



**AgEcon** SEARCH  
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

*The World's Largest Open Access Agricultural & Applied Economics Digital Library*

**This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.**

**Help ensure our sustainability.**

Give to AgEcon Search

AgEcon Search  
<http://ageconsearch.umn.edu>  
[aesearch@umn.edu](mailto:aesearch@umn.edu)

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

# AGRICULTURAL ECONOMICS RESEARCH

A Journal of Economic and Statistical Research in the  
Bureau of Agricultural Economics and Cooperating Agencies

Volume IV

JANUARY 1952

Number 1

## The Economics of Input-Output Relationships in Feeding for Egg Production

By Peter L. Hansen and Ronald L. Mighell<sup>1</sup>

*From a physiological standpoint there is good reason to believe—although specific evidence is inadequate to prove—that the law of diminishing returns applies in feeding chickens for egg production. From an economic standpoint this does not appear to have the practical significance that it does, for example, in milk production. It is almost always most profitable to feed hens to capacity. Chief opportunities for economic adjustment of production arise rather through such things as proper culling of flocks or varying the composition of the ration to take advantage of changing cost relationships of the components. The new “high efficiency” rations appear to offer promise for more profitable production under favorable price relationships.*

THE MOST EFFICIENT utilization of concentrate feeds is a key problem in the field of animal nutrition. The technical and economic phases are closely associated and experience has shown the need for joint technical-economic analysis of such questions as the most profitable rate of feeding.

From the viewpoint of the biological processes involved, animal products can be divided into two broad classes. In the first class are those products resulting from the growth of the animal, principally represented by meats. In this type of production the presence of diminishing physical returns has long been recognized.<sup>2</sup> More feed is needed for each additional pound of weight, as the animal's growth slows down with approaching maturity. The increasing level of maintenance for a

larger body over more units of time is the explanation for this phenomenon.

In the second broad class are those animal products that are “manufactured” by the mature animal. Milk, eggs, wool, honey, and the work performed by draft animals, are examples. Such products are produced as a continuous or intermittent flow through a period of time, and the presence of diminishing physical returns is not so clearly visible. The early investigators naturally thought of the analogy of a machine. The cow or the hen could be thought of as a living machine taking in feed consisting of maintenance and production portions and producing a continuing stream of output. In this approach, the relation-

<sup>1</sup>The writers are indebted to H. R. Bird, Bureau of Animal Industry, ARA, for helpful comments on several aspects of the technical phases of the feeding problem. This study was made possible by the Bankhead-Jones Special Research Fund.

<sup>2</sup>The concept of diminishing physical returns refers to the general principle of diminishing productivity. This is sometimes stated briefly as follows:

In a given state of the arts, after a certain point is reached, the application of further units of any variable factor to another fixed factor (or fixed combination of factors) will yield less than proportional returns.

ship between the production feed (above maintenance) and the output was assumed to follow a straight line of constant marginal efficiency. Feeding standards and recommended allowances have been constructed largely on this conceptual basis.

A confusing element in making and using feeding standards is the matter of capacity variations and the difficulty of determining an individual animal's capacity. Practical feeding is a matter of dead reckoning. The feeding has to be adjusted after "logging each day's sailing" and in the absence of careful records more refined methods of feeding may be out of place. In the case of hens, feeding is usually on a flock basis and this further complicates matters by making it necessary to gauge average responses of large numbers of individuals.

That biological machines may have more flexibility than mechanical machines was long believed but not definitely confirmed for milk cows until the work of Jensen, Woodward, and Associates.<sup>3</sup> Their research was carried on in a special project undertaken by the United States Department of Agriculture in cooperation with 10 State agricultural experiment stations during the late 1930's. From this it was established that although the production of milk is increased by heavier feeding, the increase in the output of milk for each additional input of feed is progressively less than feeding standards would indicate.

