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STUDIES IN LAND USE CLASSIFICATION AND IN LABOR EFFICIENCY

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In my discussion of "A Progressive Research Program in Agricultural Economics" I want to develop principally the thesis that the need exists for still more detailed studies and more careful methods of approach than we have been prone to use in the past. I want to illustrate the desirability of this type of approach by citing some preliminary results and thoughts that we have in connection with what we feel may be improved methods of approach in the field of farm management research.

In the state of Washington we have done considerable work designed to aid returning veterans and war workers in connection with the desire of these groups to become established in agriculture. In this process our own division workers, A. W. Peterson, B. D. Parrish and others have co-operated with Dr. O. H. Maughan of the Farm Credit Administration, the Department of Conservation and Development (formerly the State Planning Council), the Soil Conservation Service, the Experiment Stations Soils Section and numerous other groups and agencies in the development of what we have called Economic Land Use Class maps.

As we have worked in this process we have become convinced that a large share of the variations in farm income tend to be associated with areas of differing physical resources. Because of this we have felt that many types of studies and programs in agricultural economics and related fields should be oriented in relation to such areas. We have experimented with records analyzed first in the usual manner and then by Economic Land Use Class areas. The preliminary results have been quite interesting and encouraging. I want to show you some of our results from the analysis of a limited sample of farm management records, first without reference to land class and second in relation to it. Before doing that, however, perhaps I should provide a minimum background on the concept of Economic Land Use Classification.

The Concept of Economic Land Use Classification

First, we have become convinced that there is a rather close relationship between the combinations of physical characteristics of areas and the incomes obtainable therein with good management and adapted types of farming. Second, we draw lines around geographic areas that have the correlations of physical characteristics that are found to be associated with evidences of capital accumulation and income per farm that fall within the range of each of the Economic Land Use Classes, one through five. Economic Land Use Class 1 is used to denote areas of exceptionally favorable resources for the type of farming adapted and results in very high incomes per farm. Area 2 has physical characteristics that result in excellent incomes

and levels of living; area 3, average incomes; area 4, marginal incomes and area 5, submarginal incomes and submarginal levels of living in relation to those considered to be acceptable under our present culture.

The concept of Economic Land Use Classification crosses type of farming area lines as well as most lines of political subdivisions. In fact, we usually find three or more Economic Land Use Class areas within each type of farming area.

Our unit of study and measurement for Economic Land Use Class areas is the individual farm. Although within specific areas maps reflecting the per acre productivity of land are very helpful in drawing Economic Land Use Class maps, the finished maps reflect not differences in productivity per acre but in productivity per farm and to a large extent productivity per man. Thus we may have an Economic Land Use Class 1 or 2 area in a grass range country where physical factors are combined in such a way as to make possible exceptionally large returns per farm unit.

Size of Business

In the typical farm management bulletin quite a point usually is made of the fact that records were taken in all parts of the area studied—some in the bottoms, some in the hills, some up the shoestring valleys, etc. Because the number of records available for study usually is much too small for stable averages in small classifications, the records are all thrown into one group for most analyses. For the same reason only major sorts are made, that is, the records are sorted first by size of business, next by crop index, next by labor efficiency, next by the efficiency of livestock production, etc. Averages for one or more measures of farm income and several other factors usually are computed for each of these sub-groups.

A study somewhat of the type that I have been describing was published in our own division, based on 189 records taken in King and Snohomish counties, Washington for the farm business year 1939.[1] This bulletin tended toward what we now consider to be the right direction by dividing records first into upland and lowland farm groups and then examining variations by size of farm, rates of production and so forth within these groups. In the two counties covered by this study, there is a general tendency for the better lands to be concentrated in the lowland areas and for the poorer lands to be located in the hills. We have since determined that lowlands there vary from Economic Land Use Class 1 to 4 whereas the hills vary from 3 to 5. In a general way, therefore, the group which made this study chose for the area covered a reasonably good basis for dividing land into two general categories. The soils divisions that were made in addition were useful also, but, unfortunately they were derived largely from a consideration of the parent materials rather than from an indication of present and potential productivity.

[1] Rufener, W. W., Maughan, O. H., Pubols, B. H., Carlsen, E. W., and Wheeting, L. C., *Farming Systems in King and Snohomish Counties, Washington, 1939*, Washington Agricultural Experiment Station Bulletin 424, October, 1942, 86 pp.

