of pigmeat varies during the year, general levels falling towards the end of the dairy season when farmers are forced to quit stock or over-winter them on supplementary foodstuffs. Some idea of the present relationship between pork and bacon prices are given in the following table(9):-

<u>Fat Pigs</u>

Porkers (60-109 lb)	Av. 17d. per lb.
Baconers (110-140 lb)	Av. 18½d. per lb.

Baconers Special Grading Scheme

Prime No.1	20½d.per lb.
Prime No.2	18½d.per lb.
Grade 2	16½d.per lb.

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(8) "Early Weaning of Pigs," D.M. Smith, N.Z.J.Ag., 91,No.6 1955,p.594-599.

(9) Massey University College of Manawatu; Farm Management - Guide to 1962/63 Rural Costs and Prices; p.9.

Supplementary foodstuffs are most usually thought of as substitutes for liquid dairy by-products in times of milk scarcity. Whey, however, is low in protein and is most commonly supplemented with barley or meat meal to provide a more balanced diet. A variety of foodstuffs present themselves as supplements to liquid dairy by-products: skim milk powder and buttermilk powder, meat meal and barley-meal, leafy clover pasture, sugar beet and fodder beet and carrots are, perhaps, used most commonly.

The pigmeat producer in New Zealand thus has a high degree of flexibility available in deciding on rations for pigs, feeding, and hence subsequent fattening rates, and selling weights. As mentioned above, reasonable control can also be exercised over farrowing dates, and hence pig numbers during the season.

The remaining general aspect to consider in pigmeat production is that of uncertainty.(10) At the start of the dairy season pig producers will have information on present levels of pigmeat prices and expectations as to the movement of these prices during the year. Given an "average", "poor", or "good" dairy season, the majority of producers could make reasonable estimates, from past experience, as to the quantity of whey (or skim milk) they would be likely to have available in any

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(10) Distinction between risk and uncertainty situations is made by E.O. Heady in chapter 15 of his book: "Economics of Agricultural Production and Resource Use", Prentice-Hall, Inc., N.J. 1952:- "Risk refers to variability or outcomes which are measurable in an empirical or quantitative manner,i.e. the statistical probability of a particular outcome is known with certainty. In contrast to pure risk, the probability of an outcome cannot be established in an empirical or quantitative sense for uncertainty". Although <u>some</u> of the things referred to in this section as uncertainties could be reduced to risks with adequate records, the term uncertainty will be used to refer to positions where lack of certainty about outcomes is likely to affect the management process.

month. Whether a "good", "bad" or "average" season is in store, however, will be uncertain. Uncertainty is present in the prediction of the number of piglets that will be farrowed (we might expect 7 or 8), or as to the number in a litter that will survive to weaning. Farmers are commonly uncertain as to the number and weights of pigs that will be on hand at some future date in time; naturally enough, this uncertainty will increase as the point of interest in the future is extended. Expected growth rates from a given feeding schedule may not be achieved.

Pigmeat production in New Zealand could therefore be said to be characterised by a high degree of flexibility in production possibilities. This degree of flexibility is complementary to uncertainty, also a characteristic of pigmeat production in New Zealand.

This then is a broad description of the general situation under which management processes concerned with pigmeat production are carried out in New Zealand. The objective now is to have a closer look at these management processes.

A pig production (or management) system on a farm is the result of a management process or processes, controlled by the farmer (the degree of control will vary from person to person). The endpoint of a pig production system is the sale of a number of pigs, at given weights, over a period of time. This end-point is the result of decisions involving combinations of production factors such as fattening and farrowing facilities, farrowing and fattening schedules, number of sows, labour supply, feed supplies, etc. Decision making is the focal point of the management process. The aim of Farm Management research that

concerns us - to assist farmers in the management process - implies helping farmers make the right decisions in the context of maximising objective functions.

It may be possible to categorise decisions made in a particular production process. As we will see, this knowledge of decision categories is helpful in directing research and deriving possible management systems.

Decisions are based on expectations about technological production relationships. Thus we may be interested in elucidation of technological relationships already in use, and new technologies that might widen the field of production possibilities.

Producers may wish to compare alternative management systems in terms of economics and feasibility, as an aid to decision making.

Once the relevant decisions have been made (sometimes without reference to production relationships) and the management system has been adopted, we are interested in the success or failure of the system to fulfil the expected change in the producer's objective function.

