# THE CHARACTERIZATION OF COMMERCIAL AGRICULTURE: A TEST OF THE DELPHI EXPERT OPINION METHOD

by

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# THE CHARACTERIZATION OF COMMERCIAL AGRICULTURE: A TEST OF THE DELPHI EXPERT OPINION METHOD

ABSTRACT: Oregon's land use planning program to preserve the agricultural land base and to maintain the agricultural economy is dependent on detailed information concerning the structure of commercial agricultural enterprises. This information is presently incomplete and it was the purpose of this research to test a systematic technique for collecting it. This technique, the Delphi Expert Opinion Method, was developed by the Rand Corporation and basically is a process of structuring communication among selected experts through iterative questionnaires so as to arrive at a final group consensus free of the usual group interaction biases. In order to test the accuracy of the Delphi estimations, a mail-out survey of farm operators was undertaken and a comparison of results made. The Delphi demonstrated an excellent ability to identify qualitative characteristics, such as predominant geographic location and soil types, marketing methods, and location of processors. Its ability to characterize quantitative information ranged from excellent to fair: generally, physical characterics such as farm size, field size, and percentage of leased land were estimated quite accurately; the detailed financial characteristics of initial investments and annual operating costs were less accurate. The research suggests a number

of refinements in the technique which should decrease the time of operation and increase the accuracy of estimations.

## INTRODUCTION

The conversion of farmland to non-agricultural uses has become an issue of local, state, and national concern. The U.S. Soil Conservation Service has calculated that, between the years of 1967 and 1975, three million acres per year of rural land was being converted to non-farm uses (Dideriksen, 1977). After a recalculation of its 1978 census of agriculture, the U.S. Department of Commerce reported an even more alarming rate of decline of land in farms of nearly ten million acres per year (Fletcher and Little, 1982). With respect to the importance of the nation's agricultural land base, the National Agricultural Lands Study (NALS, 1981) projects that all of the cropland presently in production and all of the cropland in reserve will be needed for agriculture by the year 2000.

From this perspective of a soon to be exhausted land base and of a continuing rapid conversion of farmland to other uses, increasing numbers of state and local governments are experimenting with programs to preserve farmland. In order to develop and implement these programs, a number of issues must be addressed and basic information collected on the structure of agriculture at various geographic levels (Healy and Short, 1981). The importance of basing programs on solid information was emphasized in the NALS (1981) report if such programs are to be effective

in preventing development of agricultural land and of being capable of withstanding legal challenges.

In response to the unacceptable rate of conversion of farmland in Oregon, 27 thousand acres per year at the time (Aamondt, 1973), the state legislated that the counties must preserve their farmland in accordance with an agricultural lands goal which was to be promulgated by the state Land Conservation and Development Commission (LCDC). This goal, adopted by LCDC in 1975, requires that exclusive farm use zones be established, and that parcellation within these zones "shall be appropriate for the continuation of the existing commercial agricultural enterprises within the area" (LCDC, 1975). Each county, then, in preparation of its comprehensive plan and implementing ordinances needs to identify what constitutes commercial agriculture. Although commercial agriculture is not defined in the goal or in state statutes, the LCDC staff interpretation states that:

> A commercial agricultural operation is one which will: (1) Contribute in a substantial way to the area's existing agricultural economy; and (2) Help maintain agricultural processors and established farm markets. Therefore, when determining whether a farm is part of the commercial agricultural enterprise, one should consider not only what is produced, but how much and how it is marketed (LCDC, 1982).

Some of the information with which to determine the characteristics of commercial agriculture may be obtained from existing sources, e.g., Census of Agriculture, Soil Conservation Service, Oregon Department of Agriculture and county extension offices. However, these sources alone do not provide sufficient information concerning the structure of agriculture unique to a

specific area (Pease, 1982). Additional information is needed, e.g., the amount and spatial character of rented and leased lands, the predominant soil characteristics, the marketing and processing characteristics, the initial investment and annual operating costs, and the geographic distribution and concentration of operations. A systematic method for collecting this information is necessary if the counties are to meet the state goal of preserving agricultural lands.

The objective of this research, then, is to test such a method, specifically the Delphi Expert Opinion Method, hereafter referred to simply as Delphi, for relatively quickly and inexpensively obtaining detailed information on the physical, financial, and marketing characteristics of commercial agricultural enterprises. The study began with a review of the development and past applications of the Delphi technique. A methodology for application of the Delphi to the characterization of typical commercial farming operations was developed and tested in Linn County, Oregon. In order to evaluate the quality of the information provided by the Delphi, a random mail-out survey of the county's farmers was conducted. The results from the Delphi and the survey were then analyzed and compared. These steps in the research and the conclusions are discussed in some detail in the following sections.