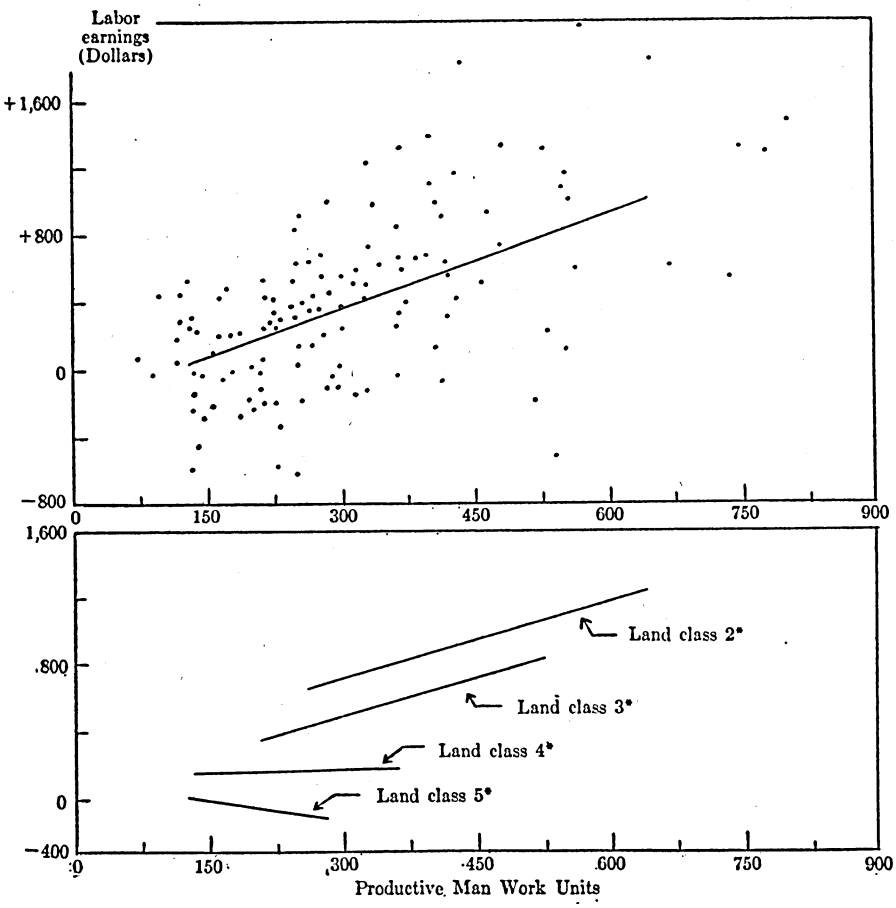

FIG. 1. Labor Earnings of Dairy Farm Operators in Relation to Size of Business for All Farms and for Farms in Each Economic Land Class, 125 Dairy Farms in King and Snohomish Counties, 1939.

The line of relationship in the top half of the chart was determined with the use of all records collected at random from operators of full-time dairy farms. Such a line leads to the erroneous conclusion (if applied generally) that increased earnings result from increasing size of business.

A more thorough analysis of the data made by segregating the records into more homogeneous groups by economic land use classes (bottom half of chart) indicates that there are distinct differences by land class in the relationship between earnings and size of business. Labor earnings increased as size of farm increased for economic land use classes 2 and 3, remained relatively constant in land use class 4, but *decreased* in land use class 5.

The line of relationship between labor earnings and size of farm business had a greater positive slope for all farms analyzed as if they comprised a homogeneous group than for any of the particular economic land use class groups analyzed separately. This is for the reason that even the relatively small farms in land use classes 2 and 3 are larger than relatively large farms for land use classes 4 and 5. Plotting all farms on a chart as if they were similar (top half of chart) results in a concentration of land class 2 and 3 farms at the upper right-hand end of the line and of 4 and 5 farms at the lower left-hand end of the line.

* Line ends drawn to average size of upper and lower one-fourth number of cases. Trend lines are regression lines fitted by the method of least squares.