### Eggs and Milk Alike

There are many reasons for believing the same physical principle holds for the production of eggs. In the first place the egg, like milk, is a secretory product of the reproductive system. Furthermore, as has been pointed out by Brody, the physiochemical, metabolic, and endocrine mechanisms of egg production are similar to those of milk production.<sup>4</sup> Differences between cows and chickens with respect to the proportions of the total feed used for maintenance and production have obscured direct comparisons. Brody in discussing this problem says: "The net energetic efficiency

thus appears to be of the same order for egg as for milk production; that is, the energetic efficiency of transforming T.D.N. into eggs when maintenance cost is not included is of the same order as the efficiency for milk production when maintenance cost is not included. It is therefore concluded that the ovary and oviduct produce eggs from egg precursors with the same energetic efficiency as the mammary gland produces milk from milk precursors."<sup>5</sup> On the other hand, the proportion of the total feed input that is used for maintenance is considerably higher for hens than for cows.

Elsewhere Brody states that "While no data are available, there is no doubt that egg production is related exponentially to feed consumption in the same manner that milk production is associated with feed consumption, that is, in accord with the principle of diminishing increments."<sup>6</sup>

Economists working with farm-record data have attempted on occasion to measure the relationship between feed input and egg production by statistical means. An example is the Wells-Clawson study reported some years ago in the *Journal of Farm Economics*.<sup>7</sup> The findings of this study were used as the ground plan for constructing a "conjectured" curve in a recent textbook on farm management.<sup>8</sup> This type of statistical analysis and the subsequent conjectures have served to point the way to further analysis but the specific findings are not supported by the available evidence from experimental work.

### Hypothetical Curve

The present writers' conclusions may best be summarized in the hypothetical curve presented in figure 1. This is a total input-output curve for egg production showing diminishing physical returns and constructed in the general manner of the curve for milk production developed in the Jensen-Woodward studies. On the basis of Brody's research, there seems little reason to doubt the

<sup>5</sup> Ibid. p. 883.

<sup>6</sup> Ibid. p. 95.

<sup>7</sup> WELLS, ORIS V., and CLAWSON, MARION. A STUDY OF EGG PRODUCTION PER HEN IN CENTRAL UTAH. *Jour. Farm Econ.* 15(4):663-664. 1933.

<sup>8</sup> BLACK, JOHN D., CLAWSON, MARION, SAYRE, CHARLES R., and WILCOX, WALTER W. FARM MANAGEMENT. New York, The Macmillan Co. 1947. pp. 936-940. Also presented in BLACK, JOHN DONALD. THE RURAL ECONOMY OF NEW ENGLAND. Cambridge, Harvard University Press, 1950. pp. 403-406.

<sup>3</sup> JENSEN, EINAR, KLEIN, JOHN W., RAUCHENSTEIN, EMIL, WOODWARD, T. E., and SMITH, RAY H. INPUT-OUTPUT RELATIONSHIPS IN MILK PRODUCTION. U. S. Dept. Agr. Tech. Bul. 815, 88 pp. 1942.

<sup>4</sup> BRODY, SAMUEL. BIOENERGETICS AND GROWTH. 1,023 pp. New York, published by the Herman Frasch Foundation. Reinhold Publishing Corporation. 1945.



presence of some diminishing physical returns in egg production. The parallelism in the physiological mechanisms for producing the two products is too striking to admit any other finding. The essential differences between the hen and the cow are taken into account in the maintenance part of the ration. In the absence of empirical data from research designed to uncover the precise shape of the production function, we are not able to prove just how much diminishing physical returns is present. But there is good reason to suppose that it is not greater than for milk production. We have therefore assumed as an upper limit that it is the same. As indicated later, the practical conclusion will not be affected by any other assumption that involves a lesser rate of diminishing physical returns.

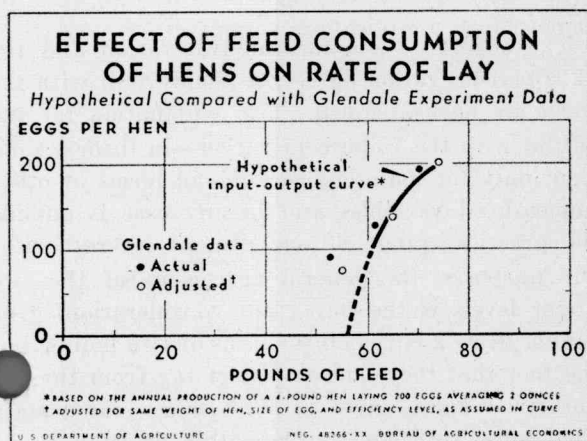


FIGURE 1.

