Poultry

UNIVERSITY OF READING

DEPARTMENT OF AGRICULTURAL ECONOMICS

Choosing a Policy of Stock Replacement in Commercial Egg Production

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Miscellaneous Study No. 38

March 1965

Price 5/-

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INTRODUCTION

Traditionally, poultry keepers in Britain have replaced their laying stock annually selling their old birds in the summer and restocking with point-of-lay pullets. This policy was adopted because the spring hatched (late summer housed) bird was the most productive. With pre-war stock and management methods, birds hatched at other times of year tended to go into a moult in the autumn and, therefore, produced fewer eggs.

The situation today is quite changed. Poultry keepers using new management techniques expect the same production from their birds regardless of when they are housed. The producer can now plan his replacement policy to take advantage of the seasonal variation in egg prices. Or, if he rears his own replacements, by rearing a number of batches of pullets each year instead of a single batch he can reduce the cost of housing and equipment depreciation per bird reared and so increase profits: alternatively he can adopt systems of production - for example rearing birds in the houses they are intended to occupy as layers - which are attractive on technical grounds but which were not possible with traditional management methods because the flock cycle is much longer than a year.

These opportunities have been recognised, but the advantages and disadvantages of different replacement policies have not been studied in detail. If point of lay replacements are purchased when should they be housed? How much is gained if housing at the right time of year is achieved? If replacements are reared on the farm, how much can be gained by rearing a number of batches of pullets each year? Is this more or less than is sacrificed by adopting a rigid replacement policy? There is no general answer to these questions. The answer depends upon the resources at the farmers command, the standards of performance he can achieve, his attitudes to future changes in economic circumstances and many other factors.

This paper is intended as an introduction to the study of choosing a replacement policy. The first and major part is concerned with a discussion of how the problem can be tackled. Hypothetical examples are analysed and the results discussed. The second part shows how variations in flock performance and farm circumstances affect the results of the analysis.

The selection of an optimal replacement policy can be a difficult problem demanding sophisticated selection techniques. These sophisticated techniques are not described here in detail. This is partly because these techniques require an electronic computer and cannot, therefore, be used by most farmers, and partly because the solutions they suggest are only slightly better than those that can be obtained when simpler techniques are used.

The problem - choice of system and choice of policy

Choosing a replacement policy for a single farm involves two decisions. Firstly a system of providing replacements has to be chosen. Replacements can be purchased at point of lay (P.O.L.) or reared on the farm. If reared on the farm they can be reared in a separate rearing unit or they can be reared in the house they are intended to occupy later as layers. If a separate rearing unit is used it may be one capable of producing one or several batches of replacements each year. The system chosen influences the capital structure of the enterprise and the type of replacement policy that can be adopted. Secondly a decision has to be made on what time (or times) of the year birds are to be housed and on what length (or lengths) of time they are to be kept. A choice of housing date and length of season for a single flock is referred to as a replacement 'plan'. A sequence of 'plans' constitutes a replacement 'policy'. The distinction between a replacement 'plan' and a replacement 'policy' is important. A 'plan' is part of a 'policy' and the profitability of an individual 'plan' is important only in so far as it affects the profitability of the 'policy' as a whole.

The choice of system of providing replacements cannot be made until the optimal policy for each system has been established. Selecting the optimal replacement policy for any one system consists of three processes: forecasting prices and the levels of bird performance expected, budgeting the outcome of alternative courses of action and selecting the optimal from these alternatives. The method of analysis varies with the system of providing replacements.

Choice of policy

Method one - The choice of a replacement policy when P.O.L. replacements are purchased.

Where P.O.L. replacements are purchased the farmer can house his birds at any desired date and keep them for any desired length of time.

The number of alternative plans that need to be assessed depends on the degree of accuracy which the planner considers to be necessary. If only a few plans are considered feasible these can be assessed from a few simple budgets; if, however, a wider review of possibilities is required the number of budgets required increases rapidly and a systematic approach is desirable. Probably the most comprehensive coverage that the accuracy of forecasting justifies is one where it is assumed that the flock can be housed at any one of 13 dates spread at four weekly intervals through the year and kept in lay for any one of seven season lengths from 40 weeks to 64 weeks. This is the coverage adopted in the analysis below.

With this coverage the profitability of 91 plans needs to be assessed. Where it can be assumed that (a) the pattern of costs incurred does not vary with the time of year at which the flock is housed (b) the production of the flock in physical terms is identical regardless of when it is housed (c) the forecasts of egg prices for future years show a repeating seasonal pattern, the necessary budgeting can be done in a systematic way. Where these assumptions are not tenable, that is where controlled or semi-controlled environment houses are not used or where the planner believes that the seasonal pattern in egg prices will not repeat in future years, the methods of analysis described below are inappropriate.

To illustrate the way in which an optimal replacement policy can be selected when P.O.L. replacements are purchased, the analysis of a hypothetical farm situation is presented.

The performance of the flock - this is a performance that might be expected from birds of the light hybrid type - is assumed to be as follows:-

1. Egg numbers: production rises to 90% (hen housed) in the third four week period of lay, and falls at a rate of 0·8% (hen housed) per week. Thus after 48 weeks the flock lays at a rate of 61%.

2. Egg size: the estimate of grading was obtained by averaging the grading of six flocks having the poorest grading in a recent national laying trial.

3. Mortality: the percentage of deaths is expected to exactly equal the percentage increase in body weight of the birds as they mature and grow older.

The prices that are expected to apply are the actual British Egg Marketing Board minimum prices to producers in 1961. These were used as being representative of the seasonal price fluctuation witnessed in recent years.* Further assumptions necessary for constructing the budgets were:-

1. P.O.L. birds are purchased for 18s.0d each. The carcass value of the flock at whatever age it is sold is equal to 5s.6d. per bird housed.

2. Food cost remains constant at 30 pence per bird housed per four week period. The tendency for older birds to eat more is balanced by mortality.

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* To check on the representativeness of egg prices in 1961, many of the calculations reported in this paper were repeated using 1960 and 1962 prices. Only minor differences resulted.

3. Fixed costs - labour, building and equipment depreciation, electricity, water etc. - total 10 pence per four week period per bird space.

4. A clear-out and rest period occurs after each flock. This is always of four weeks' duration. Thus each flock must carry fixed costs for one period longer than the length of time it is in lay.

With these estimates of performance, costs and prices the necessary budgets can be calculated in the following steps.

1. Construct a cost schedule as illustrated in Table I to show what total costs would be if the flock was kept for each feasible length of season.

2. Construct a table of egg incomes showing what this would be for each of the 91 plans. The results are shown in Table II. The table is made up of thirteen egg income schedules, one for each feasible date of housing. They differ from each other because the eggs produced by birds housed at different times of year are valued at different prices.