Important avenues of Farm Management research, in line with this discussion, are then:

(1) Understanding and knowledge of the categories of decision making existing in the production process.

(2) Elucidation of new and existing technical production relationships.

(3) Development and examples of methods for economic comparison of management systems.

(4) Studies of success and failure will add to knowledge on technical production relationships, and give actual measures of success of management systems.

(5) A profit objective function may be assumed and a "best" management system calculated using results from the fields of research listed above. If the resulting system is not practiced, reasons should be ascertained, with a view to detecting voids and shortcomings in the knowledge associated with (1), (2) and (3). If the feasibility of such a system is simply not well known, extension methods may well result in the stimulation of management processes leading to adoption of such a system.

The widely differing conditions of pigmeat production, and the flexibilities and uncertainties facing the producer, suggest that the second and third avenues of Farm Management research, in conjunction with the first field, offer the greatest possibilities in assisting decision making in pig production in New Zealand. These aspects are discussed at greater length in the remainder of this chapter. Difficulties associated with the derivation of a "best" management system are also discussed.

The fourth avenue of research listed applies only to management systems at present in use within the industry. Neither time nor finance was available for a study of this breadth.

1.3 Decision Making In The Process of Pigmeat Production

Decision making in the process of pigmeat production is

discussed under the following three categories:-

(a) Short term decisions.

(b) Intermediate term decisions.

(c) Long term decisions.

(a) Short term decisions: The existence of this category might be expected because of the degree of flexibility and uncertainty, already described, facing the pigmeat producer. These decisions will most likely relate to feeding and selling policies to be adopted for pigs on hand at the present time. These policies will be influenced by the number of pigs on hand, their weights, food supplies, prices of supplementary feeds, prices for various classes and grades of pigs, and expectations about these variables in the foreseeable future (i.e., might be one or two months).

(b) Intermediate term decisions: Relating to farrowing dates, fattening policies, provision of supplementary foodstuffs grown on the farm such as fodder beet, barley, etc. The contracting for future supplies of food, i.e., whey. It is possible for these decisions to be made on the basis of short term considerations, but if intermediate term planning is done then these are the likely fields of decision making.

(c) Long term decisions: Involving the general level and intensity of pig production in relation to labour and capital supply, size of farm, dairy cow numbers and possibility for expanding milk production; i.e., the place of the piggery in the general farm organisation.

The division of decision making as related to pigmeat production into three categories was entirely arbitrary, though not necessarily unrealistic. The existence of a greater

number of levels will not affect the result of the following discussion.

Each of the levels or categories of decision making will be inter-related. Thus the feeding schedules and selling programme that maximises net revenue in the next month depends on the number and weights of pigs on hand at the beginning of the month, together with expected supplies of foodstuffs and increases in pig numbers in this period. The number and weights of pigs on hand will depend on farrowing dates and feeding schedules in the past. Food supply may be an uncontrolled variable, i.e., supply of whey or skim milk, or controlled in the case of barley meal that can be purchased in any quantity at any time of the year at a given price. In turn, the number of sows farrowed and the dates of farrowing will depend on farrowing facilities and date when last farrowed.

1.4 Provision of Technological Information

Technological information is always necessary in a decision making process. Information on the technical process of production is summarised in the form of a Production Function, which aims to predict the level of output, for a given number and levels of inputs on which output is dependent. Commonly the Production Function is specified in mathematical form:

$$y = f(x_1, x_2, \ldots, x_k)$$

where we say the output (pigmeat production) y, is a function of various inputs (meal, whey, disease factors, breeding, etc.) $x_1, x_2, \ldots, x_k$; where the level of output depends on the level of the various inputs. There are problems associated with the derivation and mathematical specification of production

functions, that will be dealt with later.

1.5 Comparison of Alternatives

Alternative plans or courses of action may be compared, both economically and for feasibility, by methodological techniques that commonly use the technological information discussed in section 1.4 as part of their input. Methods for comparing production alternatives that suggest themselves in this case are -

(a) Partial budgeting,

(b) Linear programming,[11]

(c) Dynamic programming,[12]

(d) Simulation techniques.[13]

Partial budgeting and a linear programme have much in common. A series of partial budgets compare the profitability of alternative processes. Linear programming is a mathematical tool that enables the most profitable process, or combination of processes to be selected from a large number of alternatives. The concepts behind dynamic programming and simulation will become clear from the following discussion.

