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TYPICAL FARM THEORY
IN AGRICULTURAL RESEARCH

by

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TYPICAL FARM THEORY IN AGRICULTURAL RESEARCH.

by Dillon M. Feuz and Melvin D. Skold

INTRODUCTION

Economists, farm managers, financial advisors and policy makers frequently need to conduct farm level analyses. There is a continual need to evaluate changing technologies, government farm program effects, and changing market conditions at the farm level. The implications of changing financial conditions, policy options or technological alternatives must be understood at the farm level for educational programs to be designed or for necessary policy incentives to be offered to achieve the desired income support, supply response, or shifts in resource use.

When conducting farm level research, one is always faced with difficult decisions concerning the type of data on which to base the analysis. Frequently there are only a few options available: 1) collect individual data from a farm or a sample of farms to be analyzed; 2) use aggregate state or regionally reported data; or 3) use synthetic farms, often referred to as the economic-engineering approach. Each of these options has its advantages and disadvantages.

The advantage to collecting individual farm data is that the subsequent analyses should adequately describe the farm(s) being studied. One should be confident in the results and recommendations for that specific farm or group of farms. The major disadvantages to this method of doing farm level research are the time required and the high cost for gathering individual farm data. Unless the farms were selected

from a carefully designed random sample, the potential to make general statistical inferences to a broader group of farms is limited.

An advantage to using secondary published data at the state, or other aggregated level, is the data are relatively inexpensive to obtain. The major problem with most aggregate data is the question of what it actually represents, or is it representative of any particular farm or group of farms? Farming in many states is quite diverse, and average aggregate data may not be representative of any actual farming area or any particular farm. Furthermore, risk cannot be represented accurately with aggregate data because much of the variability faced by individual producers is "averaged out" of county, state or national aggregates.

Synthetic farms are often constructed from economic-engineering machinery budgets, agronomic crop response functions, and livestock production coefficients. They offer the advantages of relatively inexpensive data collection and data that should not be biased by peculiar management practices one may find with sample data. While these synthetic farms may represent what could or should be, they often overstate what actually is. For example, production may be overstated, leading to net income being overstated. This can be a problem in evaluating farm level impacts, and it needs to be recognized by those conducting the research.

The creation and maintenance of a set of typical farms, as a data base, can alleviate some of the data problems associated with the other sources of data mentioned. Data can be collected, or synthesized, for a set of typical farms and be quite representative of farms in an actual

area. The costs of doing this are generally less than those associated with collecting data from a large number of individual farmers.

Analyses of sets of typical farms can provide some very useful information. The impacts from changing government policies can be evaluated and compared on different farm types. Likewise, technological changes can be evaluated and compared across farm types. This type of analysis could be very beneficial in predicting such variables as: land values, government program participation, technology adoption, and profitability on various types of farms.

The objectives of this article are to 1) review the history and development of typical farm theory, 2) establish a methodology for justification and classification of typical farms, and 3) address the issues associated with the selection of an actual farm or the creation of a synthetic farm to be typical of a group of farms.

HISTORY OF TYPICAL FARM THEORY

The idea of using typical farms, or more generally representative firms, as a starting place in doing economic analysis has been in economic literature for some time. Alfred Marshall and F. W. Taussig both used this concept in their textbooks on economic principles. Their idea of a representative firm was one that had a fairly long life, was quite stable, and was able to earn an adequate economic profit.

Marshall's idea of a representative firm might be thought of as the average of a class of firms. He stated that a representative firm is managed with normal ability and has normal access to external and internal economies. Taussig was not quite as concerned about the representative firm being average. His idea of the typical firm was a

firm not far in the lead, not equipped with the very latest and best plant and machinery, but well equipped and well led.

Neither Marshall nor Taussig used the concept of representative firms as a tool for empirical research. Both were more concerned with using the theoretical and conceptual framework of the representative firm to explain economic principles of supply and price movements.

Empirical Typical Farm Research

In the 1920's Elliott used the concept of typical farms in doing agricultural economic research. His definition of a typical farm is "a model farm in a frequency distribution of farms of the same universe; or it is representative of what a group of farmers are doing who are doing essentially the same thing." By this definition, a representative farm is one that is typical of the group of farms being represented. It is not necessarily the mean of all the farms in the group being represented, but it is more of a modal concept. Elliott felt that much better recommendations could be given to the farmer using the concept of typical farms than by simply making blanket recommendations to the vaguely defined average farm.