3. Construct a table showing the rate of profit obtained when each of the 91 plans is adopted - Table III. This is constructed by subtracting the relevant cost figure in Table I from each entry in the Egg Income Table and dividing the result - which is total profit expected for that plan - by the number of periods the plan operates (the number of periods the flock is in lay plus one period for clearing out and resting the house). Thus the rate of profit if the flock is housed on January 1st and kept in lay for 40 weeks is (619 - 570) ÷ 11 = 4·5 pence per bird space period.

Table I.

Cost schedule

Length of laying season	Costs in pence per bird space			
	Non-repetitive*	Fixed	Food	Total
(weeks)				
40	160	110	300	570
44	160	120	330	610
48	160	130	360	650
52	160	140	390	690
56	160	150	420	730
60	160	160	450	770
64	160	170	480	810

* Non-repetitive costs include installation and clearing out expenses as well as bird depreciation. They occur once in the life of the flock.

Table II

Egg Incomes

(income in pence per bird housed)

Date of housing at P.O.L.	Length of laying season in weeks.						
	40	44	48	52	56	60	64
1st January	619	691	762	822	876	924	966
29th January	624	698	761	819	870	915	956
26th February	632	698	759	813	860	904	943
26th March	635	699	756	806	852	893	936
23rd April	634	694	747	796	840	886	932
21st May	626	682	734	781	830	879	929
18th June	611	665	714	765	817	870	923
16th July	598	650	704	760	816	873	929
13th August	584	641	700	760	820	879	933
10th September	582	644	707	771	834	891	947
8th October	588	655	722	789	850	909	959
5th November	600	671	742	807	870	923	971
3rd December	608	682	750	817	873	924	969

Table III shows the rate at which profit is earned when each one of the 91 plans is followed. It does not show directly the profitability of alternative policies. It provides the information from which these can be assessed.

Table III

Profit Rates
(Profit in pence per bird space per four week period)

Date of housing at P.O.L.	Length of laying season (in weeks)						
	40	44	48	52	56	60	64
1st January	4·5	6·7	8·6	9·4	9·7	9·6	9·2
29th January	4·9	7·3	8·5	9·2	9·3	9·0	8·6
26th February	5·6	7·3	8·4	8·8	8·7	8·4	7·8
26th March	5·9	7·4	8·2	8·3	8·1	7·7	7·4
23rd April	5·8	7·0	7·5	7·6	7·3	7·3	7·2
21st May	5·1	6·0	6·5	6·5	6·7	6·8	7·0
18th June	3·7	4·6	4·9	5·4	5·8	6·3	6·6
16th July	2·6	3·3	4·2	5·0	5·7	6·4	7·0
13th August	1·3	2·6	3·8	5·0	6·0	6·8	7·2
10th September	1·1	2·8	4·4	5·8	6·9	7·6	8·1
8th October	1·6	3·7	5·5	7·1	8·0	8·7	8·8
5th November	2·7	5·1	7·1	8·4	9·3	9·6	9·5
3rd December	3·5	6·0	7·7	9·1	9·5	9·6	9·4
Average for all dates of housing	3·7	5·4	6·6	7·4	7·8	8·0	8·0

This table cannot be used to assess the profitability of policies in which the laying house is left empty for more than the normal four week clear-out period. For example a flock housed on January 1st and kept in lay for 56 weeks must be followed by a flock housed on February 26th - that is 4 weeks after the first flock is cleared out.

Two kinds of replacement policies can be distinguished. The first includes policies where the sequence of plans is cyclical, i.e. where a given sequence of plans is repeated. The second includes policies where the sequence of plans is not cyclical. Policies in which the sequence of plans is cyclical will be referred to as stable policies. There are three types of stable policies:- (a) Policies where the flock has a laying cycle of exactly a year (a laying cycle is the time between the housing of one flock and the housing of its successor). In these policies the plan or plans adopted in the first year are repeated in all subsequent years. (b) Policies where each flock is kept for the same length of time but where the laying cycle is not exactly one year. Each year birds are housed at a different date. Over a number of years each housing date is used and the cycle of plans is completed. (c) Policies where each flock is not kept for the same length of time but where a cycle of flock lives is completed which is repeatable.

These policies are termed 'stable' because the cycle and therefore the profit rate earned during the cycle can be repeated indefinitely.

The profitability of policies of each of these three types can be calculated from the 'profit rates' table. The profitability of policies of type (a) are listed in the column headed '48 weeks'. For example, the profitability of a policy where the flock is housed each year in late May is 6·5 pence per bird space per four week period. The profitability of policies of type (b) can be seen in the 'average for all dates of housing' row at the bottom of the table. For example if each successive flock is kept for 40 weeks of lay the average profit earned during a cycle is 3·7 pence per bird space period. The profitability of policies of type (c) must be assessed individually. For example if the cycle consists of three flock lives (three plans) where the first flock is housed on December 3rd and kept in lay for 52 weeks (a flock life of 56 weeks or 14 periods) the second is housed on January 1st and kept in lay for 52 weeks and the third housed on January 29th and kept in lay for 40 weeks, the profitability of the cycle is calculated as the weighted average of the profitability of the component plans, i.e. [(9·1 x 14) + (9·4 x 14) + (4·9 x 11)] ÷ 39 = 8 pence per bird space period.

If the stable policy selected as optimal has a very long cycle it may be argued that before a single cycle has been completed price and performance expectations may change with the result that the policy becomes sub-optimal. This risk of taking the wrong decision because of inaccurate forecasting is inherent in all economic planning. The longer the planning period the greater the risk. Because of this a policy with a short cycle may be preferred to one with a long cycle even if the average profitability of the long cycle is higher. This would be particularly likely if the first few plans in the long cycle were less profitable than the average for the cycle.

Two further points are relevant to this question of cycle length and risk. Firstly optimal replacement policies rarely involve a cycle length of more than three or four years and where they do the cycle as a whole is usually made up of sub-cycles in which profit approximates the average profit for the whole cycle. For example where each flock is kept for 60 weeks of lay a cycle is completed after 13 flock lives (nearly 17 years). With this policy each flock is housed 12 weeks later in the year than its predecessor. Thus after three flock lives a sub-cycle is completed which shows an average profit similar to the average profit earned over the full cycle. Secondly if because of changing circumstances a new policy becomes necessary there is no reason to expect that changing from a policy with a long cycle will be more difficult than changing from one with a short cycle.

Selecting a replacement policy is not simply a question of finding the optimal stable policy for a particular flock. Unless, at the time of planning, it is found that the date at which the existing flock was housed is the same as that used in one of the plans in the optimal stable policy, a transitional policy will be necessary to effect the change from the old to the new policy. The sequence of plans in the transitional policy will not be cyclical.

An analysis of Table III shows that the optimal stable policy for the case study flock is one where replacements are housed annually on January 1st. This policy results in a profit of 8·6 pence per bird space period, i.e. 9s.4d. per bird space per year. It is apparent that this policy is more profitable than any other of either type (a) or type (b). It is not apparent that it could not be bettered by a policy of type (c), but this can be verified by evaluating the profitability of policies of type (c).