In general, the Delphi is a means of systematically collecting and progressively refining information provided by a group of selected experts. Communication within the Delphi group is facilitated by the use of iterative questionnaires and is

characterized by the following features: (1) anonymity of participant responses, (2) controlled feedback, and (3) statistical group response summary. Originally developed by the Rand Corporation for obtaining consensus among informed individuals without the problems of face-to-face discussion, the Delphi has seen numerous applications in both government and industry. Although now primarily a tool for developing policy and forecasting change, it has been shown to be a rapid and relatively efficient method for gathering current data not accurately known or available (Linstone and Turoff, 1975; Dalkey, 1969; Dodge and Clark, 1977; Mitchell, 1979).

Central to the Delphi is the advantage a group of individuals has over a single individual in making accurate estimations, or the "$n$ heads is better rule" (Dalkey, 1969). The usual procedure for obtaining a group opinion is through a face-to-face discussion; however, as reviewed by Uhl (1971), serious problems are associated with that mode of group interaction: (1) group opinion is influenced by dominant individuals who, while not necessarily the most knowledgeable, tend to talk the most; (2) group discussion often digresses from the question at hand to irrelevant and potentially biasing comments; and (3) group pressure to conform may distort individual judgement. Because group interaction in the Delphi is anonymous through the use of written responses, these problems are largely avoided. In controlled studies conducted by Dalkey (1969), the Delphi proved to be consistently more accurate than traditional group discussion in answering almanac (verifiable) type questions.

The Delphi is divided into two or more rounds: the first round elicits written responses from the experts which are then statistically summarized for the group by median and interquartile range; in subsequent rounds, each participant is provided with the statistical summary of the previous round and another response elicited based on the expert's reconsideration of his answer in light of the group response. Over successive iterations, individual responses tend to converge toward a group consensus as defined by the final median and interquartile range; maximum consensus is usually achieved after two or three rounds (Linstone and Turoff, 1975). A more extensive discussion of the mechanics involved in the Delphi is provided in the following review of its specific application in Linn County, Oregon.

## METHODOLOGY

As emphasized by Linstone and Turoff (1975), the Delphi technique of structuring group communication is not "a neatly wrapped package, sitting on the shelf and ready to use"; the technique is still evolving with respect to methodological variations and the uses to which it is applied. The application of the Delphi in this project reflects the selection of a set of procedures which satisfied the dual objective of not only testing the validity of the technique, but also of providing the participating county with a comprehensive set of potentially valuable data.

Delphi Questionnaire

The first step in the process was the development of a questionnaire with which to facilitate and control the group communication. Based on the decision to provide the county with complete information on commercial agriculture, the questionnaire was designed to cover the full range of farm types in the area and their associated physical, financial, and marketing characteristics. The resulting format consisted of a matrix of 12 farm categories by 22 questions covering 57 individual variables (Appendix A).

The farm categories, excluding grass seed operations, were defined by the Standard Industrial Classification (SIC) system (OMB, 1972) used by the Bureau of the Census in coding data from its census of agriculture. Certain categories consisted of groups of SIC types of agriculture. This grouping was necessary to reduce the number of categories in order to maintain a questionnaire of manageable proportions, and to provide for consistency with other data sources using the SIC system. However, because of their unique characteristics in Linn County, grass seed operations were separated out of the field crop SIC group and treated separately.

The spectrum of questions presented was finalized in consultation with county extension agents, county planners, and academicians in fields germane to agricultural land use. The first section of the questionnaire was concerned primarily with physical characteristics, e.g., geographic location, distance to rented and leased lands, total farm size, field sizes, landform,

and soil type. The second section covered a variety of financial and marketing characteristics, e.g., categories of initial investment and annual operating costs, types of marketing outlets, location and distance to processors, and the openness of the market to new operations.

Essential to the appropriate interpretation of each question was the concept of a "typical" farm operation which meets the definition of a commercial agricultural enterprise as defined by the LCDC. This commercial farm definition, as previously reviewed, was presented to each panelist in a set of questionnaire instructions (Appendix B). By restricting the distribution of commercial farms under consideration to the typical farm, it was hoped that each panelist would be applying the same operational definition, i.e., an average farm which was not unduly influenced by the suspected tendency of panelists to conceptualize on the basis of very large, but atypical, operations. Additionally, the panel was not overloaded with the task of characterizing the gamut of farm size classes.