Following the preparation of Economic Land Use Class maps for King and Snohomish counties in the spring of 1944 Peterson and Parrish regrouped the 189 records taken by Rufener and others for the year 1939 in relation to Economic Land Use Class areas. I want to emphasize especially a chart resulting from this analysis which depicts the relationship between earnings and size of business. The top half of this chart (Fig. 1) is essentially a replica of the chart that appeared as Figure 4 in the first King and Snohomish County bulletin. It was made by plotting labor earnings for each record against productive man work units. All records taken were used without relation to the specific area in which they were taken. An examination of this chart would lead one to believe that despite the considerable scatter there is an unmistakable general relationship between labor earnings and size of business.

The bottom half of the chart (Fig. 1) was made in the same way as the top half except that records within each land class in which records were obtained were analyzed separately. A considerable different picture from that shown above is obtained by this procedure. This chart indicates that in Economic Land Use Classes 2 and 3 increased size of business is associated with increased returns, *but* that in land use class 4 no increase in earnings accompanied increases in size. In land use class 5 there was shown to be a decrease in earnings with increased size.

You will note that throughout the range of each of these lines each land class averaged higher earnings than the next one below. You will note also that the beginnings and ends of the lines are at different positions in the bottom half of the chart. The lines were drawn to the average size of farms in the lower and upper quartile groups. The smallest one-fourth of the farms in land use class 5 were smaller in average size than the smallest group in land use class 4; the smallest farms in 4 were smaller than the comparable group in 3, etc. Similarly the largest one-fourth of the farms in land use class 5 were smaller than the comparable group in 4; the same quartile group in 4 was smaller than the comparable group in 3, etc.

Because of the tendency for farms in land classes 4 and 5 to congregate at the lower left-hand corner of the chart and for those of land class 2 to congregate at the upper right-hand corner, an exaggerated slope was obtained from an analysis of all records as if they were homogenous. For this reason the positive slope of the least-squares line for the top half of the chart is greater than that for any of the sub-groups shown in the bottom half.

Some of you may feel that we have gone further than we should in dividing a small number of records into so many sub-groups that the differences between averages obtained are no longer statistically significant Our defense is that we do not believe farm management records taken in different Economic Land Use Class areas and then analyzed as if they belonged to the same population are sufficiently homogenous to satisfy the assumptions which are inherent in the use of ordinary tests for statistical significance.

We have just completed gathering more than 1400 records for the farm business year 1944 stratified by Economic Land Use Class area. This will provide groups of from 200 to 300 records homogenous for each land class, a sample size for each area sufficient to use satisfactorily the ordinary tests for statistical significance. We are awaiting anxiously the results of analyses of these records. We suspect that we shall find that many of our farm management recommendations, like those of agronomy, horticulture and the like should be varied by areas. What is good farm management for one area may be poor for another.

Another source of information that may be very helpful in this type of study, as well as in many others, is the Master Sample of the United States Department of Agriculture and Census. Four to six farms in each of several areas for each county are included. Boundaries for sample areas are drawn on physical lines and to include the total area for all the farms included. We hope that data for such areas will be made available for use in research work.

Observation leads me to believe that there is a logical basis for the different relationships obtained from the small samples analyzed to date for the different land use class areas. The productivity per man possible in land class 5, especially, is so low that farmers there cannot profitably use hired labor even at the lower wage rates that persist in such areas in comparison with the rates paid in the better ones.

In many of the poorer areas there are actual physical barriers to expansion in size by adding more acres and it seems probable that most such areas already are being used too intensively in relation to the resources available. There is little doubt in our minds that the points of diminishing returns and maximum net income are reached more quickly with the addition of increments of inputs of one kind or another in the poorer areas than they are in the better ones. Possibilities for change in land use (for agricultural purposes) are limited by physical characteristics of the areas and by higher land prices than are justified for more extensive use which are maintained by optimistic buyers who have the widespread human tendency to buy something in the lower-price brackets. They thus create an overvaluation of such areas in relation to better ones.

There is considerable reason to believe that size of business is frequently a result factor as well as a causal one. Businesses are larger in the better land areas than in the poorer ones in part because increasing size pays relatively better in such areas than in poorer ones. Also farmers there have something left over at the end of the year with which to purchase additional land or otherwise expand size.

Labor Efficiency Studies

I should like to discuss briefly now the time and motion study approach to labor efficiency. It is common knowledge that improved labor efficiency usually is related to increased returns and that increased size of business is

associated with improved labor efficiency. General statements occur in many farm management bulletins to the effect that the individual farmer might improve his labor efficiency by making a careful examination of his barn arrangement, feeding practices and other habits. Only a few bulletins, however, have gone into sufficient detail on this subject to give farmers much help.