This result is significant. The hypothetical flock is one with good production, poor grading, a moderate to slow rate of fall-off in production after the peak, and it carries fairly high non-repetitive costs. These are all characteristics which tend to encourage a long laying season. (The reasons why this should be so are discussed later). Because of this the high returns in the profit rates table are found in the columns relating to plans where the season length is long. For this case study flock, the length of laying season giving the best profit when all housing dates are used is 60 weeks. (Although it is not shown in Table III this is fractionally better than that for 64 weeks). Even so, the optimal stable policy when P.O.L. replacements are purchased is one of type (a). This results because the variation in the profitability of plans with the same housing date but different lengths of laying season is less than the variation between plans with the same length of season but different dates of housing. If the flock is kept for a length of season greater than 48 weeks the date of housing for successive flocks must be different. In years when birds are housed at a favourable date the profit rate earned is better than that earned when the optimal policy is followed, but in years when the birds are housed at an unfavourable date the profit is lower and the net result is a lower average profitability.

Where flock performance does not favour a long laying season the high values in the profit rates table occur in the centre of the table, that is in the columns relating to shorter laying seasons. Under these circumstances the optimal policy for a flock where P.O.L. replacements are purchased is more certain to be one of type (a). There is no foolproof and simple way of determining for an individual flock whether the optimal policy is one of type (a) or type (c). (a policy of type (b) is most unlikely to be optimal). An indication is provided by the relationship between the highest figure in the "48 week" column and the highest figure in the "average of all housing dates" row of the "profit rates" table for the flock concerned. If the former is 5% or more greater than the latter a policy of type (a) is probably the optimal. The greater the difference the more certain will this be.

The advantage of choosing the right stable replacement policy can be seen for the hypothetical flock from Table III. The best policy of type (b) is 7% less profitable than the optimal. A policy of annual bird replacement in August - a policy described above as 'traditional' - results in a total profit per bird space per year of 3·8 pence x 13 = 4s. - 1½d. i.e. only 44% of the profit earned with the optimal policy.

The optimal transitional policy depends upon the date at which the existing flock was housed, or, if it is a unit being stocked for the first time the date at which the unit becomes operational. Selection is again based on the information in the 'profit rates' table. For example if when the analysis of the case study flock was done, the existing flock had been housed in July, the optimal transitional policy would be to keep that flock in lay for 64 weeks and the succeeding flock, which would be housed in November, for 56 weeks. The average rate of profit earned during the period of this transitional policy would be the weighted average of the profitability of the two plans included. i.e. (7·0 pence x 17) + (9·3 pence x 15) ÷ 32 = 8·1 pence per bird space period.

With this method of analysis there is no systematic procedure for selecting the optimal transitional policy. The number of likely alternatives however is usually small.

Method two - Choosing a replacement policy when birds are reared in the house they later occupy as layers.

The system of production where birds are kept in the same house from day-old to the end of their laying life is used primarily for the effect it is believed to have on the performance of the birds. To assess the improvements in performance that are associated with this system of production is beyond the scope of this paper. The question that is relevant is - how, with this system of production, should a replacement policy be chosen?

To illustrate the method of analysis a second case study is presented. It is assumed that the expected performance of the flock in the laying stage and the expected level of costs and egg prices are the same as in the previous case study. In addition it is assumed that:-

(a) the length of time necessary for rearing birds to P.O.L. is 20 weeks i.e. 5 four week periods.

(b) the fixed costs associated with the unit cannot be reduced during the rearing period.

(c) a clear-out and rest period between flocks of four weeks is still sufficient.

(d) the cost of rearing a P.O.L. replacement is 14s. - 5d.

This total is made up of 6s. - 3d. for food, 4s. - 2d. fixed costs (derived from assumptions (a) and (b)), 4s. - 0d. cost of day old chicks per replacement reared.

With these estimates a 'profit rates' table can be constructed in a similar way to that demonstrated in the first case study. The new table (Table IV) differs from the previous table (Table III) firstly because the cost of the P.O.L. replacement is lower, i.e. 14s. - 5d. instead of 18s. - 0d., and secondly because the gross profit expected for each 'plan' to be expressed as profit per bird space period, must in this new situation be divided not by the number of periods in the laying cycle, but by the number of periods in the rearing plus laying cycle.

Table IV

Profit Rates Case 2
(Profit in pence per bird space per four week period)

Date of housing at day old	Length of flock life in weeks					
	64	68	72	76	80	84
1st January	7·4	7·6	7·6	7·7	7·7	7·8
29th January	6·4	6·5	6·7	7·0	7·3	7·6
26th February	5·5	5·9	6·5	7·0	7·4	7·8
26th March	4·9	5·7	6·5	7·1	7·7	8·0
23rd April	5·1	6·1	7·1	7·8	8·3	8·6
21st May	5·8	6·9	8·0	8·7	9·1	9·2
18th June	6·7	8·1	8·9	9·6	9·8	9·7
16th July	7·4	8·5	9·5	9·8	9·9	9·6
13th August	7·9	9·2	9·7	10·0	9·9	9·5
10th September	8·3	9·1	9·6	9·7	9·4	9·1
8th October	8·3	9·0	9·3	9·1	8·9	8·5
5th November	8·4	8·8	8·9	8·8	8·4	8·1
3rd December	8·1	8·3	8·4	8·1	8·1	8·0
Average for all dates of housing	6·9	7·7	8·2	8·5	8·6	8·6

Selecting the optimal stable policy for a unit where birds are kept from day old to culling in the same house is more difficult than when P.O.L. replacements are purchased. This is because the optimal stable policy is almost certain to be one of type (c). A policy of type (a) is most unlikely to be optimal. With it the laying season would have to be either 28 weeks (if the flock cycle is one year) or 80 weeks (if the flock cycle is two years).

Table IV shows that for the example flock the best policy of type (b) is one where flocks are kept for 80 weeks (20 weeks in the rearing and 60 weeks in the laying stage). This results in an average profit rate of 8·6 pence per bird space period. The cycle is complete after 13 successive flocks, each housed at different dates, have completed their production cycles.

This policy can be improved by shortening some and lengthening other flock lives. It is then of course a policy of type (c). For example, for two flocks in the cycle, one housed in February and the other, its immediate successor, housed in October, the average profit rate is 8·1 pence per bird space period. If the flock housed in February is kept for 84 instead of 80 weeks, and the following flock, now housed in November, is kept for 76 weeks the average rate of profit for the period is increased to 8·2 pence per bird space period. Other modifications are possible which increase profit, but the total improvement possible is very small.

There is in fact, no systematic and simple method that the farmer or field advisor can use for selecting the actual optimal policy. The best policy of type (b) is a close approximation in terms of profitability and this can usually be improved as illustrated in the example above. But finding the true optimal out of the many alternatives possible involves a lot of calculation, probably more than is usually justified. A close inspection of Table IV shows that the variation in the profitability of the plans included is much less than that found in Table III. This small range in the profitability of different 'plans' is a normal feature in a profit rates table constructed for a poultry unit where birds are kept from day old in the laying house and it explains why it is less important in this situation to select the actual optimal policy.

