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Contents

OPTIMAL PRODUCTION SCHEDULING IN PIG PRODUCTION*

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1. THE PROBLEM

Commercial pig production is an intensive form of farming characterised by continual changes in the economic relationships that influence profitability. Little is known about what combinations of marketing mass and therefore of final products (weaners, porkers, baconers, sausagers) will produce the greatest profits in a well-managed unit. Such determinations are complicated by cyclical and seasonal fluctuations in pigmeat prices. Decisions on marketing ages potentially influence the whole organisation of the farm enterprise, affecting among other things, such factors as scheduling of mating, utilisation of buildings and other capital goods, the application of labour, etc.

As a pig gets older from the weaner stage, the feed conversion rates and dressing percentages change. Labour requirements also change according to the ages of pigs. Various types of pigs, for example, weaners, porkers and baconers, fetch different prices per kilogram.

Porker prices, apart from a long-term rising trend, show cyclical fluctuations[1] that are more acute in the case of heavier than lighter pigs[2]. Seasonal fluctuations in pigmeat prices vary between different stages in the pigmeat cycle and between different categories of pigmeat[3]. Calculated seasonal price indices are shown in Table 1. The seasonal fluctuations imply that it might be profitable to vary the numbers of pigs marketed as well as the relationships between types of pigs marketed.

In this article an attempt will be made, given a certain set of price relationships, to draw up optimal production patterns and schedules for farmers with above-average economic and physical levels of efficiency[4].

2. RESEARCH METHOD

In this study linear programming was used to determine an optimal production pattern in pig production. A linear programming model consists of an objective function and a matrix of constraints[5].

2.1 The linear programming model

2.1.1 The objective function

The objective function is a profit-maximising function which includes the following types of activities:

2.1.1.1 Sales activities

The sales activities consist of the numbers of pigs marketed. Seven types of pigs are considered, namely, weaners (18 kg), porkers (45 kg, 60 kg and 70 kg), baconers (90 kg and 100 kg) and sausagers (125 kg). Because sales of each of these can take place in any month of the year there are 84 sales activities. The coefficients used are net sale values per pig and comprise the remainders after the marketing costs are deducted from market values.

2.1.1.2 Purchase activities

The model must also determine how much of the following inputs must be bought:

(i) Feed, expressed in kilograms. Four types of feed are of concern: sow and boar rations, creep rations, growth rations and finishing rations.

(ii) Labour hours per year, on the assumption that the same amount of labour is hired each month.

(iii) Pig-pen space, subdivided into dry-sow pens, farrowing pens and feeding pens.

* Based on an M.Sc.(Agric.) thesis by M.D. Nel at the University of Pretoria.
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The authors wish to thank Mr H.A.W. Venter, Department of Animal Production, University of Pretoria, for help in connection with animal husbandry aspects.

TABLE 1 - Seasonal price index for the following grades at the high and low points of the pig price cycle for the Johannesburg market from 1959/60 to 1973/74

Low Point of Cycle	January	February	March	April	May	June	July	August	September	October	November	December
Weaner	81,1	83,0	83,6	88,4	96,3	86,2	98,7	90,2	106,7	104,2	111,6	169,8
Super porker	94,9	94,1	93,6	102,1	100,1	98,2	104,9	101,8	100,8	101,0	94,7	103,3
Grade I porker	95,9	94,5	94,1	102,6	101,8	100,6	105,1	100,3	100,2	100,6	98,7	104,9
Grade I baconer	99,1	101,8	100,4	99,8	98,6	99,1	98,8	99,2	99,3	101,1	101,4	101,3
Grade II baconer	101,7	103,3	100,6	100,2	97,5	98,8	98,9	98,2	97,8	100,7	100,0	102,4
Sausager	97,9	102,2	100,0	106,0	103,3	106,0	99,3	90,9	93,8	97,9	100,7	101,7
High point of Cycle												
Weaner	79,2	83,4	79,8	87,8	88,5	91,2	90,6	94,8	94,1	97,7	125,8	186,4
Super porker	94,6	94,4	96,3	103,2	100,9	101,5	102,6	101,8	100,5	102,2	100,6	102,0
Grade I porker	93,9	92,8	94,8	103,4	101,9	102,0	104,8	102,4	100,2	101,3	100,4	102,1
Grade I baconer	100,8	103,0	100,2	100,0	97,7	98,7	99,3	99,3	98,5	97,9	102,4	102,5
Grade II baconer	100,0	103,1	99,4	101,6	97,1	98,0	97,9	99,2	98,2	98,2	105,0	102,4
Sausager	98,0	103,2	99,8	110,6	101,3	103,4	100,3	95,2	89,5	96,8	102,0	99,8

Source: Nel, M.D. (1975). *Optimale organisasie en skedulering in varkproduksie.* M.Sc.(Agric) thesis, University of Pretoria, p. 24

There are altogether eight buying activities in the model.