There are two ways in which a more effective approach to this problem may be made. The first method is to take records on time requirements, distances traveled, etc., under existing methods within a sample of farmers who are doing the job well at the present time. Comparisons then are made to determine which existing methods and arrangements are best. Such comparisons and the conclusions derived represent an extension of orthodox farm management techniques into detailed studies of one specific factor.

The other approach is that of the industrial engineer. Under this method each job is broken into its component processes, analyzed and re-assembled. It is a creative process. Perhaps this type of approach should be the function of the engineer rather than of the economist. In any event it has a place accompanying or following the comparisons of existing methods which clearly fall in the field of agricultural economics.

Studies in labor efficiency of the types outlined have been sponsored by the National Work Simplification group at Purdue University. Funds for starting work in this field were made available by the General Education Board, Rockefeller Foundation. Numerous enterprises and jobs have been studied by workers at several schools who have been spending considerable time on work simplification studies.

At the State College of Washington, C. H. Zuroske of our group has cooperated with the Divisions of Dairy Husbandry and Horticulture on studies of dairy chores and apple picking. The dairy study so far has involved mostly the comparison type of study that I mentioned first, whereas the apple study has involved, among other things, the development of a new picking bucket which enables workers to pick a full box of apples at one trip and allows the elimination of one of the jobs formerly performed—that of leveling the boxes.

I have here some charts that Mr. Zuroske has prepared from typical milking sequences for two dairy herds. These charts illustrate a part of the method and also indicate some of the conclusions that may be derived from these detailed studies. Let's examine first the milking procedure at Bonneville Dairy, Yakima. (Fig. 2). You will note that on this farm the milker goes to a cow with a wash cloth, washes her udder, takes machine off the cow immediately preceding her in the milking process, pours the milk into a pail and then puts the machine on the cow on which he washed the udder. He then gets the pail and goes to the cow from which he took the machine and hand strips for two minutes. Following this he weighs the milk, records the weight and then dumps the pail into a can on the cart. He then gets his wash cloth and washes the udder of the next cow, takes off the machine,

FIG. 2. Typical Sequence of Milking Procedure
Bonneville Dairy, Yakima, Washington
February 19, 1945

Time	Seconds	Job	Feet traveled
	13	Washes udder of cow 21	
	7	Goes to cow 7 and takes machine off	21
4:36	15	Pours milk into a pail which is by the cart behind cow 6	8
	4	Goes to cow 21	14
	26	Puts machine on cow 21	
	8	Takes strip pail to cow 7	21
4:37		Hand strips cow 7	
	120		
4:38			
	7	Carries milk to cart behind cow 6, weighs milk and records weight	7
	5	Pours milk into can on cart	
4:39	18	Gets wash cloth by cart and goes to cow 20	11
	20	Washes udder of cow 20 and tosses cloth to wash pail	
	7	Goes to cow 21 and takes off machine	3
	14	Pours milk into pail by cart	17
4:40	8	Takes machine to cow 20	15
	37	Puts machine on cow 20	
	16	Goes to cow 21 with strip pail	24
4:41	216	Hand strips cow 21	

Supplementary Information

A sequence of 10 cows required 46.9 minutes, an average of 4.69 minutes or 281 seconds per cow.

There were 25 cows in this herd. Twenty-one cows were being milked. There was a total of 62 dairy animals on this 120 acre farm. The cows were milked and fed grain in a milking parlor, fed hay in out-door racks and housed in loafing sheds. One man spent full time milking and cleaning the milking parlor, milk house equipment, and another man spent full time feeding grain and hay and cleaning the barns and lots. Due to labor shortages this herd was reduced from 40 to 25 cows.

FIG. 3. Typical Sequence of Milking Procedure
R. J. Bidstrup, Yakima, Washington
February 21, 1945