There are two reasons explaining why the variation in the profitability of plans in a profit rates table for a flock in which birds are kept from day-old to culling is less than that in a table for a flock in which replacements are purchased at P.O.L. Firstly, it is cheaper to rear a bird on the home farm than it is to purchase it at P.O.L.. The advantage is the same for all 'plans'. All are more profitable by the same amount. Consequently the relative differences in the profitability of the alternative 'plans' is less. Secondly, as bird depreciation is lower the decline in average costs per period with length of season is much less marked and the 'plans' involving short laying seasons are relatively more profitable.

Method three - Choosing a replacement policy where replacements are reared on the farm in a separate unit. (Laying and rearing units fully utilised).

The possibility of housing replacements at any time of year, without affecting performance has been seen as an opportunity for increasing profits by reducing the costs of the replacement chick. If the rearing process is so organised that an increased number of batches can be reared each year the costs of depreciation of buildings and equipment employed in the rearing unit can be spread over a larger number of birds; also the higher the ratio of laying to rearing units the lower is the total capital outlay per laying bird, and, for a given capital sum, the larger is the number of laying birds that can be kept.

With a given rearing system the cost of the replacement pullet is reduced to a minimum when rearing housing and equipment is fully utilised. In this situation P.O.L. replacements become available at regular intervals. Where laying houses are also fully utilised each flock life must be of the same length. The problem of choosing a replacement policy is therefore one of selecting the length of laying season which results in the highest profit. This problem exists only where the ratio of laying to rearing houses is not predetermined. For example if the poultry unit consists of one rearing and three laying sections, if the rearing section can produce a maximum of three batches of birds per year, and if both rearing and laying sections are fully utilised, then each flock must be kept in lay for 48 weeks. A longer or shorter laying season is possible only if the ratio of laying to rearing accommodation can be changed.

The method of analysis is again illustrated. In addition to the assumptions about performance, costs and egg prices used in the previous case studies, it is assumed that (a) the longest stage in the rearing process is 12 weeks i.e. a batch of chicks can be housed at day-old 12 weeks after the preceding batch was housed, (b) the cost of rearing (assuming the rearing unit is used to capacity) is 12s. - 8½d. The direct costs of rearing total 12s. - 0d., the same as in the previous case study. The remaining 8½d. is the cost of depreciation of buildings and equipment. Investment in buildings and equipment is 20s. - 0d. per bird space (that is per birds reared, not per birds housed), and this is depreciated at a rate of approximately 14%. The annual cost is therefore 3s. - 0d. As 4·33 batches can be reared per year the cost per bird is 8½d., (c) investment in buildings and equipment in the laying unit is the same as in the previous examples 25/- per bird space. (d) capital for investment in buildings and equipment is in limited supply on the farm and restricts the size of the enterprise.

The optimal length of laying season is found in two stages. Firstly, using budgeting procedures like those already described, the profit per bird space period is calculated for each feasible length of season.

This can be done by constructing a simplified profit rates table which shows the profitability of plans which in the full profit rates table would appear (1) in the column headed "48 weeks" and (2) in the bottom row of the table labelled "average for all dates of housing". The figures in (2) and certain combinations of the figures in (1) are measures of the profitability per bird space period of all the policies which are possible when this system of providing replacements is used. These are shown in the first row of Table V. This measure of profit, however, is not adequate as a criterion for choosing the length of laying season with this system of production. This is because the number of bird spaces is not a reliable index of the size of the whole enterprise when rearing is done on the farm. The longer the laying season the smaller is the capital outlay per laying bird. What the criterion for choosing must be depends on what factor of production is the one which limits the total profit of the enterprise. Where, as it is assumed here, capital for investment in building and equipment is the resource the shortage of which restricts total profits, the criterion must be "profit per unit of capital". It is necessary therefore to know, for the example flock, how much capital per bird space is required for each feasible length of season.

From the two sets of information included in Table V the desired value - 'profit per unit of fixed capital invested - is deduced for each feasible length of laying season. These show that the best length of laying season for this case study flock is 60 weeks. This length of laying season, however, is possible only if the required ratio of 16 laying houses to 3 rearing houses can be achieved. Economies of scale favour the use of relatively large laying houses. Consequently this ratio could not be achieved except on large poultry farms. On most farms, therefore, the best policy would be a compromise - a 56 week laying season and a ratio of laying to rearing units of 5:1.

Table V

Effect of differences in length of laying season on capital investment and profit where rearing and laying units are fully utilised.

	Length of laying season (in weeks)				
	48	52	56	60	64
Profit in pence per bird space period	11·5	11·9	12·0	12·0	11·7
Capital outlay per bird space (shillings)*	29·6	29·3	29·0	28·7	28·5
Profit pence per 25/- fixed capital investment per period.	9·7	10·2	10·3	10·4	10·2
No. of laying units served by one rearing unit	$4\frac{1}{3}$	$4\frac{2}{3}$	5	$5\frac{1}{3}$	$5\frac{2}{3}$

* Capital outlay in both the laying and the rearing stage. If laying birds are kept for 48 weeks the capital outlay is made up of 25s.-0d. (the capital outlay on the laying flock) plus 20s. - 0d. ÷ 4·33 (the capital outlay in rearing housing and equipment divided by the number of laying bird spaces served by one rearing bird space.

Method four - Choosing a replacement policy where separate rearing units are available but are not fully used.

The fourth system of production considered is one where replacements are reared on the farm but where the rearing unit is not fully utilised. With such a system the producer has some freedom to choose the times of year for housing and the lengths of laying seasons most suitable for his flock.

The method of choosing a replacement policy under these circumstances is again illustrated with a case study. It is assumed that estimates of bird performance, costs and egg prices, remain as in the previous case studies. It is also assumed that the degree of flexibility being considered is that which results when the ratio of laying to rearing houses is 3:1 and that the rearing unit is capable of producing $4\frac{1}{3}$ batches of P.O.L. replacements in a year.

A new 'profit rates' table is constructed to show the expected profitability of different 'plans'. This can be constructed from first principles. Here it is constructed by adjusting the figures in Table III to allow for the difference in the cost of the replacement pullets. The adjustment is equal to the difference between the cost of the purchased P.O.L. pullet (18s. - 0d.) and the direct cost of the home reared pullet, (12s. 0d.) divided by the number of periods the flock, for the 'plan' in question, utilises one of the three laying houses. The cost of building and equipment depreciation incurred in rearing can be ignored. With a given system of rearing and a given ratio of laying to rearing houses this cost is fixed. It occurs as a constant charge per laying bird space period whatever policy is adopted. This cost needs to be considered only if a comparison is made between policies where the ratio of laying to rearing units is different.

The profit rates for alternative plans for this new situation are presented in Table VI.