For each question a space was provided for the panelist to rate his/her expertise on a scale of one (low confidence) to five (high confidence). In a study by Brown (1966), the subgroup of panelists with the highest self-rating had collectively better accuracy than the average; however, such a relationship between accuracy and self-rating was not found to be statistically significant in a later test of the Delphi by Brockoff (1975). Apparently, in some cases, the subjective self-rating of expertise

does not coincide with the panelist's actual objective expertise. Self-ratings were, however, considered to be potentially valuable in selecting the most accurate subgroup in this application of the technique because of the narrow limits of expertise of some of the panelists; a farmer of one type of agriculture may have very limited knowledge of certain aspects of another type and would rate his responses accordingly.

## Panel Selection

The success of the Delphi is, of course, dependent on the quality of the participants. Selection of the experts to serve on the Linn County panel was guided by the understanding that their cumulative expertise would replace a random survey as the basis for the validity of the information obtained. The panelists were selected in consultation with the county extension agents: the minimum requirements were a group which represented a breadth of knowledge on agriculture and which was most likely to provide unbiased responses.

The resulting panel consisted of fifteen farmers, two bankers, two agricultural extension agents, two processor representatives, one farm cooperative manager, one Soil Conservation Service official, one Agricultural Stabilization and Conservation Service official, and one farm commodity buyer for a total of 25 participants. A group of this size was considered to be ideal from the perspective of both manageability and overall accuracy.

In a study of group error as a function of group size, Dalkey (1969) compared the error of groups ranging from one to 29 and found that the average error dropped dramatically when group size exceeded nine and continued to improve as the size increased, although assymptotically after 25. This relationship was less clear in a later study by Brockoff (1975); however, the groups he tested were limited to ones of seven, nine and eleven. Although the relationship of group size to error may not be conclusive, for the purpose of this study a relatively large group was necessary to provide the diversity of backgrounds and to insure that sub-groups defining a specific farm type would be of sufficient size to calculate a meaningful response summary.

Round I

The process of operationalizing the Delphi began with the convening of a panel of experts at an evening session in a meeting room of a Linn County restaurant during the first week of June. Notification of the scheduled meeting was sent to each panelist with an enclosed card to be returned indicating a commitment to attend. Since stimulating a willingness to participate, as well as to do so conscientiously, often requires an incentive such as a token payment or honorarium (Scheele, 1975), a banquet was provided prior to the Delphi. A brief statement of purpose preceeded the dinner and the participants and project investigators were given a chance to get acquainted. Following the meal the tables were cleared, materials distributed, and a detailed

explanation of the Delphi process was provided by the principal investigator. The definitions of typical, commercial agricultural enterprise, and SIC farm categories were stressed, along with the important requirement that participants not verbally communicate with each other concerning responses to the questionnaire. The project investigators responded to questions during the session and attempted to clarify any problems in question interpretation. Upon completion, the questionnaires were collected for later processing and an explanation was given concerning the next iteration which would be mailed out to each panelist.

Response Summarization

The assembled questionnaires were edited to insure that self-ratings were filled out and that questions were answered in the correct units; notations were attached concerning questions which would need to be reanswered on the following round. The data, representing 23,400 total items, were stored on computer tape, and the responses for each question were then summarized by the median and interquartile range for all responses with self-ratings or three or more.

Selection of the median as the best measure of central tendency in the distribution of responses was based on the work by Dalkey (1975),which discusses the analogy of group estimation to the theory of errors of physical measurements. Past applications of the Delphi indicate that the responses tend to follow a lognormal distribution in which the geometric mean is more accurate than the arithemetic mean as a measure of the group estimation. Since

the median of a lognormal distribution is equal to the geometric mean, it serves as a surrogate measure of central tendency. Its usefulness is also evident from its freedom from distortion by extreme estimations and, because it is often used in the description of a distribution to convey the concept of a "typical" observation, it is especially appropriate in this application which emphasizes estimations of a typical nature.

In addition to the median, the response summary included the interquartile range, i.e., those responses lying between the 25th and 75th percentiles of an ordered distribution. This range communicates to the panelists a measure of the spread around the group estimation and serves as an indicator of convergence between successive iterations.