Figure 1 is therefore constructed in the following manner:

1. Maintenance and production portions of the ration of a 4-pound hen, laying 200 eggs per year, are computed on the basis of average feed inputs given by Titus.<sup>9</sup>
2. A feed input-egg output curve with an exponential rate of 72 percent, or of the same order as that found in the Jensen-Woodward studies for good cows at high-producing stations, is assumed.<sup>10</sup> The curve is drawn by using a short-cut method devised by Mendum.<sup>11</sup>

<sup>9</sup> TITUS, HARRY W. PRACTICAL NUTRITIVE REQUIREMENTS OF POULTRY. U. S. Dept. Agr. Yearbook Agr. (Food and Life) 1939. pp. 787-818.

<sup>10</sup> JENSEN, et. al., op. cit., p. 42.

<sup>11</sup> MENDUM, SAMUEL W. A DEVICE FOR MEASURING YIELDS. Jour. Farm Econ. 30:357-364. 1948.

Note again that the production curve so constructed is essentially the same as the curve for milk production by Jensen-Woodward. This makes the further assumption that a 200-egg hen is a "good" hen comparable with the "good" cows at the high-producing stations in the milk study. The question at issue is whether such a curve would have the same economic significance for the production of eggs as for the production of milk? We must look at the differences between the aggregate production functions for milk and eggs. The most obvious one is that maintenance is a relatively larger part of the hen's total ration, about three-fourths for good hens as compared with less than half for good cows.

A closely related matter is that cows are consumers of less expensive roughage as well as of concentrates, but hens are almost solely "concentrate minded." In practice the roughage portion of a cow's ration may approximately cover its maintenance needs, or considerably more if it is of good quality and freely available. The concentrates are used mainly for milk production. But the hen must first meet its large maintenance needs out of the more expensive concentrates. This means that given percentage changes in the total concentrates fed have much more economic significance for the hen than for the cow. Or looked at the other way around, a considerable percentage change in the production ration for the hen represents a comparatively small change in the total concentrate ration. For example, a 20-percent change in the production ration in figure 1 would amount to a change of only about 5 percent of the total concentrates fed. The effects of changes of this magnitude are difficult to gauge even under experimental conditions where other variables are under some degree of control. Under commercial conditions it would be even more difficult.

In practice, the fact that birds are fed in flocks, rather than individually, introduces another element that becomes an insuperable obstacle to the determination of fine differences. Even in a flock of uniform breeding, there are individual differences in capacity, and a situation with a given ration freely available to a number of birds of differing capacities means that it is not possible to adjust the rate of feeding except on an average flock basis. With the further factor of some unavoidable waste under practical feeding conditions it means that there is no possibility of making any

direct application of the principle of diminishing physical returns if it is of no greater magnitude than that indicated in figure 1.

### Glendale Experiment

The foregoing will also serve to interpret more clearly the evidence from the only careful experiment that appears to have been made in the United States on the problem of feeding at different levels for egg production. This is the experiment conducted at the U. S. Department of Agriculture's Southwest Poultry Experiment Station, at Glendale, Ariz., in 1936 and 1937.<sup>12</sup> This work was designed to ascertain the effect of very limited feeding on egg production rather than to measure the effect of more moderate variations from usual rates of feeding. Furthermore the procedure was unlike that in the Jensen-Woodward research on milk production in which both total quantity and composition (roughage and concentrates) were varied, in that the different levels of feeding at Glendale involved no change in the composition of the ration. With present knowledge of poultry nutrition it would be possible to design an experiment in feeding for egg production that would be more nearly comparable with the Jensen-Woodward study. Such a design would involve more points within a shorter range at higher levels of feeding and would include changes in the proportions of the constituents in the ration.