The optimal stable policy may be of type (a), (b) or (c). A policy of type (a) is one in which each of the flocks - three in this example - is kept for 48 weeks of lay and where there must be an interval of at least 12 weeks between flocks. The best policy of this sort can be seen from Table VI to be one where the flocks are housed in November, late January and late April. Flocks housed at these three dates provide 12·6, 14·0 and 13·0 pence profit per bird space period respectively. The average rate of profit for the three flocks is 13·2 pence. No other three housing dates separated by a minimum 12 week interval provide such a high average profit.*

Table VI

Profit Rates. Case 4
(Profit in pence per bird space per 4 week period)

Date of housing at P.O.L.	Length of laying season in weeks					
	44	48	52	56	60	64
1st January	12·7	14·1	14·5	14·5	14·1	13·4
29th January	13·3	14·0	14·3	14·1	13·5	12·8
26th February	13·3	13·9	13·9	13·5	12·9	12·0
26th March	13·4	13·7	13·4	12·9	12·2	11·6
23rd April	13·0	13·0	12·7	12·1	11·8	11·4
21st May	12·0	12·0	11·6	11·5	11·3	11·2
18th June	10·6	10·4	10·5	10·6	10·8	10·8
16th July	9·3	9·7	10·1	10·5	10·9	11·2
13th August	8·6	9·3	10·1	10·8	11·3	11·4
10th September	8·8	9·9	10·9	11·7	12·1	12·3
8th October	9·7	11·0	12·2	12·8	13·2	13·0
5th November	11·1	12·6	13·5	14·1	14·1	13·7
3rd December	12·0	13·2	14·2	14·3	14·1	13·6
Average for all dates of housing	11·3	12·1	12·5	12·6	12·5	12·2

The best stable policy of type (b) is one where a laying season of 56 weeks is regularly used. The profit rate shown for this policy is 12·6 pence per bird space period.

There is a very large number of possible policies of type (c). The planner can be certain of choosing the best only if he evaluates each. A policy very close to the optimal can be estimated if a number of policies, which appear from the table to be among the most profitable, are selected, and if each of these is evaluated.

* This is not a net profit figure for depreciation on rearing equipment and housing has not been deducted.

The selection of policies that are likely to be amongst the most profitable may be based on the following two principles. Firstly the best policy of type (c) is likely to be a variation of the best policy of type (b). In other words the plans included in each policy selected should be scattered round the column in which the average profit for all dates of housing is the highest. In this case this column is the one headed "56 weeks". Secondly only a small proportion of the plan included in a policy selected for evaluation will themselves provide a low rate of profit.

To facilitate the selection of policies for evaluation the plans in the profit rates table are divided into the more and the less profitable plans. The more profitable plans - the dividing value used in Table VI is 12·6 pence, the highest figure in the "average for all dates of housing" row - are shaded. This shading brings out the pattern in the table.

Each policy chosen and evaluated must be one in which the interval between the housing of flocks is at least twelve weeks and where laying houses are never unoccupied for more than the four week "clear out" period. The implications of these restrictions are as follows. Firstly the relative grouping of housing dates does not change if each flock is kept for the same length of time. Secondly the life of a given flock cannot be made shorter than the life of the preceding flock unless that preceding flock was housed earlier than the given flock by more than the minimum twelve weeks. Thirdly in a similar way the life of a given flock cannot be made longer than that of the following flock in the cycle unless that following flock was housed later than the given flock by more than the minimum period.

Conforming with these restrictions a policy was selected for the case study. This is described in Table VII.

Table VII

A stable replacement policy for the case study flock

		1st flock season	2nd flock season	3rd flock season
Laying house I	P.O.L. date	Nov.5th	Dec.3rd	Dec.3rd
	Laying life in weeks	52	48	56
	Profit rate*	13·5	13·2	14·3
Laying house II	P.O.L.date	Jan.29th	Feb.26th	Mar.26th
	Laying life in weeks	52	52	52
	Profit rate*	14·3	13·9	13·4
Laying house III	P.O.L.date	Apr.23rd	May 21st	Sept.10th
	Laying life in weeks	52	64	56
	Profit rate*	12·7	11·2	11·7

* Pence per bird space period.

With this policy the same housing dates are used again after the first nine flock lives have been completed. The cycle is therefore repeatable. In the second cycle House I is stocked with its first flock in late January, House II in late April and House III in early November. The fourth cycle is identical with the first in that House I is stocked for the first time in early November. In each house nine flocks are kept in ten years. The profit rate resulting from this policy is 13·1 pence per bird space period. This is calculated as the weighted average of the profit rates of the individual plans included in the cycle.

Other cycles could be worked out and evaluated in this way and the best chosen. In this case however no further analysis would be done. The policy evaluated above cannot be very much less profitable than the best of type (c). Only two of the nine 'plans' included in each cycle lie in the unshaded area of the table. Even so the profitability of the policy is less than can be achieved by using the best policy of type (a). Although a policy of type (c) better than the best of type (a) may exist the gain is likely to be marginal.

This result is significant. It has already been noted that the performance of the case study flock is one which, in the absence of seasonal variations in egg prices, justifies a long laying season. Yet in this present assumed situation where the integration of rearing and laying units allows some manipulation of housing date and length of season for individual flocks, a policy where birds are replaced annually is found to be a good choice. The degree of integration is important. Although this cannot be discussed here it can be deduced that the less the integration the stronger is the probability that an annual replacement of stock is advantageous. For flocks less suited on grounds of performance than the case study flock to long laying seasons a policy of type (a) is more likely to be optimal.

Comparing the profitability of policies where different systems of providing replacements are used.

The farmer is faced not only with the problem of selecting the best policy with a given system of providing replacements. He must also decide which system of providing replacements to adopt. If only one system is considered a policy less than optimal may be selected. In fact unless every system is considered a sub optimal selection may result.

Comparing the profitability of replacement policies when different systems of providing replacements are used is a problem only when the measures of profitability used in the original analysis are not comparable. The measures of profitability used in the four methods of analysis presented above are not comparable in two respects. Firstly, in Method IV profit is measured before the cost of depreciation on rearing housing and equipment has been deducted. In each of the other three methods profit is shown net of this depreciation cost. Before it is possible to make comparisons between the profitability of policies where different systems of pullet replacement are used, the profits calculated by Method IV must be reduced by the cost of depreciation on rearing housing and equipment. Secondly, profits have been measured "per bird space period". This, although a suitable criterion for assessing replacement policies when one system of providing replacements is used, is not suitable when different systems of providing replacements are compared, (where different methods of analysis have been used). The resource use pattern is not the same for all systems.

A true comparison between different systems can be made by expressing profit as total profit. It is simpler however to express it as profit per unit of the limiting resource.* The limiting resource is not the same for all producers, but the one that is probably most commonly the factor limiting profits is housing space or, what amounts to the same thing for a new enterprise, capital for investment in buildings and equipment.