The decision was made to exclude from the statistical summary those responses for which a low confidence in the estimation was indicated by the panelist, specifically any response below a three self-rating. Selection of this cutoff point was a priori, but conceptually supported by the need to appropriately weight the type of expertise unique to each panelist. A test of this presumptive conclusion was included in the analysis of the results.

Round II

The statistical response summary was calculated for each

variable, transcribed on a blank questionnaire, and returned by mail to each of the panel members along with a copy of their original questionnaire. Included in this iteration was a letter instructing them to reconsider their first estimation in light of group response (Appendix C). They were, of course, free to retain their original answer if highly confident of its accuracy; otherwise, any changes were to be recorded on the copy of their original questionnaire. A postage-paid return envelope was provided along with an encouragement to complete the re-evaluation and return the materials as soon as possible. Personal telephone contacts were used to encourage continued participation of those panelists who were slow in responding.

Group Consensus

Because of the complexity of the questionnaire and the consequent expectation that the panelists might do less than a conscientious job, or drop out entirely, a third round was not considered. This lack of a third opportunity to consider the movement of the group response may have left the inter-quartile ranges broader than desirable; however, studies have shown that the greatest convergence occurs on the second or third rounds and substantially less in successive rounds (Linstone and Turoff, 1975).

The revised Round II questionnaires were used to edit the original data file and a final group consensus calculated.

Four of the panelists returning questionnaires were eventually dropped from the Round II summary because of perceived lack of careful reconsideration of their original responses. The final panel consisted of 16 expert opinions whose group response summary was used in the validation test.

## Validation Instrument

In order to test the accuracy of the Delphi results, a random survey of Linn County farm operators was undertaken. The survey, prepared in cooperation with county extension agents and the university's Survey Research Center, was designed and implemented in accordance with Dillman's (1978) Total Design Method. Care was given to shaping a survey instrument which would obtain the best possible responses and to organizing the survey process such that each step would be carried out in full detail and on schedule.

Identifying the population of farm operators which would be sampled presented a problem because the most complete documentation available, as compiled by the U.S. Bureau of Census, is confidential information and not available for use by anyone other than the Bureau. The next most comprehensive list of operations located was one maintained by the Agricultural Stabilization and Conservation Service (ASCS). This list is compiled on Addressograph plates and serves as a mailing list for correspondance and the ASCS Newsletter. It represents,

in its unorganized linear format, a random population of potential farm operations of commercial scale. Each plate consists of a name and address, plus coded information on ownership, farm size, cultivated acres, number of separate tracts, and general geographic location. The number of farms listed as either "operator" or "owner-operator" totaled 1,518 which compares fairly closely with the Census of Agriculture (Bureau of Census, 1981) count of 1,695.

In consultation with the Survey Research Center, a 33 percent sample size was selected and the sample population drawn by selecting every third name from the ASCS list. A name was skipped and not counted in the sequence if the address was for an owner, but not an operator. The resultant sample consisted of 512 potential commercial farm operations. A subsequent re-sample was necessary to include more horticultural and dairy enterprises identified as being under-represented by the county extension agent.

The survey questionnaire was designed to elicit responses on the same set of variables as the Delphi exercise. The format was significantly simpler in that the respondent categorized his operation and then answered the questions accordingly; it consisted of a title page explaining the project and three pages containing 16 questions (Appendix D). The questions were worded to minimize problems in interpretation and arranged to provide for an ease in answering. A pre-test was conducted which

suggested some minor changes; however, all the problems were not corrected, as is discussed in the analysis of the process.

The structure and timing of the various steps in the survey process closely followed the Dillman method, except that prior to the first mailing, an article was placed in the county extension service bulletin which summarized the study and asked the cooperation of farmers receiving the forms. The initial mailing was made in mid-June and then followed two weeks later by a reminder card to those who had not yet responded; after five weeks a final plea and a replacement questionnaire was sent to the remaining non-respondents[1] (Appendix E).

As each survey was received, it was checked for inclusion in the sample. Respondents who did not answer key questions, such as for farm size or gross value of products sold, were excluded; other questionnaires were returned unanswered because of operator retirement or death, sale or lease of the land, or land not in farm use. Each complete questionnaire was reviewed for respondent errors and coded for keypunching and subsequent analysis.[2] The survey process was terminated two months from the first mailing; however, straggling responses were included up until the final analyses were completed.