2.1.1.3 Transfer activities

Transfer activities are required to schedule production. The transfer activities, which are all included in the objective function with zero coefficients, include the following: sows mated monthly and the utilisation and idleness of labour hours and the various types of pens each month. There are 108 transfer activities in the model.

2.1.1.4 Summary

The objective function, which contains a total of 200 activities, is shown in Table 2. The objective function covers pigmeat price levels at the low point of the cycle with 1969 ruling prices.

2.1.2 The constraints matrix

In this model there are 137 constraints. The constraints matrix therefore consists of 200 columns and 137 rows. Because of the large space required, the full constraints matrix will not be presented in this article[6]. Instead, the various types of constraints will be discussed briefly and illustrated with figures.

2.1.2.1 Size of the unit

The unit is a 100 breeding sow unit.

2.1.2.2 Sales constraints

In a model such as this it is necessary to link the numbers of pigs of various weights marketed in any month to production, in other words, mating of sows, pregnancy and growth periods and mortalities. Although the marketing of pigs in one particular calendar year (year t), is being scheduled, it also in certain cases, for example, pigs marketed in January, covers scheduling or taking into account of production activities in the previous year (year t-1). These production activities include utilisation of pens and labour as well as matings. In respect of sows mated in January, pig marketings, for example, are mathematically expressed as follows, with weaner marketings as the unit:

$$8{,}25x_1 - 0{,}89x_{44} - 0{,}92x_{57} - 0{,}95x_{70} - 0{,}97x_{82} - 1{,}00x_{95} - 1{,}00x_{108} - 1{,}00x_{121} = 0$$

where: x_1 = number of sows covered in January
x_{44} = number of weaners marketed in July
x_{57} = number of 45 kg porkers marketed in August
x_{70} = number of 60 kg porkers marketed in September
x_{82} = number of 70 kg porkers marketed in September
x_{95} = number of 90 kg baconers marketed in October
x_{108} = number of 100 kg baconers marketed in November
x_{121} = number of 125 kg sausagers marketed in December

A series of constraints such as this was drawn up to cover all months.

2.1.2.3 Pen constraints

These constraints have to do with the numbers of pens required annually, utilised monthly and empty monthly. Pens appear in the objective function as buying activities. Therefore a series of constraints must be introduced to see that the unit provides enough pens for production activities. The negative coefficients of pen space in the objective function imply minimisation of purchases. The constraints see to it that in whichever month the most pens of a certain type are required, that number must be provided at the full annual cost. Three types of pens are concerned: farrowing pens, feeding pens and dry-sow pens.

The number of *farrowing pens* used in any month is linked to the number of sows mated in corresponding months. If each sow will occupy a

TABLE 2 – Objective function in simplex model

Activity		Number	Coefficient
TRANSFER ACTIVITIES			
Sows mated, Jan. – Dec.		x_1 -x_{12}	0
Feeding pens used, Jan. – Dec.		x_{159}-x_{170}	0
Feeding pens idle, Jan. – Dec.		x_{171}-x_{182}	0
Labour hours used, Jan. – Dec.		x_{184}-x_{195}	0
Labour hours idle, Jan. – Dec.		x_{196}-x_{207}	0
Dry sow pens used, Jan. – Dec.		x_{135}-x_{146}	0
Dry sow pens idle, Jan. – Dec.		x_{147}-x_{158}	0
Farrowing pens used, Jan. – Dec.		x_{13} -x_{24}	0
Farrowing pens idle, Jan. – Dec.		x_{25} -x_{36}	0
PURCHASE ACTIVITIES			
kg creep ration		x_{210}	-0,061
kg growth ration		x_{211}	-0,059
kg finishing ration		x_{212}	-0,045
kg sow and boar ration		x_{209}	-0,048
Labour days		x_{208}	-1,632
Farrowing pens		x_{37}	-35,04
Dry sow pens		x_{122}	-9,84
Feeding pens		x_{183}	-4,80
SALES ACTIVITIES			
Pigs marketed			
18 kg:	Jan.	x_{38}	-0,18
	Feb.	x_{39}	-0,11
	March	x_{40}	-0,09
	April	x_{41}	0,08
	May	x_{42}	0,36
	June	x_{43}	0,01
	July	x_{44}	0,44
	Aug.	x_{45}	0,13
	Sept.	x_{46}	0,72
	Oct.	x_{47}	0,64
	Nov.	x_{48}	0,89
	Dec.	x_{49}	2,84
45 kg:	Jan.	x_{50}	9,72
	Feb.	x_{51}	9,60
	March	x_{52}	9,55
	April	x_{53}	10,68
	May	x_{54}	10,45
	June	x_{55}	10,20
	July	x_{56}	11,12
	Aug.	x_{57}	10,70
	Sept.	x_{58}	10,47
	Oct.	x_{59}	10,56
	Nov.	x_{60}	9,74
	Dec.	x_{61}	10,84
60 kg:	Jan.	x_{62}	14,50
	Feb.	x_{63}	14,36
	March	x_{64}	14,28
	April	x_{65}	15,83
	May	x_{66}	15,52
	June	x_{67}	15,16
	July	x_{68}	16,39
	Aug.	x_{69}	16,09
	Sept.	x_{70}	15,64
	Oct.	x_{71}	15,67
	Nov.	x_{72}	14,48
	Dec.	x_{73}	16,07