Having mentioned briefly the analytical techniques that we wish to use to assist in decision making, we now discuss their use with respect to the levels of decision hypothesized to exist in the pig production process.

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(11) "Linear Programming Methods" Earl O. Heady and Wilfred Candler, Iowa State University Press, Ames, Iowa, 1958.

(12) "Dynamic Programming" R. Bellman, Princeton University Press, Princeton, N.J. 1957.

(13) "Scientific Programming in Business and Industry", A. Vazsonyi, J. Wiley and Sons, N.Y., 1958, Ch.13.

1.6 Short Term Decisions - Economic Analysis

The short term position of the pig producer is characterised by his resource situation, and prices in the immediate future for pigs and foodstuffs, and the fact that reasonable knowledge exists about these variables. Under these conditions we can expect decisions to be made. For example: towards the end of the dairy season a pig producer will have a certain number of pigs of given weights on hand, feed supplies from dairy by-products will be declining, as will be the price for pigmeat. The decisions to be made will generally revolve around the question: what is the most profitable course of action to follow with the pigs on hand? Should some pigs be sacrificed at pork weights so that sufficient feed will be available to take the remaining stock to bacon weights? What are the economics of wintering pigs on supplementary foodstuffs? Perhaps it would pay to mate some pigs as gilts to be sold in-pig during winter? The right answers to these questions (and others) will depend on the resource restrictions mentioned and the technological production relationships that exist. It might be sufficient to provide a farmer with knowledge as to the growth rate that can be expected when pigs of various weights are fed different amounts of foodstuff per week, to enable him to calculate his most profitable (or desirable) short run policy. In this situation partial budgets or linear programming may be used to assist in comparing alternatives. Both these analytical methods will make use of the technological production relationships given by the pigmeat production function. At other times of the year the short run decision process may involve greater or less opportunity for alternative courses of action.

It is known that some pig producers in the Manawatu are at present successfully exploiting the flexibilities that exist in pigmeat production by making mainly short term decisions, and roughly letting farrowing dates, etc. work themselves out, the pigs being dealt with in a manner appropriate to the particular occasion. A study of pig producers using this approach may indicate special features which are necessary for the success of this management system. However, without doing such a study it is possible to imagine one such feature of this management system. The provision of cheap sources of supplementary foodstuff, notably fodder beet where labour is plentiful, could result in pig production being less dependent on a variable supply of liquid dairy by-product such as whey. The removal of the necessity to ensure that pig numbers and appetite are fitted to available feed supplies over the year is probably an essential prerequisite to the success of the management system described. Rather then, feed supply is adjusted, via the use of relatively cheap and storable supplements, to pig supplies. A series of successful decisions can thus be made in the short run.

Of course, short run decisions will be made under other circumstances, the important thing to note is that short run decisions are made, that technological relationships are usually an essential input to the decision making process and that partial budgeting and linear programming could assist in comparing alternatives - both in terms of economics and physical feasibility.

1.7 Intermediate Term Decisions - Economic Analysis

Consider briefly the characteristics of short term decisions. In the short run, the right decisions will depend

on the current resource situation, prices and expectations about future variables; the level of some being controlled by present decisions. The present resource situation is a result of past decisions. Past decisions therefore affect the profit it is possible to make in the immediate future; or, our range of present decisions is affected in part by past decisions. In the case where this situation exists (as it does in pigmeat production), the advantages that might exist in intermediate term (say 12 months) planning are obvious. This sort of economic reasoning forms the background for the analytical method of Dynamic Programming. The method applies to the production process where, what has been done in the past affects what can be done at present.(14) This is obviously the case in pigmeat production where past feeding rates will have affected the present weight of the pig, and the present weight together with feed supplies will determine the weight that can be attained at the end of the current period.

The general idea in dynamic programming is to select a period of time over which it is desired to maximise profit (or minimise cost, etc.). This period is divided up into a number of sub-periods, which might correspond to our short term decision periods. It is then possible to consider systematically the effect of making decisions in any following period. The decisions made in the last sub-period will not affect those made in prior sub-periods, we may therefore safely maximise profit for the last sub-period, subject of course to resource

(14) As well as referring to sequential decisions in time dynamic programming may refer to sequential decisions in space, or in general, to any n-dimensional problem that can be split into n one-dimensional problems.