The Glendale experiment consisted of two parts, each covering a year. One part of the experiment began December 24, 1935, and ended December 23, 1936. Another part began January 8, 1936, and ended January 6, 1937. The White Leghorn pullets used were divided into groups of 25 each. All were of the same strain and as nearly as possible of the same weight. In the first part of the experiment two lots with three groups of 25 birds each were fed different quantities of an all-mash ration. The birds in the first group in each lot were given unlimited access to the ration, and so ate all they wanted. The second group was fed 87.5 percent as much as the first group and the third group only 75 percent as much. In the second part of the experiment another lot of three groups was used to repeat the same experiment again. The three repe-

titions of the experiment agreed in their results.<sup>13</sup> For simplicity only one repetition of the experiment will be used here.

The results of this repetition are shown in figure 1 by the three heavy circular dots. The three light circular dots represent an adjustment for size of bird, size of egg, and the average efficiency level assumed in the hypothetical curve. As indicated above, the results are those obtained from feeding a full ration and 12½ percent and 25 percent less than a full ration. In terms of the production ration the latter two are evidently on the order of 50-percent and 100-percent reductions from a full ration, far more drastic than any restricted feeding that might be considered practical and much below any level used in the Jensen-Woodward study.

The adjusted dots for the full ration and the 87½ percent ration agree reasonably well with the curve we have assumed. The explanation for the output with the 75-percent ration—in theory, sufficient only for maintenance—lies in terms of other unmeasured variables and in any case is outside the practical range of our present interest. For our purposes, the general agreement of the two upper levels is the important consideration. One cannot draw a curve on the basis of two points, but the fact that they do not depart far from the hypothetical curve gives at least some reassurance. They agree sufficiently to be within probable limits of error. Controlled experimental work on more points between the 87.5- and 100-percent levels would be necessary to establish the curve definitely. The conclusion nonetheless stands that the curvature is so slight that the relationship may be treated as a straight line.

### Requirements, Allowances, and Farm Records

The preceding discussion suggests the anomalous conclusion that rates of feeding for egg production should never be varied. Although the principle of diminishing physical returns operates, the several obstacles to practical application are insurmountable and the possible gains appear to be too small to be worth while. On the face of it, the excellent technical information assembled by the poultry specialists and the recommendation to feed a full

<sup>12</sup> HEYWANG, BURT W. THE EFFECT OF RESTRICTED INTAKE ON EGG WEIGHT, EGG PRODUCTION AND BODY WEIGHT. Poultry Science 19(1):29-34. 1940.

<sup>13</sup> HANSEN, PETER L. INPUT-OUTPUT RELATIONSHIPS IN EGG PRODUCTION. Jour. Farm. Econ. 31:694. 1949.

ration at all times would seem to answer the economic question once and for all. Are we to conclude that no variations from full feeding are ever likely to be profitable under farm conditions? Before trying to answer this question, let us examine some of the differences between research findings, recommended allowances, and farm-record data.

"Feed requirements" for egg production have been worked out by the poultry nutritionists.<sup>14</sup> These represent careful summaries of the controlled research that has been conducted to measure as precisely as possible the maintenance and production needs for laying hens of given weights. The "recommended nutrient allowances" published by the National Research Council contain an additional margin of about 5 pounds more feed per 100 eggs at all levels of egg production than the strict "requirements."<sup>15</sup> The maintenance allowance is also slightly higher. At the 200-egg level this means about 85 pounds of feed for a hen weighing 4 pounds instead of about 74 pounds, according to Titus.

The National Research Council's "recommended allowances" of pounds of feed for egg production have an interesting history.<sup>16</sup> They trace directly to a study published by Byerly in 1941 in which developed a formula to summarize the results of the several available studies on feed consumption for egg production.<sup>17</sup> The studies he summarized included not only controlled experiments but several based on data from egg-laying contests. Byerly's findings indicate higher feed inputs than do those of Titus, Brody, and others, mainly because data from egg-laying contests show higher feed inputs than do closely controlled experiments.

Farm-record data usually indicate even higher feed consumption than the recommended allowances. For example, the following tabulation compares the findings from a few selected studies of farm records with the quantities of feed per layer that the recommended allowances would suggest.