Activities		Number	Coefficient
SALES ACTIVITIES			
Pigs marketed			
70 kg:	Jan.	x_{74}	16,12
	Feb.	x_{75}	15,73
	March	x_{76}	15,73
	April	x_{77}	17,46
	May	x_{78}	17,32
	June	x_{79}	17,08
	July	x_{80}	17,99
	Aug.	x_{81}	16,98
	Sept.	x_{82}	16,98
	Oct.	x_{83}	17,02
	Nov.	x_{84}	16,70
	Dec.	x_{85}	17,98
90 kg:	Jan.	x_{86}	21,36
	Feb.	x_{87}	22,07
	March	x_{88}	21,68
	April	x_{89}	21,56
	May	x_{90}	21,25
	June	x_{91}	21,36
	July	x_{92}	21,29
	Aug.	x_{93}	21,43
	Sept.	x_{94}	21,43
	Oct.	x_{95}	21,87
	Nov.	x_{96}	21,94
	Dec.	x_{97}	21,94
100 kg:	Jan.	x_{98}	23,32
	Feb.	x_{99}	23,66
	March	x_{100}	22,94
	April	x_{101}	22,88
	May	x_{102}	22,09
	June	x_{103}	22,44
	July	x_{104}	22,54
	Aug.	x_{105}	22,30
	Sept.	x_{106}	22,16
	Oct.	x_{107}	22,94
	Nov.	x_{108}	22,79
	Dec.	x_{109}	23,45
125 kg:	Jan.	x_{110}	24,56
	Feb.	x_{111}	25,78
	March	x_{112}	25,15
	April	x_{113}	26,86
	May	x_{114}	26,13
	June	x_{115}	26,86
	July	x_{116}	24,93
	Aug.	x_{117}	22,53
	Sept.	x_{118}	23,36
	Oct.	x_{119}	24,56
	Nov.	x_{120}	25,34
	Dec.	x_{121}	25,68

farrowing pen for a period of 1,6 months 3,6 months after being mated, for example, it is evident that farrowing pens used in January must be linked with sows mated in August and September as follows:

$$0{,}68x_8 + 1{,}0x_9 - 1{,}03x_{13} = 0$$

where x_8 = sows mated in August
x_9 = sows mated in September
x_{13} = farrowing pens used in January

The number of pens used and idle each month is equal to the number purchased:

$$1{,}0x_{13} + 1{,}0x_{25} - 1{,}0x_{37} = 0$$

where x_{13} = farrowing pens used in January
x_{25} = farrowing pens idle in January
x_{37} = farrowing pens purchased

A set of constraints such as this was drawn up for each month.

A sow uses only two types of pens: *farrowing pens* and *dry-sow pens*. With 100 sows as a constraint, in any month the farrowing pens used plus the dry-sow pens used must equal 100. Although a sow and her farrow occupy a farrowing pen jointly for 1,6 months, the sow herself spends only 1,3 months, in other words approximately 0,9 of the total utilisation time, in the farrowing pen. In this way the following equation is derived for January:

$$1{,}0x_{135} + 0{,}9x_{13} = 100$$

where x_{135} = dry sow pens used in January
x_{13} = farrowing pens used in January

Similar equations were drawn up for each month. Use and idleness of dry-sow pens are linked to purchase in a similar way as in the case of farrowing pens.