In the late 1950's, Thompson carried out research using the idea of typical farms. He stated that typical farm studies allow for detailed examination and insights into the individual farm, while economizing on the resources required for the study. Like Elliott, Thompson emphasized the point that typical farms should represent a modal concept and not be based on averages. He also suggested that developing a synthetic typical farm may be more appropriate than using any actual farm to represent a group of farms.

In the decade of the 1960's the idea of representative farms constituting a typical or modal concept was replaced by the idea of a representative farm being some weighted average of all the farms in the group. Plaxico and Tweeten thought of a representative farm more as a statistical concept, having a mean and variance associated with it. They emphasized that representative farms should be closely tied to representative resource situations. While much of their research was at an aggregated policy level, they recognized the usefulness of representative farms as providing a framework for analyzing public policy effects on different types of farms.

Numerous researchers conducted supply response studies using representative farms during the 1960's and early 1970's (Sheehy and McAlexander; Zepp and McAlexander; Sharples). Most of these studies were not as concerned with farm level issues as they were with regional responses. The economics profession generally moved away from the concept of modal typical farms.

Some interest was again generated in typical farm theory when the Economic Research Service, USDA began to construct a set of typical farms for the U. S. in the late 1970's (Strickland and Fawcett). They returned to the idea of typical farms being more modal, having a modal complement of machinery and typical enterprises in modal sizes. They stressed that a typical farm was not representative of all farms in the region. This work was interrupted by the death of Strickland and typical farm theory dropped out of the agricultural economic literature.

The farm financial crisis of the early 1980's created a need for more farm level research. Hatch et. al. continued the typical farm

research begun earlier by Strickland and Fawcett. They used census data to create a set of 20 typical farms for the U.S. to be used in evaluations of agricultural policy at the farm level. Their work with census data constituted a more objective procedure for defining typical farm enterprises than had been used in many of the previous studies.

Richardson and Nixon developed the "Farm Level Income and Policy Simulation Model: FLIPSIM" to conduct farm level research in Texas. Kletke began working on a set of typical farms for Oklahoma, Feuz developed a set of typical farms for Colorado, and Murray-Prior and Stanton used the idea of typical farms in work they did on New York dairy farms. Batte, Farr and Lee also used a case farm, or typical farm, approach in simulating effects of various credit programs on farm financial survival. The efforts of these researchers are examples of relatively current applied research aimed at providing useful recommendations at the farm level.

Selection and Classification Issues

Several researchers have discussed the problems associated with adequately defining typical farms and what criteria should be used in making typical farm classifications (Miller and Skold). The criteria used and the resulting classification schemes seem to vary a great deal depending upon the purpose of the research study.

In his work on aggregation error issues associated with using representative farms in doing supply estimates, Miller (1967) found that no set criteria could be used for delineating types of farms. He felt that a unique choice of stratification factors may be best for each

specific research project, but in general he favored a product or commodity based classification.

Collinson discussed some of the problems associated with farm classification. He stated that a classification scheme not based on a specific objective becomes much too complex. Once an objective has been established, then classification should proceed based on limiting homogenous resources, i.e. tillable crop land, pasture land, annual rainfall, etc.

In general, Collinson felt that variations in soil type will normally form boundaries for different types of farms. He identified three general criteria to be used in classifying farms: 1) pattern of climate and soil; 2) common cultural practices; and, 3) fairly constant man/land ratio. The variations in climate and soil will generally be manifested in different cropping and livestock practices. The differences in cultural practices, or regional farming traditions, may be observed as differences in technology employed or cropping practices followed. The man/land ratio may be better expressed as the capital/labor ratio in more developed agriculture.

Thompson's work in defining typical resource situations differed somewhat from Collinson's, but was still primarily resource based. He proposed four common classification criteria: 1) acres of various kinds of land; 2) amount and seasonal nature of labor availability; 3) capital for variable expenses; and, 4) capacity of fixed assets. In addition to these criteria, he also mentioned soil type, topography, and market outlets as being important for geographic stratification. He suggested

that stratification proceed in the following order: 1) region; 2) size; and, 3) commodity.

Thompson stated that the discussion of a typical farm implies 1) that knowledge of the essential characteristics of the group is at hand and 2) that one farm, real or synthetic, can embody these essential characteristics. If the planned use of the typical farm is well known in advance, then Thompson suggests that it may be a relatively straightforward task to identify these characteristics. The characteristics that will be held constant in the analysis also need to be identified.