levels at the beginning of the sub-period. These resource levels depend on decisions made the sub-period before (if they do not we have not got a "dynamic" situation), hence it is possible to make our decisions to maximise profit from both sub-periods. The process is continued backwards to the first sub-period and results in a plan that maximises profit for the whole production period. Suitable as dynamic programming sounds in theory for the planning of pig production over a period of say 12 months, severe limitations arise in practice. When there is more than one decision variable to consider in each of the sub-periods the size of the problem becomes rapidly unmanageable.(15)

As we have already discussed, pig production in New Zealand is characterised by some degree of uncertainty and a high degree of flexibility manifested in many alternative production possibilities. Where dairy by-products provide a major portion of pig food, intermediate term planning is necessary to organise pig numbers and appetite in such a way as to maximise profit from the variable feed supply. One aim, according to our definition of desirable Farm Management research, is to evolve methods of deriving plans that will

(15) Where the same parameters carry over from period to period, Candler has shown that the problem can be solved once and for all using Parametric Linear Programming: "Reflections on Dynamic Programming Models", W.V. Candler, J.Farm Econ.Vol.42 pp.920-926, Nov. 1960. However the author knows of no explicit discussion that reduces or simplifies the computational burden of dynamic programming where more than one decision variable is involved in each sub-period and where different decision variables may exist in different sub-periods..

maximise profit (or some other criterion) in any given resource/price situation. The theoretical possibility and practical problems associated with dynamic programming as such a method, have been discussed.

Linear Programming was described previously as a method of comparing the economics of alternative production processes with the aim of selecting the most profitable combination; and might therefore appear to be a suitable aid to intermediate term decision making (planning). However, the large number of production alternatives and restrictions that are, as we have noted, characteristic of pigmeat production, mean that the size of a linear programme to tackle this sort of planning becomes prohibitive. For example, consider the production situation where whey is the main source of pig food during the year. Let us divide the 12 month production period into 26 two-week periods; we may then estimate the expected quantity of whey available in each of these periods. Let us consider the unrealistic assumption that we will only produce pigs to pork weights, and that we wish to consider only three alternative rations that will enable us to do this. Sows may be farrowed, theoretically, in any of the 26 two-week periods during the year, thus each pork production ration results in 26 pork producing activities (or processes). Barley meal may be purchased in any period to supplement whey supply, and let us consider the case where we vary parametrically the total quantity of meal purchased from zero to some upper limit. Without adding any further restrictions such as fattening facilities, labour supply, etc., we have 27 restrictions, and 4 x 26 = 104 activities, (3 x 26 = 78 pork producing activities,

and 26 buying meal activities). This gives an initial matrix of 27 x 105 = 2835 elements. Although a very considerable number of these elements will be zero in the initial tableau, they may not be after several iterations. A linear programme of this size is too big for convenient analysis by electronic computers in common use in New Zealand, such as the IBM 650 which has 2000 memory cells on drum storage. (Magnetic tape storage could be used but would be time consuming.)

Even if this problem could be solved on a larger computer, it can readily be appreciated that the formulation of production alternatives was unsatisfactory, and a solution would be of relatively little use in planning pigmeat production. The size of the problem could be reduced by either considering a shorter production period, or by dividing the 12-month period into fewer sub-periods, i.e., months. However, the introduction of further production alternatives and resource restrictions to give a more realistic description of the problem again result in the capacity of computers such as the IBM 650 being exceeded.

It appears, therefore, that the size of the problem prohibits the use of linear programming for intermediate term planning of pig production in New Zealand, at least in the case where a variable supply of dairy by-product provides the main source of foodstuff. If linear programming could be used, i.e. electronic computers with sufficient fast access storage space were available, an important aspect would be the specification of alternative rations for pig production to various weights. This information is derived from the pigmeat production function.

A third and less widely understood class of analytical

methods could possibly be used for intermediate term planning for pigmeat production, where decision making may best be described as multistage. These are known as Simulation Techniques. Where distribution functions can be specified for the random variables that occur in the production process; i.e., the number of pigs per litter, the whey supply in a given month, the probability of getting a sow in pig at the first or second or third heat after weaning, etc., we have the possibility of simulating the production process. Physical production relationships will be given by the pigmeat production function. A pig production model for some period (i.e., 12 months) is set up with restrictions on labour supply during the year, fattening and farrowing facilities, number of sows, etc. Pigmeat prices at any time may be also specified in terms of a probability distribution.