Feeding pens consist of growth and finishing pens. The number of pens needed monthly is expressed as percentages of a 125 kg sausager and fixed cost per feeding pen space serves as a basis for the equation. Mortality is also taken into account and equations of the following type are used:

$$0{,}61x_{86} + 0{,}5x_{87} + 0{,}33x_{88} + 0{,}3x_{89} + 0{,}07x_{90} - 1{,}0x_{159} = 0$$

where x_{86} = number of 90 kg baconers marketed in January
x_{87} = number of 90 kg baconers marketed in February
x_{88} = number of 90 kg baconers marketed in March
x_{89} = number of 90 kg baconers marketed in April
x_{90} = number of 90 kg baconers marketed in May
x_{159} = feeding pen space used in January

In a similar way equations were obtained for other months and marketing masses. Feeding pen space used and idle each month is linked to total purchases in a way similar to the method used for farrowing pens.

2.1.2.4 Labour constraints

The model also attempts to indicate how many labourers must be employed full time. Labour constraint equations are deduced from required labour hours per month per pig over the whole growth and feeding period, taking mortality into account. Labour hours used in January are linked as follows to baconer production:

$$0{,}43x_{86} + 0{,}44x_{87} + 0{,}63x_{88} + 0{,}69x_{89} + 0{,}86x_{90} + 0{,}87x_{91} + 0{,}1x_{92} + 0{,}1x_{93} + 0{,}1x_{94} + 0{,}07x_{95} - 1{,}0x_{184} = 0$$

where x_{86} = 90 kg baconer marketed in January
x_{87} = 90 kg baconer marketed in February
x_{88} = 90 kg baconer marketed in March
x_{89} = 90 kg baconer marketed in April
x_{90} = 90 kg baconer marketed in May
x_{91} = 90 kg baconer marketed in June
x_{92} = 90 kg baconer marketed in July
x_{93} = 90 kg baconer marketed in August
x_{94} = 90 kg baconer marketed in September
x_{95} = 90 kg baconer marketed in October
x_{184} = Labour hours used during January

Equations for all the other months' marketing masses were obtained in the same way.

The labour hours used and idle each month are linked to the number that must be employed in a way similar to the method used for farrowing pens.

2.1.2.5 Feed constraints

These constraints were introduced to ensure that feed purchases (a purchase activity again) are linked to the requirements of pigs of various ages, taking mortality into account. Provision was made for sow and boar rations, creep rations, growth rations and finishing rations.

2.2 Assumptions and premises used

An analysis such as this must of necessity be based on assumptions that relate mainly to a certain level of technical efficiency, as reflected in physical input and output data. Certain assumptions about prices must also be made. In this case it is accepted that the cycle is at its low point with prices such as those that obtained in 1969 and that seasonal price indices will obtain as shown in table 1.

Certain assumptions are also made to simplify a model. Such assumptions include in this case the following:

2.2.1 There are no capital constraints.

2.2.2 It is accepted that each month consists of 30,5 days and that certain activities that take place in a specific month - for example, the mating of sows - take place on the 15th day of the month.

2.2.3 There are no problems regarding market quotas.

2.2.4 It is accepted that the planning for marketing scheduling for a particular year is done the previous year because marketing in year t follows partly on production activities that took place in year t-1.

2.2.5 The replacement of sows is not taken into account. It is accepted that replacement takes place at a constant rate, that culled sows are sold at constant prices and that over and above the number of pigs ready for marketing there are enough additional young sows of high quality for this purpose.

2.2.6 Transport costs are accepted as given and constant.

2.2.7 It is assumed that the farmer employs only regular labour appointed on an annual contract.

2.2.8 The feed pens are flexible in the sense that partitions between pens can be added or removed as the situation requires.

2.2.9 A boar to sow ratio of 1:20 is maintained. A boar is used for four years and a sow for 5 farrows.

2.2.10 In order to transform a continuous process such as pig production into a discrete process that ends in one year's pig production it is accepted that the same organisation is kept to for two consecutive years - for example, the year before the low point of the cycle and the year when the low point is experienced.

2.2.11 A uniform production method and cycle is accepted, based on the opinions of Kemm[7,8] and four specialist pig farmers in the Witwatersrand-Pretoria area who were visited during July 1974.