To complete the process of selecting the optimal policy for the case study flock a comparison is made between the profitability of the best policies attainable with each of the four systems of providing replacements. It is assumed that capital for investment in buildings and equipment is the limiting resource. The results of the comparison are shown in Table VIII.

This table shows that the optimal replacement policy is one where rearing is done on the farm in units fully integrated with the laying units. This policy which provides a profit of 10·3 pence per 25s. - 0d. capital invested per period, is one where each flock is kept in lay for 56 weeks (see page 18). The range in profitability per 25s. 0d. capital investment, for the four policies compared is 1·7 pence per period or 1s. 6½d. per year.

The difference in the profitability of alternative replacement policies shown in Table VIII is not the only factor that should affect the farmers decision. How will prices change

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* Usually in problems involving the comparison of policies where different systems of providing replacements are used the limiting resource is the same whichever system is used. If this is not so the comparison has to be made on the basis of a total profit measure. If there is no limiting resources there cannot be a profit maximisation problem.

in the future and how will this affect the decision? Is the risk attached to each policy equal? These and other questions have to be answered and the answers considered in conjunction with the results of the analysis before a decision can be made.

Table VIII

Comparison of the profitability of the best policies for different systems of providing replacements

System of providing replacements	Profit as calculated (pence per b.s.p.)	Profit net of depreciation on rearing equipment (pence per b.s.p.)	Fixed capital per bird space (shillings)	Profit per 25/- capital invested (pence per period)
Purchase at P.O.L.	8·6	8·6	25	8·6
Home reared - continuous rearing and laying	8·7	8·7	25	8·7
Separate home rearing. Fully integrated	12·0	12·0	29	10·3
Separate home rearing. Not fully integrated Ratio of laying to rearing 3 : 1	13·3	12·4	31·6	9·8

The effect of variations in flock circumstances on the choice of replacement policy

The conclusions reached for the case study flock do not apply for all flocks. These conclusions depend on expectations of future production and costs. For each flock these expectations differ and because of this the optimal replacement policy can be expected to differ. It is not possible to list the situations that exist in practice and indicate for each the optimal replacement policy. The list would be endless. Instead the effect of variations in expectations are studied by changing one at a time the level of expectations for the case study flock, and noting the way in which these changes alter the conclusions. The variations considered are variations in egg production, costs and egg prices.

Variations in egg production

The variations between flocks in egg production, excluding that variation which is not forecastable, result from (a) a difference in the speed at which the rate of lay falls after the peak, (b) a difference in the rate of lay at 'peak', (c) a difference in egg size.

To illustrate the effect of a change in each of these characteristics on the choice of replacement policy the analysis done for the case study flock was repeated using different estimates of egg production. All other assumptions remained as before. The egg production characteristics of the four flock situations analysed are presented in Table IX.

Table IX

Egg Production characteristics of four flocks

	Percentage production at 'peak'	Rate of fall in production after 'peak' % per week	Grading
Flock I*	90	0·8	Small**
Flock II	90	1·0	Small
Flock III	80	1·0	Large***
Flock IV	90	1·0	Large

* Case study flock
** The grading assumed is that recorded for six flocks laying small eggs in a recent National Laying Trial.
*** The grading assumed is that recorded for six flocks laying large eggs in a recent National Laying Trial.

The results of the analysis of the case study flock, already presented in previous tables and the results of similar analyses completed for three other flocks with the egg production characteristics detailed in Table IX are presented in Table X.

A comparison of the results of the analysis for Flock I and Flock II (Table X) illustrate the effect of a difference in the rate of fall off in production after the 'peak'. An increase in the rate of fall off in production after the peak affects the earning power of the flock in two ways. Firstly, fewer eggs are laid for any given length of laying season and income is lower. Secondly the income advantage of the flock with the slower rate of fall off increases the longer the flock is kept. The implications of these affects on the choice of a replacement policy are:-

(1) The flock with the slower rate of fall-off (Flock I) is more profitable whichever system of providing replacements is used. Because of

this less can be gained by using a system of providing replacements designed to reduce the cost of these replacements if this reduces the size of the laying flock.

(2) The flock with the slower rate of fall-off in production tends to achieve its best profit with a longer length of laying season. For example when a system of providing replacements in separate rearing units which are fully utilised, is followed, the optimal length of laying season for Flock II is 52 weeks; for Flock I it is 56 weeks. This relationship between rate of fall-off in production and optimal length of laying season is not important in flock situations where P.O.L. replacements are purchased. It is over-ridden by the important relationship between date of housing and rate of profit.

(3) Where P.O.L. replacements are purchased the optimal date of housing for the flock with a faster rate of fall-off in production is later in the year. This is because the optimal date of housing is the one which forces a coincidence between the period in the life of the flock in which the number of eggs in the large grades is at a maximum and the season of year at which the discrepancy between the price of the large and the small grades is at a maximum. If the fall off in production is rapid the period during which the production of the larger eggs is at a maximum is earlier in the life of the flock and therefore the optimal housing date is later. This effect is not strong and is not apparent in the comparison between Flocks I and II in Table X.

The affects of a change in the rate of production at 'peak' on the choice of replacement policy, which are illustrated by a comparison of the results for Flock III and Flock IV shown in Table X are:-

1. the flock with the higher rate of production at 'peak' earns a better profit whatever replacement policy is adopted. Because of this

Table X

Description* and profitability per 4 week period of optimal policies for 4 flocks with different production characteristics** and for 4 different systems of production.***

Flock	System of providing replacements												
	I				II		III			IV			
	Date of housing	Length of laying season weeks	Profit: Per bird space pence	Profit: per 25/- fixed invmt. pence	Profit: Per bird space pence	Profit: per 25/- fixed invmt. pence	Length of laying season weeks	Profit: Per bird space pence	Profit: Per 25/- fixed invmt. pence	Date of housing	Length of laying season weeks	Profit: Per bird space pence	Profit: Per 25/- fixed invmt. pence
I	Jan.1st.	48	8·6	8·6	8·7	8·7	56	12·0	10·3	-	-	13·3	9·8
II	Jan.1st.	48	5·8	5·8	6·7	6·7	52	9·0	7·7	Jan. Apr. Nov.	48	10·4	7·5
III	Apr.23rd.	48	7·3	7·3	6·8	6·8	48	9·4	7·9	Jan. Apr. Jul.	48	11·2	8·2
IV	Apr.23rd.	48	16·0	16·0	12·8	12·8	48	17·7	14·9	Jan. Apr. Jul.	48	19·7	14·9

* A description of the policy is not given where this is one of type (c)

** Shown in Table IX

*** The 4 systems are those already described, i.e. I - where replacements are purchased at P.O.L.; II - where replacements are reared in the house they occupy as layers; III - where replacements are reared in separate units and where the rearing and laying units are fully integrated; IV - replacements are reared in separate units which are not fully integrated with laying unit - the ratio of laying to rearing units is 3 : 1.

the flock with the high 'peak' is less likely to have as an optimal replacement policy one where the system of providing replacement necessitates the use of scarce resources, i.e. in the present comparison capital, in the rearing instead of in the laying stages of production. In the comparison of Flock III and IV the difference in the rate of production at 'peak' changes the optimal policy from one where replacements are reared on the farm in separate units to one where P.O.L. replacements are purchased.