## RESULTS

A discussion of the Delphi and survey is followed by the validation and associated tests of the Delphi technique as applied in this study. To this end, a number of tasks were

indicated: (1) analysis of the Delphi and survey processes and their results, (2) selection of farm categories which were measured with the highest precision for the validation, (3) identification of that subsample in each category surveyed which met the commercial agricultural definition, (4) elimination of variables which were not adequately measured, (5) comparison of the Delphi and survey results and calculation of the accuracy of the Delphi, and (6) an examination of the effect of iteration, self-rating, and panelist occupation.

## Delphi

The completeness with which the Delphi questionnaires were answered on both rounds was quite variable, a result not unexpected because of the diversity of backgrounds on the panel and the differences in general knowledge concerning major versus minor farm categories. The leading agricultural enterprise in Linn County, grass seed, was characterized by more panelists on Round I than any other category, specifically, 60 percent responded on this category as averaged across all questions answered by panelists who indicated a self-rating of three or more. The response dropped to only 16 percent answering questions on horticultural operations. On the final round, the proportion of panelsits, with self-ratings of three plus, responding to each of the farm categories fell into the following order: grass seed 68 percent, cash grains 56 percent, general crops 50 percent

field crops 44 percent, vegetables 38 percent, Christmas trees 38 percent, berries-grapes-tree fruits-nuts 31 percent, intensive animal husbandry 31 percent, dairy 31 percent, general livestock 25 percent, extensive animal grazing 19 percent,and horticultural specialties 19 percent. Selection of those categories with the highest panel input for comparison in the validation test was emphasized, but would, of course, remain subordinate to the categories measured with the greatest precision in the validation instrument.

The number of panelists returning questionnaires on Round II represented a 36 percent drop in participation from Round I. Such an attrition is not uncommon in mail-back Delphi questionnaires; as reviewed by Dodge and Clark (1977), other Delphi exercises have lost from 38 to 68 percent of the participants over several rounds. Even carefully designed and executed mail surveys of general populations show a nonresponse rate of from 24 to 41 percent, and the longer the questionnaire, the higher the nonresponse (Dillman, 1978). Because of the recurrent and extensive demands on the panelists' time imposed by a questionnaire of the length and complexity used in this research, the observed 36 percent loss was not considered excessive. The possibility that a self-selection bias, resulting from the chance that those who continued to participate differed systematically from those who dropped out, was considered. Although seven of the nine panelists choosing not to participate in Round II were farmers, the difference in panel composition was not

found to be statistically significant; the Chi-square test of expected panel composition to the actual composition did not suggest that the dropout of the farmers was due to anything other than chance, $X^2$ = .126 (P=75%). The group response, then, of the final round represents the considered opinion of a smaller, but not overly dissimilar, panel of experts, and may be of interest to the county in its raw form.

A considerable variation in the rate of response to different questions was noted during both rounds. On the final round,the number of panelists answering any single question, as averaged across all farm categories, ranged from 64 percent identifying the predominant landform to 17 percent placing a value on miscellaneous annual operating expenses. With respect to general question categories, the Delphi showed the greatest ease in answering questions on physical characteristics; response to geographic location, farm size, and field size was highest relative to more complex physical questions on the relationship between soil quality and field size as both relate to rent distance; the greatest difficulty was in discerning a relationship between farm size and farming district.

Fewer panelists answered questions on the financial characteristics than for any other general category, and of these, approximately twice as many were more confident in estimating initial investments than annual operating costs. This difference in response was probably due to the general versus specific information requested, i.e., knowledge concerning initial

land, building, and equipment costs would be more widely held than the specific annual costs of energy, labor, maintenance, and interest on equipment. With respect to the marketing questions, the panel was more confident in describing the openness of the market to new operations than in estimating the breakdown of marketing outlets and processor locations. The fewest answers were tallied for the estimation of the minimum acreage necessary to arrange a contract with a buyer or processor; however, this low response may be more a reflection of question format than a problem in answering, because the wording allowed a nonresponse in place of a definite answer.

Of central importance to the Delphi technique is the encouragement of convergence over successive rounds. Hopefully, as the spread of the interquartile range narrows, a focus of opinion occurs and the group estimate converges on the true value or quality. Ideally, this study would have included sufficient iterations to detect an end point to significant change in the summary statistics. However, for the reasons previously discussed, the study was terminated at two rounds and the data accepted with the implied caveat.