Time	Seconds	Job	Feet traveled
3:35	49	Washes the udders of cows 6, 7 and 8	18
3:36	15	Gets milking machine unit from cart which is behind cow 6 and carries it to cow 6	8
	21	Puts machine on cow 6	
	10	Gets second unit from cart and carries it to cow 8	12
	29	Puts machine on cow 8	
3:37	10	Gets third unit from cart and carries it to cow 7	10
	30	Puts machine on cow 7	
	13	Walks to cow 6	3
3:38	18	Adjusts machine and machine strips a few seconds	
	5	Gets wash cloth from pail which is behind cow 7	5
	32	Washes udders of cow 9, 10 and 11	18
3:39	8	Goes to cow 6	10
	9	Checks machine on cow 6. Udder is milked out so he removes machine	
	10	Carries machine to cart behind cow 6 and pours milk into five-gallon can	4
	5	Carries machine to cow 11	20
	22	Puts machine on cow 11	
3:40		The procedure continues in the same order Off cow 7, pours milk and puts machine on cow 9 Off cow 8, pours milk and puts machine on cow 10 Checks machines on cows 11 and 9 Washes cows 12, 13 and 14 Procedure is repeated to cow 30	

Supplementary Information

A sequence of 10 cows required 24.8 minutes, an average of 2.48 minutes or 149 seconds per cow.

There were 75 cows in this herd. Sixty-five cows were being milked. There was a total of 141 dairy animals on this 97 acre farm. The cows were milked and fed grain in a milking parlor, fed hay in out-door racks and housed in loafing sheds. One man spent full time milking, feeding grain and caring for new calves and sick animals, and another man spent full time feeding hay and cleaning the milking parlor, loafing sheds and lots. A third man spent about one-fourth time feeding and cleaning. The hay feeding arrangement was well planned. A power manure loader was used to clean the lots and loafing sheds. Because of the efficiency in milking, cleaning and feeding, a large number of productive man work units per man were accomplished.

pours milk into pail, puts machine on next cow and then returns to hand strip the cow milked last. The average total time required per cow for the milking process is 4.69 minutes or 281 seconds per cow. A very significant portion of this time was spent hand stripping.

Now let us examine the milking process at another large Yakima Valley dairy farm. (Fig. 3). On this farm the operator uses three units of milking machine. He washes the udders of three cows, puts one unit on each of them, and then washes the udders of three more cows. He then goes to the first of the cows on which he placed a unit, sees that the udder is milked out, removes machine, pours milk into five-gallon can and then places unit on another cow. The procedure continues in the same order until all cows have been milked. An average of 2.48 minutes or 149 seconds per cow are required.

The principal differences between the milking methods in these two herds were that the first operator used only one unit (two others were lying idle in the milking shed), hand stripped and weighed the milk individually for each cow. Although comparisons of this sort must be made within the complex framework of considerations of milk production per cow, both present and long-time, possibilities for disease, milk quality and the like it is entirely possible that the farmer who milked his cows in approximately half the time per cow required by the other made considerably more money as a direct result of this difference. In one case 2.25 men cared for 65 milking cows; in the other two men cared for 25 milking cows. In both cases there was a goodly number of other dairy animals. On the less efficient farm Mr. Zuroske was told that the number of milking cows was reduced from 40 to 25 because of the labor shortage.

The examples I have used admittedly show more contrast than usually exists between different dairy farmers. Only limited increases in labor efficiency can be made on many farms, but, nevertheless, labor efficiency studies should become a very valuable supplement to farm management research and should be expanded considerably in relation to the time that has been spent on them in the past. Such work should be especially important in making farmers motion conscious and it should provide them with tools for the analysis of their own jobs. It should provide a basis for improving labor efficiency without increasing size of farm. This is important because not all farmers can, or should, increase size of business.

As with other farm management recommendations those dealing with labor efficiency should be made in relation to Economic Land Use Classes. In such areas labor saved may not justify the additional investment required to obtain it.

In labor efficiency studies the case that is studied is very important. Many of the conclusions must be based on individual cases or very small samples. Hence, it becomes very important to select cases carefully, perhaps one or a few for representativeness and one or a few that represent an exceptionally good job in the field that is to be studied.

Research work in labor simplification may remain relatively unpopular because of the rigorousness of the field work required. Because of the impossibility of setting up routine blanks to cover job methods, most of the field work probably will need to be done by the person who is to make the final analyses.

I have tried to introduce to you the factor of Economic Land Use Class which when used as a primary sorting factor causes data to yield answers that are somewhat different, in some respects at least, from those obtained by more common approaches. I have tried also to give you a brief introduction to the job simplification approach to labor efficiency studies. The land use class concept provides a new sorting factor for use in basic analyses while the job simplification approach provides a more detailed outline than has been available generally for the study of one of our orthodox farm management factors—that of labor efficiency.

I am sure that you will hear more about both of the factors within the next few years.