The results of a simulation of the production process revolve around the answers to various questions that are asked during the run. The simulation may therefore proceed by asking how many sows are available for mating and how many of these should we mate at this time. The answers to these questions will then give subsequent farrowing dates and the numbers of piglets obtained and weaned will depend on two more questions and answers. A selected ration will result in predicted liveweight gains of the animals. Whether food supply is from whey or supplementary feed, or some combination, will depend on the expected quantity of whey available, and the competition from other animals for foodstuff, at that time; this information also being the result of questions and answers. Similarly with questions on selling weights - the answers to

which may well be determined by expected future whey supply and prices. The method of "obtaining the answers" is given by random sampling techniques; resulting in the name of Monte-Carlo for this type of simulation. Thus the value of a particular variable is obtained by random sampling the relevant probability density function. A large number of simulations (carried out on an electronic computer) results in a large number of production plans. Some results occur more frequently and with higher profits than others. We thus obtain a large number of plans and some idea of their probability of occurring, and the expected profit from each can be calculated.

Whether or not sufficient information exists for the specification of the distribution functions of some of the important variables mentioned above is not known. The possibility of using simulation techniques for an analysis of the profitability of alternative methods of pigmeat production could be the subject matter of another study.(16) This method would, however, appear to offer definite possibilities as a method of attack in intermediate term planning of pigmeat production. Once again, it would be essential to be able to predict live-weight gains from various feeding rations as an integral part of the simulation technique.

We conclude, therefore, that the nature of the problem and the methods of analysis available make intermediate term

(16) For an introductory paper on the use of simulation as a research technique in agriculture see: "An Introduction To The Use Of Simulation In The Study Of Grazing Management Problems" P.L. Arcus. Proc.N.Z. Soc. of An. Prodn. Vol.23 pp. 159 - 68, 1963.

planning a relatively uncertain proposition. If suitable methods of analysis and adequate computing facilities were available, technological information from the pigmeat production function would be an essential part of such an analysis.

1.8 Long Term Decisions - Economic Analysis

Long term decisions will be concerned with the general level of pig production that is most profitable, or meets some other requirements. Pigmeat production competes with milk production for labour, capital, and in some cases (where supplementary crops are grown) for land. In making long term decisions as to the desirable level of pig production, Budgeting and Linear Programming are analytical methods that allow the relative profitability of various levels of pigmeat and milk production to be compared. However, the apparent profitability of any level of pigmeat production will depend on how well short and intermediate term decisions have been made.

1.9 Summary

We have discussed pigmeat production with the aim of doing Farm Management research to assist pig producers in maximising their objective functions. We realise that a production process is the result of decisions made by the farmer. The uncertainty and flexibilities associated with pigmeat production have been stressed. Three levels of decision making in pigmeat production were postulated, and Farm Management research was discussed in relation to each of these levels.

1.10 Conclusions

The inter-relation between levels of decision making is evident, and it is realistic to assume that this inter-relation and the relative importance of these levels will vary between farms. However, the existence of this situation should not deter us from doing Farm Management research into problems associated with these levels of decision making.

It would appear likely in this situation that elucidation of the technological relationships that exist in pigmeat production (the pigmeat production function) would be of value in making decisions, especially in the short term.

A study of methods of economic analysis, concentrating either on some form of Dynamic Programming, or Simulation Techniques, would be of greatest value for intermediate term planning. However, the pigmeat production function is also essential to economic analysis (crude though it may be) for intermediate term planning.

Successful long term decisions can best be made when based on optimum short and intermediate term planning of the piggery.(17)

Two main fields of Farm Management research are thus seen to be:

(1) Elucidation of new or existing technical production relationships.

(2) Development and experience of methods of economic analysis.

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(17) Long term planning will often be done when these conditions are not fulfilled. This, however, could well result in less than optimum long term planning as the present profitability of pig production is sub-optimum with respect to resources in use.

In helping to decide in any particular instance which of these fields most warrants research, we should try to focus attention on the decision variables considered by farmers, and where the lack of knowledge exists that presumably hampers decisions. Time has not allowed an actual survey or case farm studies of farmers to determine these variables and knowledge voids with respect to pig production. However, it is felt that general knowledge and discussion with a few people in touch with pig production problems has been sufficient to describe fairly accurately the problem setting.

This discussion has lead to the conclusion that the correct estimation of the production function should be a primary consideration in research aimed at helping farmers make the right decisions in pigmeat production in New Zealand. The remainder of this thesis is therefore directed towards this aim.