Convergence was observed in the spread of the interquartile range in 58 percent of the group estimates for Round II. The amount of convergence ranged from zero to 100 percent for any single question on a single farm type and from 13 to 51 percent as averaged across all farm types. Unfortunately, interpretation of the significance of this convergence as an indicator of

of consensus was impaired by the lack of additional iterations, and, more importantly, by panel attrition. Panelist dropout may cause the median to move and the interquartile range to increase or decrease simply by the loss of data items in their determination; indeed, an increase in the interquartile range was noted in 7 percent of the questions. Analysis of the effect of panelist dropout was limited by the fact that the estimations of participants who were not included in Round II contributed to the group response on which the final panel based its reconsiderations. Simple elimination of dropouts from Round I and the comparison of recalculated response summaries to Round II would have been specious. Nevertheless, the observed convergence was an encouraging sign that the participants were approaching a consensus on many of the questions.

Changes in the median values from Round I to Round II occurred in 26 percent of the questions as averaged across all farm types. With respect to single farm types, the fewest changes were noted for berries-grapes-tree fruits-nuts, 12 percent, and the most for extensive animal grazing, 41 percent. Again, it must be noted that panelist dropout may have contributed to the movement of the medians and, that without additional iterations, stabilization of this measure of central tendency as another indication of consensus could not be determined. Also, the medians were of dubious value for those questions with very few responses, and especially in the cases of fewer than three. When the ordered distribution of responses was not symmetrical, the closest and/or higher value was reported as the median.

Survey

Selection of a mail questionnaire instead of more easily controlled telephone or face-to-face methods necessarily reduced the expectation of a high response rate; however, response rates of 60 to 75 percent should be expected for carefully administered mail surveys of the general public (Dillman, 1978). The final response rate in this survey was just over 63 percent, which was considered adequate considering that farmers in the summer are less likely to take the time to participate than at a less demanding season. The initial mailing achieved a 44 percent response, which was subsequently increased by the two follow-up reminders. The extra time and expense of such follow-up efforts were considered justified by the substantial increase in returned questionnaires.

A problem with the ASCS list of farmers was apparent from the number of surveys returned unanswered. Slightly over 24 percent of the questionnaires were of no use because the persons to whom they were addressed were either retired, deceased, or had sold the farm. Evidently the list is not updated with respect to these events. Five percent of the surveys were unusable because the land was used for non-agricultural purposes e.g., timber holdings, rural residential, or "hobby farms" with no outside sales. Two and one-half percent of the surveys were returned unanswered, either with a stated reason for refusing to participate or no reason at all.

For the 36 percent of the sample for which no response was

received, the possibility of a nonresponse bias was considered from a geographic perspective, i.e., did the nonrespondents show the same geographic distribution as those who chose to participate. Because the ASCS list was coded into 11 regions and the questionnaires numbered accordingly, an evaluation of distribution was possible. The expected nonresponse did not exceed 10 percent in any single region and varied an average of only 6.5 percent over all regions. Obviously the nonrespondents were not associated with one area of the county over another. However, whether they may have differed in some other systematic way was beyond the scope of this research to determine.

For the purpose of the validation test, only that farm category surveyed at the highest level of measurement precision was selected. The first step in determining this best characterization was an analysis of the survey results in relation to the 1978 Census of Agriculture data. The decision was made to eliminate from consideration those farms which were obviously not contributing in a substantial way to the area's agricultural economy. An initial cut was made at operations of each farm type reporting gross sales of less than $2,500 and the remaining number of operations then compared to the known population as reported in the census. Many of the survey respondents consequently dropped were very likely "hobby farms" whose inclusion would have suggested a higher sampling rate of commercial farms than was actually the case.

As noted (Table 1), no farm operation from the survey

characterized itself in the Cash Grain category and very few in either Intensive Animal Husbandry or Extensive Animal Grazing. The obvious problem with the survey sample of General Livestock being greater than the census population indicates that some farmers were characterizing their operations quite differently than was the census bureau. A similar problem occurred in the Cash Grain situation in which these farmers probably categorized themselves as General Crop Farms (Hickerson, 1982). The sample proportion of Christmas Tree operations was unknown because they are not considered in the census of agriculture. These problems brought into question the reliability of the survey for these categories and therefore their value as tests of the Delphi.