When actually choosing a farm to be typical of a group, Thompson pointed out that there is nothing to be gained from random selection. He states that a choice based on judgment will be no worse and may be far better. If only one farm is chosen to represent a group of farms, then a random choice may turn out to be the least representative farm. On the other hand, a wise selection could result in a typical farm that is very representative of the group of farms. The use of synthetic farms is also gaining in popularity, according to Thompson, and they may be superior to selection of an actual farm as being typical.

In some of the early work on typical farms, the classification criteria were somewhat more product oriented. Elliott listed crop and livestock systems as the first classification criterion, followed by soil type, topography, precipitation, and length of growing season.

The work done by Strickland and Fawcett for the ERS, USDA on representative farms was also more product oriented. They observed that most farms only produced one or two major agricultural products. Their first step in defining a typical farm was to identify the major output

produced, e.g., winter wheat, corn, or beef cattle. The typical farm was then defined based on cost of production, census data (resources) and other available data. The ERS also uses sizes and locations of farms in creating their sets of representative farms, as well as enterprises found on the farm and the machinery compliments.

Many key issues concerning typical farm theory and application have been addressed in this discussion of the history of typical farm theory. One issue that requires further examination is the errors or biases associated with aggregation and disaggregation of data. Associated with this issue is the distinction between typical farms and representative or average farms.

AGGREGATION ERROR

Some researchers use the terms typical farm and representative farm interchangeably. However, there is a major difference between the idea of a firm being typical in a modal concept, versus being representative in an average concept. The types of data required, the analyses performed, and the interpretations of the results are all considerably different for a typical farm compared to an average farm. The main issue is the potential bias from aggregating farm level data or using average or aggregate data at the farm level.

The aggregation error issue, i.e., using farm level data to perform regional analyses, is well presented by Day, by Miller (1966) and by Lee. Day set up conditions that are necessary to allow one to take results from a representative farm analysis and generalize these to an aggregate level. Miller (1966) and Lee considered the possibility of relaxing some of the restrictions under certain circumstances while

avoiding most of the aggregation problems. Frick and Andrews also looked at some alternative methods of obtaining unbiased supply aggregates. The direction of this research was from the farm level to some aggregate level.

There is also a potential for biased results if one uses average aggregate data to do farm level analyses. Consider the case of three firms (A, B and C) producing the same outputs (Y1 and Y2) with the same technology but with different resource ratios (Figure 1). Many farms are not totally balanced in their resources; e.g., some may have excess labor for the amount of capital, or others may have excess land for the level of capital and labor. If one accepts the postulate that labor and capital markets are not perfect markets, then it is reasonable to assume that on many farms not all of the constraints are binding. That is the case with firms A, B and C in Figure 1. However, if one averages all of the resources available to firms A, B and C, then it will generally be the case that the resources will be more balanced, i.e., all of the constraints are binding.

Two phenomena occur from the use of average data in doing farm level analyses: 1) production is over stated, and 2) there are more production possibilities, which may lead to production distortions. Using the graphs in Figure 1, these phenomena are clearly demonstrated. If one assumes that Y1 and Y2 are like products and that we can add them together, then maximum production from Firm A, B and C is 7.0, 7.4 and 6.0 units, respectively. The total production from the three firms is 20.4 units. However, when the resources are averaged, the average firm can produce 7.0 units, so that total production from three average firms