		Eggs per layer	Estimated weight per bird	Feed per layer	
				Actual	Recommended
		Number	Pounds	Pounds	Pounds
Minnesota	1949	182	4½	108	86
Indiana	1945-46	154	4½	93	83
New York	1946-47	172	4½	110	85
Utah	1929-31	157	4	78	79

Under farm conditions, variations in waste may be considerable and statistical procedures in computing average feed inputs probably introduce some upward bias in the data. The significant point is that somewhat more feed is usually reported fed under practical farm conditions and this further complicates estimates of actual rates of feeding and average efficiencies of production.

Now let us return to the question of whether variations in rates of feeding are ever profitable. The simplest case is the one that goes on all the time in making poultry and other rations. That is varying the ingredients in mixed feeds to take advantage of changes in the prices of the individual items. Within limits, this can be done without affecting the quality of the ration. But there are definite limits. The example of the recent "high energy" or "high efficiency" rations as compared with standard rations illustrates this point. Such rations have been developed successfully for broiler production and to some extent for egg production, although more research is needed on the latter question.

High-efficiency rations are balanced rations made by combining ingredients that represent the most efficient sources of each of the desirable nutrients. This involves also the elimination of carriers of undesirable quantities and qualities of fiber and other factors. In this way a more concentrated ration of superior quality is provided and the layer is able to consume a greater quantity of digestible nutrients. The hen's effective capacity is increased and average egg production is raised. But the high-efficiency ration usually costs more. So the economic problem is one of estimating whether the value of the additional eggs is more than the additional cost which must be paid for the entire ration.

An analogous problem arises in connection with the use of home-produced grains in the poultry ration. The home-produced grains available on a particular farm may have an "in place (cost) value" that is appreciably less than that of a pur-

<sup>14</sup> Titus, loc. cit. pp. 801-802.

<sup>15</sup> NATIONAL RESEARCH COUNCIL. RECOMMENDED NUTRIENT ALLOWANCES FOR DOMESTIC ANIMALS. no. 1, RECOMMENDED NUTRIENT ALLOWANCES FOR POULTRY. A report of the Committee on Animal Nutrition. 24 pp. Washington, D. C. Revised March 1950.

<sup>16</sup> National Research Council, op. cit. p. 17.

<sup>17</sup> BYERLY, T. C. FEED AND OTHER COSTS OF PRODUCING MARKET EGGS. Maryland Agr. Expt. Sta. Bul. A1 (Tech.), 29 pp. 1941.



chased-feed mixture and, although sometimes inferior in productive efficiency, it may be more profitable to feed. Some reduction in output will be profitable if it comes about through using a ration enough lower in total cost. In this respect the hen has an advantage over the cow, because any reduction in average cost of the concentrate ration for the hen is reflected through the whole ration.

The principle involved in feeding laying rations of different values and different efficiencies is the reverse of the principle of the "margin" in feeding beef cattle. Cattle feeders ordinarily make a profit from the fact that the feeding operation improves the quality and price of the entire animal. The additional price applies to the whole weight of the animal, so that what would be an excessive feeding cost if figured only against the additional weight put on, is profitable because of the increased value of the entire carcass. In the case of egg production, it is not the value of output but the value of the input item that is affected, so the margin of profit shrinks very rapidly if the average price of the entire feed input advances.

Let us illustrate with an example of a 4½-pound layer producing 200 eggs. Such a layer might be fed 100 pounds of concentrates under farm conditions. Shifting to a high-energy ration might increase the intake of feed nutrients by 5 percent and the rate of lay 10 percent, with an advance in the price of the ration of, say, 10 percent. If we assume the price of eggs at 50 cents a dozen, standard ration at \$5 per hundredweight, and high efficiency ration at \$5.50, additional receipts and expenses may be estimated as follows:

Additional Receipts:	
20 eggs @ 50 cents per dozen =	\$ .84
Additional Expenses:	
100 lbs. feed @ \$5.50 =	\$5.50
Less 100 lbs. feed @ \$5.00 =	\$5.00
	\$ .50

Clearly this would be a profitable venture. But if the price of eggs were only 30 cents, the additional receipts would have been only 50 cents, or no more than the additional costs. Or corresponding increases in the prices of feed with the price of eggs unchanged would have a similar effect.