In this system sows and boars are kept in individual pens and the boars are taken to the sows for mating. The sows stay in the individual sow pens after mating until four days before farrowing, when they are transferred to farrowing pens. They remain there until the farrows are 5 weeks old. At this stage they are taken back to the sow pens. Normally they can be covered again between four and ten days after this return.

Farrows remain in the farrowing pen until they are six weeks old. Thereafter they are transferred to a feeding pen where they remain until they are three months old, after which they are transferred to finishing pens.

Expressed in terms of days, the commercial sow and commercial pig production cycle is as follows:

Consecutive days	Particulars
1	Sow is mated
110	Sow is taken to farrowing pen
114	Sow farrows
149	Farrow weaned at 5 weeks - sow taken back to sow pens
155	Sow can be mated again
156	Farrow to growth pens at age of 6 weeks - remains here until three months of age
170	Piglets now 8 weeks old - 18 kg weaner
224	Pigs 110 days old - 45 kg porker now goes to finishing pens.
240	Pigs now 126 days old - 60 kg porker
254	Pigs 140 days old - 70 kg porker
289	Pigs 175 days old - 90 kg baconer
309	Pigs 195 days old - 100 kg baconer
339	Pigs 225 days old - 125 kg sausager.

2.2.12 A further group of assumptions regarding technical coefficients was obtained from a variety of publications[9] and is given in Table 3.

As regards mortality, it was accepted that 1,126 weaners are required to produce one baconer.

From this information and from information obtained by Smith[10] a table was drawn up that was used in the analysis to reflect feed consumptions per pig under good management conditions (Table 4).

2.2.13 As regards labour coefficients, data obtained from four specialist pig farmers were used. Wage figures gathered during 1974 were deflated to 1971 and 1969. The labour coefficients appear in Table 5.

2.2.14 Both mortalities and cost of pens were obtained from the four farmers already mentioned.

TABLE 3 - Total feed consumption per commercial pig, taking mortality into account

	18 kg	45 kg	60 kg	70 kg	90 kg	100 kg	125 kg
Creep ration (kg)	6	6,2	6,4	6,6	6,75	6,76	6,77
Growth ration (kg)	12	78,6	81,3	83,2	85,6	85,7	85,8
Finishing ration (kg)			59,8	97,2	176,0	228,3	365,7

TABLE 4 - Technical coefficients in pig production

Live marketing masses	Carcass mass[1,2]	Grade	Slaughter percentage[1,2]	Age in days from birth[1]	Feed: Meat conversion rate[1,2]	Farrows per year[3]	Pigs marketed year/farrow[1,3,4]
kg	kg		%				
18	11,8	Weaner	66	56	2:1	2,18	9,3
45	31,5	Super porker	70	110	2,45:1	2,18	9,0
60	43,2	Super porker	72	126	3:1	2,18	8,7
70	52	Porker Grd.I	74,3	140	3,1:1	2,18	8,5
90	69,3	Baconer Grd. I	77	175	3,3:1	2,18	8,25
100	78	Baconer Grd.II	78	195	3,5:1	2,18	8,25
125	100	Sausager	80	225	4:1	2,18	8,24

Source: 1. Kemm, E.H., *op. cit.*
2. Rhodesia Pig Industry Board, *op. cit.*
3. Four intensive specialist pig farmers visited in Witwatersrand-Pretoria area, July 1974
4. Kassier, W.E., *op. cit.*, p. 6

TABLE 5 - Labour coefficients

Type of pig	Labour hours per pig per month
Dry sow and boar	0,83
Sow in farrow	7,91
Weaner -18 kg	0,64
45 kg pig	0,62
60 kg pig	0,43
70 kg pig	0,43
90 kg pig	0,43
100 kg pig	0,43
125 kg pig	0,43
Hours of labour per week per labourer	56,5
Wage per hour	c
1974	25,0
1971	17,4
1969	13,6

3. EMPIRICAL RESULTS AND DISCUSSION

The IBM company's MPS routine was used to solve the model on the University of Pretoria's IBM 370 computer.

Results are given in a condensed form in Table 6. The condensed form is used to save space. Where there was no variation between months in the solution, separate provision was not made in Table 6 for each month. Certain activities that assumed zero values in the solution were also not included in the table.