Horticultural Specialties were well represented in the survey, and, to a lesser degree, so were Vegetable, Field Crops (Grass Seed), and Dairy operations. While Grass Seed was characterized separately in the survey, it is grouped with Field Crops in the census. Because nearly all large field crop farms in Linn County are engaged exclusively in the production of grass seed, the Grass Seed category of the survey closely approximates the Field Crops data in the census (Hickerson, 1982). These operations, then, appear to have been surveyed without the aforementioned problems and might qualify as validation test data. The Berries-Grapes-Tree Fruits-Nuts category was dropped at this point because it was recognized as too broad to be characterized as a single group.

Table 1. Farm Survey Response Breakdown by Standard Industrial Classification Category for Farms with Gross Sales over $2,500/year

| Farm Category | Census Population (N) | Survey Sample (n) | Percent of Population (n/N) |
|---|---|---|---|
| Cash Grains | 49 | 0 | 0% |
| Field Crops (Including Grass Seed) | 296 | 39 | 12.8% |
| Vegetables and Melons | 43 | 8 | 18.6% |
| Berries, Grapes, Tree Fruits and Nuts | 38 | 4 | 10.5% |
| Horticultural Specialties | 18 | 8 | 44.4% |
| General Farms, Primarily Crop | 35 | 5 | 14.3% |
| Intensive Animal Husbandry | 113 | 4 | 2.6% |
| Dairy Farms | 48 | 5 | 10.4% |
| General Farms, Primarily Livestock | 8 | 29 | * |
| Extensive Animal Grazing | 445 | 16 | * |

* Farms in survey not categorized the same as in the Census of Agriculture, see text.

The remaining categories--Grass Seed, Horticultural Specialties, Vegetables, and Dairies--were next analyzed to determine the range typical of farm sizes which contribute in

a substantial way to the agricultural economy. In order to establish a measure of what constitutes a substantial contribution, the census data was reviewed and the relationship between size and total gross farm sales was noted. The minimum size was set at that level above which the aggregated farms contributed in excess of 90 percent of the total gross sales. The upper limit of the range was then set based on the modal size class above the minimum. The resulting subsamples for each category which satisfied the concept of typical (modal) commercial agricultural enterprises fell into the following size ranges: Grass Seed farms of 320 or more acres, Vegetable farms of 160 to 999 acres, Horticultural Sepcialties of one to 40 acres, and Dairies of 40 to 499 acres.

Examination of the survey results for these subsamples indicated few problems with question interpretation or answering. Except for questions dealing with the distance a farmer is willing to travel to rent fields of specific size and soil quality combinations, most respondents showed little trouble in answering questions on physical characteristics. Also, little difficulty was noted in answering most questions in the financial and marketing categories; however, the miscellaneous section on annual operating costs was often left blank. Although designed to be as clear as possible, three questions presented a problem: land value, miscellaneous operating expenses, and taxes and insurance. It was not clear whether or not land value included rented and leased lands; miscellaneous expenses included major

fertilizer and chemical costs which should have been itemized separately; taxes could have meant income as well as property. These questions were dropped from further analysis and from use in the validation test.

A variety of descriptive statistics were calculated for the remaining variables: mean, mode, standard deviation, standard error, and .90 confidence limits.[3] The latter were calculated for each sample in order to evaluate the effect of sample size on the reliability of the data. Inspection of these confidence intervals for each category revealed that the survey characterization of Grass Seed operations measured the means within the narrowest limits of error. Because of the small sample populations for the other categories, the confidence intervals were consistently quite large, even though the proportion of the known population was relatively high.

Comparison of the survey to census data (Table 2) also points to the Grass Seed category as being the most accurately characterized. According to the census, the mean farm size for the size interval under consideration was 996 acres compared to the survey mean of 1,076 acres. Also, the gross value of farm sales, if adjusted for the increase in price received since the measurement in 1978 (USDA, 1982), compares fairly closely to the survey. A test of other variables also measured in the census was not possible because of the suppression of data at the county level.

Table 2. Comparison of Census of Agriculture* to Survey (Farms within Specified Size Ranges, only)

| | Census Means | Survey Means |
|---|---|---|
| Grass Seed (Field Crops) | | |
| 320+ acres | | |
| Total sales | $218,210 | $251,206 |
| Total acres | 996 | 1,076 |
| Vegetables | | |
| 160 - 999 acres | | |
| Total sales | $168,439 | $215,500 |
| Total acres | 315 | 434 |
| Dairy Farms | | |
| 40 - 499 acres | | |
| Total sales | $149,465 | $280,000 |
| Total acres | 134 | 180 |
| Horticultural Specialties | (Data suppressed by Bureau of the Census) | |