### Economy in Use of Feed Through Culling

An important means of controlling the use of feed and the average rate of feeding with hens is through culling. The culling process is far more

important with hens than with cows as a means of adjusting profit margins. Under certain conditions of price it may mean the difference between a cash loss and a cash profit. Nonproducing animals are carried at a loss unless there is assurance of later productivity. But the carrying cost is relatively larger for hens than for milk cows because there is not the opportunity for shifting maintenance to home-produced roughage of low cost. Furthermore, low egg production is much more likely to go beyond "the point of no return" than low milk production, because of the large proportion of maintenance charge. A low-producing cow may still pay its way, but a low-producing hen hardly ever does, because it has a relatively larger cash maintenance board bill to meet before showing any net return. Poultry specialists have correctly placed much emphasis on the importance of culling. For example, with eggs at 50 cents per dozen and feed at \$5 per 100 pounds it takes about the first 100 eggs per layer to meet the cash costs of feed. Returns above feed costs then rise sharply, so that a 150-egg hen would show a return of about \$2.16 per hen and a 200-egg bird about \$4.32. The poultryman is something like the small retail merchant who has to own or lease quarters, stock the store, and incur a considerable overhead. He makes no net return at all until the overhead is covered. After that point the profits rise rapidly as his volume increases.

The economic rate of culling will evidently change, however, with different egg-feed price ratios, and with changes in the relative prices of poultry meat. During a single production period many producers do not have much opportunity to add to the number in the laying flock, so that as they proceed through the year, the size of their operations is gradually reduced. This means that the other resources—the buildings, labor, and general overhead are less efficiently utilized. It will not really pay to cull out any hen that is making a return above cash operating costs, taking into account the salvage value for meat purposes currently and later on. This being so, it is clear that changes in relative prices of feed, eggs, and chickens, will affect the economic margin for culling during a production cycle and from season to season. If concentrate feeds become relatively scarce and high priced, one of the first adjustments poultrymen should make is to cull their flocks more carefully and closely. Paradoxically, the statistical ef-

fect of adjusting to such shifts in the economic margin is to increase the average input of feed per layer. Ordinary culling methods are not precise enough to permit a very close adjustment to the economic margin unless some form of trapnesting is feasible for at least part of the time. Consequently many producers may have to be content with culling the obvious low producers in about the same fashion. Frequently the decision as to time of culling turns on the present and prospective level of the price for chicken meat.

### Efficiency in Use of Feed Resources

All of the foregoing is pertinent to the most economical use of feed and other resources in the production of eggs. But how well do hens compare with other livestock in the efficiency of converting feed into food products?

As pointed out earlier, Brody concluded from his studies that the net efficiency of energy conversion in the production of eggs was of the same order as that in the production of milk. "Net efficiency" refers to the efficiency with which the production portion of the total ration is used, "gross efficiency" to the over-all efficiency of the whole ration. His actual findings showed a net efficiency somewhat higher for eggs than for milk, but this was considered within expected limits of error. Net efficiency of energy conversion calculated for the experiment at Glendale, Ariz., comes out at about 75 percent, while similar calculations for estimated average feed requirements by Titus are slightly less.<sup>18</sup> If one computes the net efficiency of conversion on the basis of the National Research Council Recommended Allowances of 14 pounds of feed per each 100 eggs, the net efficiency is only about 49 percent.

The gross efficiency of the entire ration is the more important measure when comparisons are to be made with other types of livestock production. Taking whole milk as 100, average outputs of food products are shown in the tabulation in the next column.<sup>19</sup>

In terms of food energy, eggs are only half as efficient as whole milk, but for protein they are nearly three-fourths as efficient. These comparisons

are in average terms for the United States and for the total ration including, in the case of cows, considerable roughage with very limited alternative uses. If the averages were computed in terms of the most highly commercialized producing areas, the relative position of egg production might be slightly lower. For example, the average milk production per cow in the five States with the highest production per cow is about 30 percent above the national average whereas egg production per hen for the five States ranking highest for eggs is only about 20 percent above the national level.