The results reflect one of the shortcomings of the simplex model, namely, the fractional form in which the activities appear in the solution. Integer programming under many circumstances offers a solution to this problem. Its use enlarges the model

TABLE 6 - Optimum organisation in a 100 sow unit at the low point of the pig price cycle

Activity	Level
Profit figure*	6 381,98
Number of sows mated each month	18,18
Number of farrowing pens needed	29,09
Number of farrowing pens idle	0
Dry-sow pens needed	73,82
Dry-sow pens idle	0
Number of sows dry each month	73,82
Rations	
Sow and boar (kg)	99 308
Creep feed (kg)	12 182
Growth (kg)	154 060
Finishing (kg)	213 097
Pigs sold	
18 kg weaners (each month)	0
45 kg porkers (each month)	0
60 kg porkers:	
January	34,0
February	90,0
March	0
April	157,9
May	89,6
June	2,3
July	157,9
August	157,9
September	39,1
October	79,0
November	0
December	157,9
70 kg pigs (each month)	0
90 kg baconers:	
January	0
February	117,7
March	64,5
April	150,0
May	0
June	64,9
July	147,8
August	0
September	0
October	112,9
November	74,9
December	150,0
100 kg pigs (each month)	0
125 kg sausagers (each month)	0

Activity		Level
Labour hours per month purchased		610
Labour hours used:	January	571
	February	610
	March	610
	April	608
	May	556
	June	610
	July	600
	August	535
	September	566
	October	607
	November	610
	December	603
Labour hours idle:	January	39
	February	0
	March	0
	April	2
	May	54
	June	0
	July	10
	August	75
	September	44
	October	3
	November	0
	December	7
Total labour hours idle per year		234
Feeding pens purchased		225
Feeding pens used:	January	167
	February	225
	March	220
	April	225
	May	151
	June	220
	July	225
	August	130
	September	165
	October	225
	November	225
	December	225
Feeding pens idle per month:		
	January	58
	February	0
	March	0
	April	0
	May	74
	June	5
	July	0
	August	95
	September	60
	October	0
	November	0
	December	0
Idle feeding pen capacity per year		297

* Depreciation and interest on breeding pigs is not taken into account

considerably, however, and therefore also increases the cost in computer time. In addition, many available integer linear programming routines do not necessarily give integer solutions[11] and sometimes no solutions are obtained because the computer can get into cycle between two or more potential optimal solutions[12]. In view of the above and of the size of the matrix of constraints it was decided not to apply integer programming in this analysis.

In Table 6 a profit figure of R6 381,98 is shown. This, however, does not represent the net profit payable from a 100 sow unit. Fixed costs of breeding animals and the animals that replace them and of pens for the replacement animals amount to R1 917,12, which results in a net income of R4 464,86, without taking into account general overhead costs and land values. Total capital investment (excluding land) for the unit amounts to R21 646, which means that the net income per R100 of capital is an amount of R20,63.

Although the model makes provision for matings to be scheduled, the results show that this is not necessary. It is therefore necessary to try to produce the maximum number of pigs per sow and this requires mating as soon as a sow comes into heat after her farrow is weaned. This simplifies management and results in dry-sow and farrowing pen space being fully utilised throughout the year.

The results also show that weaner sales and those of lighter porkers (45 kg) are not profitable; the value added in the form of meat makes it profitable to feed pigs until they reach a weight of 60 kg at least. Heavier porkers (70 kg) also do not appear in the solution. A pig must be sold as a medium mass porker or be fed to the light baconer stage of 90 kg. It is also not profitable to feed a pig until it reaches the heavy baconer or the sausager stage; the marginal value product is smaller than marginal costs.

Differential seasonal fluctuations in pigmeat prices, however, mean that marketing should be scheduled between 60 kg porkers and 90 kg baconers to maximise profit. Another result is that total pig production will vary from month to month. For example, in December and April 308 pigs (158 porkers and 150 baconers), will have to be marketed and in July 306 pigs (158 porkers and 148 baconers). By contrast, deliveries in January and September, respectively, will amount to only 34 and 39 pigs, all porkers.

This results in labour and feeding pen requirements differing from month to month. Labour will be fully utilised for only four months and feeding pens for only 6 months. The greatest under-utilisation of both will occur in August - an under-utilisation of 12 and 42 per cent, respectively. This under-utilisation could be useful for management purposes in that repair work could be done. In addition, leave times of labourers could be scheduled to coincide with times when under-utilisation can be expected - in the months of January, May, August and September.

The results show indisputably that it would be profitable for a commercial pig farmer to schedule his marketing activities, taking into account seasonal fluctuations in pigmeat prices.

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(4) In a later article the effect of changes in relative price levels will also be analysed.

(5) See HEADY, EARL, O. & CANDLER, WILFRED (1963) Linear programming methods. Iowa State University Press, Ames.

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