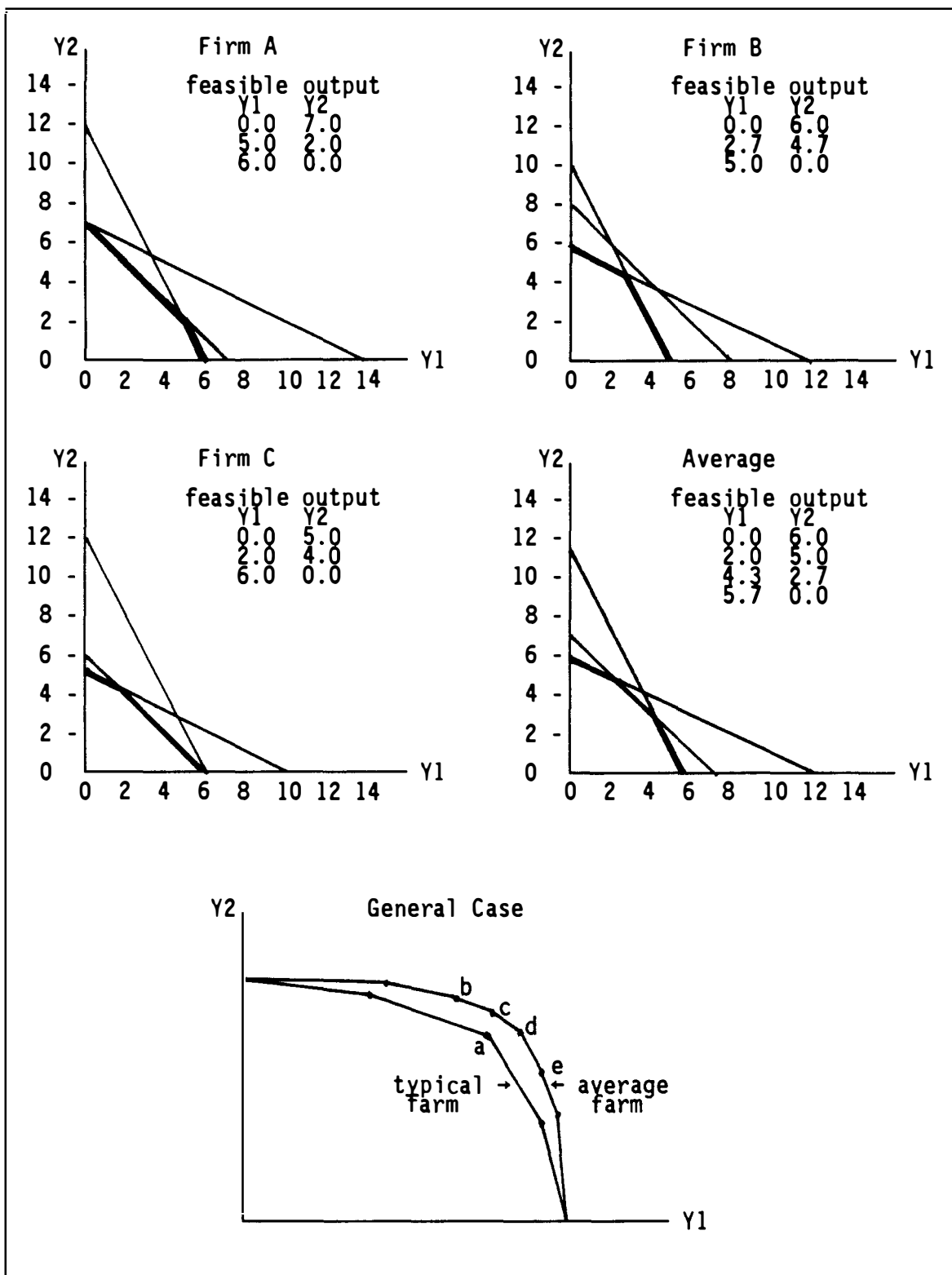


FIGURE 1. GRAPHS DISPLAYING THE POSSIBLE ERRORS ASSOCIATED WITH AVERAGING RESOURCES.

would be 21.0 units. The second phenomenon is observed by noting that each of the firms has three production possibilities (two corner solutions and one interior solution), while the average firm has four production possibilities (two corner solutions and two interior solutions).

The graph of the general case illustrates the possible distortions between a typical, modal farm, versus a representative, average farm. If the price ratio of Y1 to Y2 was such that point "a" would be optimal for a typical farm, then one of three possibilities would occur for the average farm: 1) point "b" would be optimal, in which case production of Y2 would be overstated and production of Y1 would be understated; 2) points "c" or "d" would result in production of Y1 and Y2 being overstated; and 3) point "e" would overstate production of Y1 and understate production of Y2. Which of these possibilities would occur would depend upon the price ratio of Y1 to Y2.

The bias just shown from the use of average aggregate data was based only on resources being averaged. However, much of the data reported at the state or national level also averages several different types of technologies. This could then lead to more potential bias from using average data rather than modal or typical data.

TYPICAL FARM METHODOLOGY

One method of avoiding the possibility of average bias from aggregate data is to develop sets of typical farms. The typical farms are modal farms, or may be thought of as case farms, and they can be real or synthetic. The important characteristic of typical farms is

that the resource base and the technological constraints are typical and are not the average of a group of farms.

Three important issues need to be considered when creating a set of typical farms: 1) justification for the farm type; 2) criteria for stratification; and, 3) the desired level of detail. Agriculture is very diverse in many areas and there are probably hundreds of different farm types in operation in some areas. To attempt to model all of the different types of farms would be very costly and would be a move away from the typical farm being used to represent a large number of farms in an area.

Justification

What warrants the inclusion of one farm type in a set of farms and the exclusion of another farm type? Several criteria could be and have been used in different studies. Resource use -- including land, labor, and capital -- is often used to select farm types. The value of the products produced by farms of a certain type is also important. Specific types of technology employed may be a criterion for some classification schemes.