2. a higher rate of production at the 'peak' is associated with a longer laying season. This is not a conclusion that emerges from the numerical analysis but is one that can be deduced. If the rate of fall-off in production is the same for two flocks but the 'peak' is different, the difference in income earned by the two flocks becomes proportionately greater the longer they are kept.

3. the level of production at peak has very little effect on the best date of housing when P.O.L. replacements are purchased and kept for a year. The best housing date under these circumstances for both Flock III and IV is late April. It is not the number of eggs that are laid but the distribution of egg production by grade and time of laying that makes one housing date better than another. If the difference in production between the two flocks had been a percentage difference constant through the laying life there would have been no difference in the optimal housing date.

The effects of a change in egg size on the choice of replacement policy, which are illustrated by a comparison between Flocks II and IV, are:-

1. the flock laying the larger egg earns a higher profit whichever replacement policy is chosen. The indirect effect of this, which is to favour a policy where replacements are purchased at P.O.L., has

already been discussed. The assumption that it is possible to keep birds laying large eggs with the same food cost as that incurred with small egg laying birds is unrealistic, but it is necessary if an understanding is to be gained of the effect of egg size on the choosing of a replacement policy.

2. The flock laying a larger egg, if kept in lay for a year should be housed later in the year. Whereas the optimal housing date under these circumstances for Flock II is early January, the optimal housing date for Flock IV is late April. The reason for the difference is that egg size tends to increase as the flock grows older at a constant rate regardless of the size of egg at the beginning of the laying season. If at the beginning of the season egg size is fairly large, a high proportion of 'large' and 'standard' eggs is laid fairly early in the life of the flock, and later in the season much of the gain in egg size is lost in the production of extra large eggs. Because of the resulting slow rate of change in the percentage of grading towards the end of the season, the period when the maximum number of eggs of the larger grade is laid occurs relatively early in the life of the flock. For this period of the laying season to coincide with the time of year at which the discrepancy between the large and small grade prices is at a maximum the large egg laying flock must be housed later than the small egg laying flock.

3. The flock laying a large egg benefits from a shorter laying season. This conclusion illustrated by the comparison between Flock II and IV, results from the argument developed above. Because changes in egg size for the flock starting production with a relatively large egg are not fully rewarded with the existing grading system, the change in egg numbers becomes a more important determination of egg incomes. This causes the average earning power of a flock laying a large egg to reach a maximum when the laying life is relatively short.

Variations in costs

Changes in the level and distribution of costs have parallel effects on the character and profitability of the optimal replacement policy to those discussed for changes in laying performance. It has been assumed that the cost schedule does not change with the time of year at which the flock is housed. Thus differences in costs affect the length of time that a flock should be kept but not the date at which it should be housed.

Differences in the three types of cost - 'food', 'fixed', and 'non-repetitive' - have different effects on the comparative advantage of alternative replacement policies. A variation in food costs affects the profitability of alternative replacement policies in two ways. Firstly it affects the relative advantage of long or short seasons. Food is not consumed during the clear out period therefore the advantage of a reduction in food consumption when the measure of profit is 'per bird space period' is relatively greater if the flock is kept for a long laying season. A reduction in food cost per four week laying period of three pence per bird space (this is a 10% reduction) results in an improvement in profit per bird space period of 2·77 pence if the flock is kept for 48 weeks of lay and 2·82 pence if the flock is kept for 64 weeks. The relative advantage, however, - in this case only 0·05 pence for a difference in season length of 26 weeks - is very small and may be discounted. Secondly a change in food costs affects the general level of costs and profit in the same way as would a change in 'fixed' costs. i.e. labour, depreciation on housing and equipment, fuel, etc.

For any replacement policy a change in fixed costs will increase or decrease total costs per bird space period by the same amount whatever replacement policy is adopted. The 'best' policy for each system of providing replacements is not changed but the relative advantage of the different systems does change. An increase in fixed costs increases the comparative advantage of those systems of providing replacements where for the sake of cutting the cost of the replacement, the size of the laying flock has to be reduced. The affect is the same as the main affect that results from a change in food costs. This is illustrated in Table XI. The profitability of the alternative 'best' policies for Flock IV presented in Table X are adjusted to what they would be if food or fixed costs were increased by given amounts.

Table XI

The affect of changes in 'food' and 'fixed' costs on the profitability of Flock IV with different systems of providing replacements
(profit in pence per 25/- fixed capital investment per period)

Increase in Food Cost. (pence per laying period).	Equivalent increase in 'fixed' costs. (pence per period)	System of providing replacements		
		I	III	IV
4	3·7	12·3	11·8	11·9
6	5·5	10·4	10·3	10·5
8	7·4	8·6	8·7	9·0

Although System I remains the most profitable where food costs are increased by up to four pence per period, when this cost is increased by sixpence or more System IV becomes the most profitable.

A change in the level of non-repetitive costs has a similar effect on the comparative advantage of alternative replacement policies as a change in the rate of fall off in production after 'peak'. A change in the rate of fall-off in production changes the slope of the average income curve, a change in 'non-repetitive' cost changes the slope of the average cost curve. The significance of a change in costs however is much less. Of the case study flocks, Flock II had a faster rate of fall off in production than Flock I - 1% instead of 0·8% hen housed production per week. Because of this difference, the difference between the profit rate of Flock I and Flock II increased by 1·6 pence per bird space period if both flocks are kept for 64 compared with 48 weeks of lay. For a comparable affect the level of non-repetitive costs must change by almost seven shillings per bird.

Variation in the egg price pattern

The present seasonal variations in egg prices affects the choice of a replacement policy in two ways which are closely related. Firstly, the existence of this variation makes the housing of replacements at one time of year much more profitable than housing at other times of year. Secondly, because it is not possible to house successive flocks at the same time of year unless each has a flock cycle of a year there is a tendency for a laying season of 48 weeks to be optimal. An example of this effect is provided by the analysis of Flock II. When replacements are reared in separate units (System III) and where, because the rearing and laying units are fully integrated, dates of housing cannot be controlled, the optimal length of laying season is 52 weeks. When the rearing units are not fully integrated (System IV) the optimal policy is one involving 48 week laying seasons.

If the egg price pattern became more variable from one part of the year to another these tendencies would be strengthened. This however is unlikely. The seasonal variation in egg prices, which results from the seasonally biassed production of eggs is itself an economic force that should in time eliminate this seasonal bias in production. With no seasonal variations in egg prices the problem of selecting a replacement policy would be a problem of selecting an optimal length of laying season. The best system of providing replacements would then be the system by which they are produced at the lowest cost.