Food Product	Food Energy	Protein
	<i>Percent</i>	<i>Percent</i>
Milk, whole .....	100	100
Eggs .....	45	71
Chickens .....	33	67
Hogs .....	140	45

The above comparisons explain why wartime production of whole milk has been especially emphasized in places like the United Kingdom in which a large part of the concentrate feed must be imported. In such times and places eggs and pork are still more concentrated products that can better be imported from abroad. In the United States, scarcities of concentrates have never been great enough to call for stringent allocation between classes of livestock, but attention should be directed to ways of promoting more efficient use and of preventing wasteful use of feeds.

### Summary

Technical research in feeding supports the thesis that diminishing physical returns is present in the feed-egg relationship. This may be of the same order as in the case of milk production. But the maintenance part of the ration for laying hens is a much larger proportion of the total ration than is true for cows, and it consists of expensive concentrates instead of roughages of lower price. These circumstances, when coupled with the necessary practice of flock rather than individual feeding, lead to the conclusion that a total curve of diminishing physical returns of the order assumed cannot be distinguished from a straight line. The straight-line assumption of the feeding standard therefore appears sufficiently accurate for practical purposes. This means that full feeding is usually the most profitable for egg production.

<sup>18</sup> Titus, loc. cit., pp. 801-802.

<sup>19</sup> Computed from CHRISTENSEN, RAYMOND P. EFFICIENT USE OF FOOD RESOURCES IN THE UNITED STATES. U. S. Dept. Agr. Tech. Bul. 963, 98 pp. 1948.



Diminishing physical returns therefore does not present the same problem in relation to the economic rate of feeding as it does in the production of milk. But the economic problem does appear in choosing the ingredients that enter a mixed poultry ration and in the choice between "high efficiency" and "standard" rations. The evidence on "high efficiency" rations for egg production is still in the experimental stage but the prospect is that it will be striking. A somewhat similar situation arises in the choice made between farm-produced feeds and purchased concentrates for those who mix their own rations. The general principle involved is a choice between a lower cost and less productive ration on the one hand and a higher cost but more productive ration on the other.

The chief economy that is possible in the use of feed for production of eggs still arises from cull-

ing the low producers. The culling process may involve economic as well as physical decisions because the rate of culling may be varied profitably under different relative conditions of price, provided practical means are available for measuring egg production from individual hens. This conclusion emphasizes the need for devoting research attention to the problem of providing practical means of identifying individual rates of lay more accurately under the usual conditions of commercial flocks. Some form of trapnesting for limited periods may be feasible in some cases. Perhaps more rapid and accurate methods of manual examination can be developed. Some advances appear to have been made recently with methods involving both internal and external examination. Any such leads may well be vigorously pursued and thoroughly tested.

---

## Conducting a Survey of Ownership of Forest Land in California

By Adon Poli

*An extensive type of forest-ownership survey has been under way in California since 1947. This article describes the procedure that was developed for this study and illustrates with a few basic tables the kind of information obtained. The integration of the ownership study with the forest-inventory data obtained by foresters in their regular Forest Survey is an example of the mutual interests of the physical and social scientists.*

OWNERSHIP as a factor influencing the management of forest land is a comparatively new line of research among foresters and forest economists. Interest stems mainly from the realization that attitudes of owners influence the use and management of land. All kinds of individuals and public and private agencies own forest land. They acquire it in many ways, including purchase, inheritance, homestead, gift, and grant. They own it in units of varying sizes, in contiguous and non-contiguous tracts, by itself and in combination with

agricultural and other kinds of land. They keep it for different reasons, only one of which may be for growing timber.

All these factors combined produce complex patterns of land ownership and complex situations which strongly influence public and private programs for management. Studies in land ownership furnish knowledge about the people who own the land and of the patterns their land holdings make. This knowledge helps those who are responsible for administering land-use and land-manage-