The actual criteria selected usually are highly dependent on the purpose for doing the farm classification. A purpose for this article is to illustrate to farm managers, researchers and extension personnel the usefulness of using typical farms as the framework for conducting farm level research and developing extension educational programs. Presumably, those farm types which are representative of the largest amount of production and/or represent the majority of farm receipts will be of greatest importance to those individuals.

One also must make a distinction between typical farms and typical farmers. In some areas and for some purposes the emphasis should be on typical farmers rather than typical farms. Having mentioned that caveat, this paper will proceed with a discussion of typical farms.

Classification Criteria

Hazell and Norton identified three rules used in many classification schemes: 1) similar proportions in resource endowments; 2) similar yields; and 3) similar technologies. Rule 1 implies a similar land to labor ratio and often results in various size groupings. As a result of rule 2, irrigated and non-irrigated land is separated. Different soil types, climatic conditions, and topography are also effectively separated. With rule 3, farms are separated according to the predominant crop(s) produced and/or different technologies used in production.

Many states or other regional areas have some very distinct geographic areas. By first separating farm types by these general areas, many of the differences in crop yields due to soil type, climate, irrigation method, etc. can be identified. This is the first step in stratifying the farms into distinct farm types. The second step is to look at the major crop(s) and/or livestock produced. By grouping farms according to similar production, much of the technology employed will also be similar. The third step is to consider the size of operations. Size is generally important if there are economies of size which change the technology employed and the resulting capital to labor ratios.

Level of Detail

The appropriate level of detail is very closely related to the

purpose(s) of the research and the scope of the project. One would generally expect that a set of typical farms for a particular state would have more detail and be more specific than a set of typical farms for the U.S. Likewise, if the primary purpose for the set of farms is farm level analyses, then a very detailed set of farms is probably warranted. This discussion on the level of detail does not imply that more general farm types can be less rigorously defined; rather, it is concerned with the degree of differentiation between farm types. One also must be concerned with the level of detail when actually selecting or creating a farm to be typical of a group of farms.

TYPICAL FARM SELECTION

A very critical step in typical farm research is the selection or creation of an actual farm to represent a group of farms. Two key issues involved are 1) Does the typical farm selected conform to the desired description for that specific farm type? and 2) Are the technologies employed, resources available, and management practices typical to the group being represented? An additional consideration is the use of an actual farm versus a synthetic farm. The choice will probably depend upon the purposes of the research and the preference of the individual conducting the research.

If one chooses to select an actual farm for the typical farm, then, as Thompson pointed out, nothing is to be gained from randomness in selection of that farm. A random selection may result in a farm that is at an extreme end of the spectrum of the farms being represented by a group. Therefore, the farm that is selected should be as typical of the group as is possible to determine. One also needs to be aware of the

influence of management. A farm might be typical in its resources and technology, but if it has superior management, the results obtained from analyses of it may not be typical for the group of farms.

One means of avoiding the management issue is to construct a synthetic farm to be the typical farm. In this manner, typical management skills can be assumed and built into the synthetic farm. Also with a synthetic farm there is not a problem with the disclosure of individual farm data. A fault of many synthetic farms is that they are not typical in the sense that they are too good, too efficient, or too mechanical. For example, a machinery budget may call for a 100 horse-power tractor to accomplish a certain field operation, but a farmer would probably use a 120 horse-power tractor to be sure he could get the job done in a timely manner. So, if one is trying to represent a typical farm, and not an optimal farm, care needs to be taken in the construction of the synthetic farm.

CONCLUSION

Typical farm theory is not new to agricultural economics research. The need to quickly assess the impacts of policy changes and alternative technologies on farms and ranches still makes the typical farm approach to analysis a very useful procedure.

Aggregating and averaging of agricultural production into broad geographic and commodity output groups can lead to some very misleading perceptions about farm level economic impacts. Analytical systems which recognize specific commodity outputs, distinct resource characteristics and local geographic areas, e.g. sets of typical farms, provide the potential to more accurately gauge farm level impacts.

While much of the work with typical farm selection and classification has been and will probably continue to be somewhat subjective, there are some issues that need to be addressed, or at a minimum recognized, by those performing the farm level analyses. Aggregation error and bias associated with some sources of data, justification of farm types, classification schemes, level of detail, and the use of synthetic versus actual typical farms were some of the focal points of this article.

Analysis of typical farms is a very useful tool in assessing farm level impacts. A researcher who understands the strengths and limitations of typical farm theory can perform essential analyses to be used by policy makers and/or individual farmers.

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