General Conclusions

The optimal replacement policy for an individual flock depends on the expected performance of that flock, the expected costs and expected prices. These expectations change from farm to farm because of differences in managerial skills and differences in resources. Because of this it is not possible to state the optimal policy for a particular farm with any precision without taking into account the peculiar circumstances of that farm.

However it is possible to draw a number of general conclusions which can be applied by the practical poultry farmer to the solution of his own problem.

Optimal policies on farms where the system of providing replacements is established.

System 1 - where P.O.L. replacements are purchased. The optimal policy is almost certain to be one where birds are replaced annually. For each of the case study flocks the optimal policy was one in which the laying season was 48 weeks (Table X). The time of housing depends on the performance of the birds. Where grading is good and/or where the number of eggs laid falls off fairly rapidly after the peak (Flocks III and IV) a late housing date is the more profitable. Conversely where small eggs are laid or where the rate of fall off after the peak is slow (Flocks I and II) an early housing date is more profitable. The optimal housing date is likely to be between November and May.

A single housing date and a 48 week laying season may not be optimal in two situations. Firstly for the producer who sells his eggs direct to the consumer and who, to maintain his market, must produce a constant output in terms of both number and grade of egg through the year, and secondly, for the producer who operates on borrowed capital and who is unable to increase his borrowings to the amount that would be necessary to replace all of his birds at one time, a more even distribution of housing dates through the year may be preferable.

System II - where birds are kept in the same house from day old to culling. The optimal policy is likely to be one where each flock is kept for a similar but not necessarily the same length of season. This length of season, which varies with the performance of the flock, is likely to be between 48 and 56 weeks of lay. Only flocks with exceptional performance will justify longer or shorter laying seasons.

System III - where replacements are reared on the farm and where both rearing and laying units are fully utilised. Here the existing ratio of laying to rearing houses determines the length of laying season. In a situation where this system of production has been selected but where the ratio of laying to rearing houses has not been determined the optimal length of laying season is likely to be between 48 and 56 weeks.

System IV - where replacements are reared on the farm but where the rearing unit is not fully utilised. Here the optimal policy depends on the extent to which the rearing facilities are utilised and on the performance of the flock. If the rearing unit is almost fully utilised the optimal policy will approximate that found to be optimal, for birds with the same performance, when the rearing unit is fully utilised, i.e. System III; if the rearing unit is used for a relatively small part of the time the optimal policy will approximate that found to be optimal when P.O.L. replacements are purchased. The effect of differences in performance can be seen in Table X. Where flock performance favours a long laying season (Flock I) the optimal policy is one of type (c); where flock performance favours a shorter laying season (Flocks II, III and IV) the optimal policy is one of type (a).

Choice of system of providing replacements

The best system for the individual farm depends on the expected performance of the birds and upon expected levels of prices, costs, etc.. The effects of variations in performance are shown in Table X. Where bird performance is good ensuring a high level of profitability and particularly where this performance favours a medium length of laying season (Flock IV) purchasing P.O.L. replacements is advisable. Flocks, like Flock III, which are characterised by a similar pattern of egg production with respect to both time of lay and grading but which produce a smaller number of eggs earn their highest profits if replacements are reared on the farm in such a way that the least favourable housing dates can be avoided (System IV). Flocks like both Flocks I and II, where performance favours a long laying season achieve highest profits if replacements are reared on the farm and if the rearing units are fully utilised (System III).

Rearing replacements in the house they are intended to occupy later as layers was not a best method of providing replacements for any of the case study flocks. A laying house is expensive to use as a rearing house. While it is being used by growing birds it cannot be producing a profit. Only if using this system of rearing results in an improved performance from the laying birds is its use likely to be justified.

The choice of system of providing replacements is also influenced by other factors not concerned with the performance of the birds. The most important of these is the relative cost of purchased and home reared P.O.L. replacements. This relationship is only partly controlled by the farmer. If the price of purchased P.O.L. replacements fell from the assumed level of 18s.0d. to 17s.0d. the optimal policy for Flock III would change to one where P.O.L. replacements are purchased. With a further reduction of a shilling a bird it would be advisable with flocks having a performance like those of Flock I and II to purchase P.O.L. replacements. A rise in the price of P.O.L. replacements of approximately 1s.2d. per bird would be needed to change the optimal policy for Flock IV from being one where replacements are purchased at P.O.L.

With increasing specialisation in the poultry industry it is probable that the purchase price of P.O.L. replacements will fall relative to the cost of rearing. This will favour replacement policies where P.O.L. replacements are purchased. At the same time it is also probable that egg prices will continue to fall. This will act in the opposite direction. If profit margins fall the opportunity cost of investing resources in pullet rearing will also fall.

In choosing a system of providing replacements the circumstances of the individual farm are of great importance. These are so varied that it is impossible to generalise on their effect. The limiting resource is not always capital for housing and fixed equipment. Where it is not, the criterion for assessing alternative policies is different. The conclusions may also be different. Finally where the analysis relates to an existing poultry farm, if the deduced best method of providing replacements is not the same as the system in current use, there will be costs associated with the change from one system to another. The gain from changing the system of providing replacements must be balanced against the costs.

Summary

1. The problem of choosing a replacement policy exists because there is a seasonal variation in egg prices, because the production of a flock changes as it grows older and because the average cost structure changes as a flock grows older. Because of these three factors alternative replacement prices are not equally profitable.

2. Solving the problem on an individual farm involves three processes - forecasting, budgeting and selecting. Forecasts must be made of expected levels of production and costs for each stage in the life of the flock and expected prices at each time of year. These forecasts must be combined into budgets showing the outcome of housing birds at different times of year and keeping them for different lengths of season. From the results of this budgeting a replacement policy can be selected. The problem of selecting is simple if only a few alternatives are considered and if the right criterion for selection is known. But in cases where it is considered necessary to review the whole range of possibilities selection can be very difficult demanding sophisticated programming techniques. If different systems of production are envisaged as possible the process must be completed for each system. Usually most of the forecasts and much of the budgeting work used in the analysis of one system can be used in the analysis of others.

3. Methods of budgeting and selecting are described which can be used in the following situations:

(a) where point of lay replacements are purchased,

(b) where replacements are reared in the house they later occupy as laying birds,

(c) where replacements are reared in separate units and where these are fully utilised, i.e. where the rearing and laying units on the farm are fully integrated,

(d) where replacements are reared in separate units but where these are not fully utilised i.e. there can be some variability in the length of time individual laying flocks are kept.

These methods are illustrated by means of case studies. For each of these as far as possible the same assumptions are used so that comparisons can be made.

4. The optimal replacement policy for each farm is different because of the different resources (and skills) at the farmer's disposal. The range of these differences in practice is very wide. To illustrate the effect of changes in performance and costs on the comparative advantages of alternative replacement policies the analyses made for the case study flock is repeated using different assumptions of production and of costs.

5. Much of the difficulty of selecting an optimal replacement policy arises out of the seasonal variation in egg prices. If this were to be eliminated - and economic forces are operating in this direction - the problem would be simplified to one of finding the optimal length of laying season.