* Adjusted to 1981 crop year prices (USDA, 1982)

Validation Test

As revealed in the foregoing analysis of the results of both the Delphi and the survey, the Grass Seed data was shown to be the best characterization with which to test the accuracy of the Delphi Expert Opinion Method. The survey mean of the selected size class typical of commercial grass

seed operations (320+ acres) was compared to the Delphi estimations and a standardized error calculated. The Delphi's error for each variable was calculated as the absolute value of the survey statistic minus the Delphi statistic divided by the survey statistic. This method of measuring the error was selected in order to standardize results expressed in dollars, acres, percent, miles, etc. The error may be conceptualized as that factor by which the actual value (survey) must be multiplied to give a value which is then either added to or subtracted from it to equal the Delphi value. In those survey variables where a single value represented over 50 percent of all values, the mode was selected as the best measure of the typical situation to use in the error calculation.

The accuracy of the Delphi estimations was extremely good on some questions and less so on others (Table 3). With respect to the main question categories, the Delphi most accurately characterized marketing and processing followed by physical and then financial characteristics: an average error of .055, .118, and .265, respectively. The error on individual question variables ranged from .000 to 1.174 with a mean of .164. The mean error was determined from 42 of the 57 variables measured and did not include those variables dropped because of interpretation problems, those not surveyed, and those with an undefinable error, i.e., when the divisor was a zero.

The Delphi accuracy was highest, zero error, when identifying qualitative characteristics, such as predominant soil type or

Table 3. Comparison of the Delphi Characterization of Typical Commercial Grass Seed Operations to the Validation Instrument (Survey)

| | Delphi Question | Survey (A) Characterization | Delphi ($A_1$) Characterization | Error $\frac{A - A_1}{A}$ |
|---|---|---|---|---|
| 1. | Annual value of total farm sales | $251,206 | $200,000 | .204 |
| 2. | * | | | |
| 3. | Total acreage (including rented and leased land) | 1,076 | 1,000 | .071 |
| 4. | ** | | | |
| 5. | Size by Farm District | | | |
| | District I | 526 | 500 | .049 |
| | District II | 1,018 | 1,000 | .017 |
| | District III | 702 | 500 | .288 |
| 6. | Landform | Terraces | Terraces | .000 |
| | Soil Type | Wet, clayey | Wet, clayey | .000 |
| 7. | Field size on most common soil | 78 | 80 | .026 |
| 8. | Minimum field, most common soil | 10 | 10 | .000 |
| 9. | Field size on better soils | 51 | 50 | .020 |
| 10. | ** | | | |

| Question | Survey | Delphi | Error |
|---|---|---|---|
| 11. Percent acreage rented or leased | 48.4% | 60% | .154 |
| 12. Location of rented or leased land: | | | |
| Adjacent | 56% | 35% | .375 |
| Less than 5 miles | 36% | 30% | .167 |
| 5 to 10 miles | 0% | 20% | *** |
| More than 10 miles | 0% | 10% | *** |
| 13. to 16. Miles willing to travel to rent fields: | | | |
| Typical size/ common soil | 8.8 | 10 | .136 |
| Minimum size/ common soil | 2.7 | 5 | .851 |
| Typical size/ better soil | 9.9 | 10 | .010 |
| Typical size/ poorer soil | 4.0 | 5 | .250 |
| Minimum size/ better soil | 2.3 | 5 | 1.174 |
| Minimum size/ poorer soil | 0 | 0 | .000 |
| 17. Minimum initial investment: | | | |
| Buildings | $111,937 | $ 80,000 | .285 |
| Machinery and equipment | $209,687 | $150,000 | .285 |
| Livestock | 0 | 0 | .000 |

| Question | Survey | Delphi | Error |
|---|---|---|---|
| 18. Annual operating costs: | | | |
| Livestock replacement | 0 | 0 | .000 |
| Energy | $10,379 | $13,000 | .253 |
| Labor | $17,015 | $13,000 | .236 |
| Repairs | $ 8,460 | $12,000 | .418 |
| Interest on equipment | $ 6,502 | $10,000 | .538 |
| Equipment replacement | $17,700 | $25,000 | .412 |
| 19. * | | | |
| 20. Openness of market: | | | |
| Very limited | 8% | 0% | *** |
| Somewhat limited | 38% | 45% | .184 |
| Open | 54% | 55% | .018 |
| 21. Marketing outlets: | | | |
| Broker, dealer, warehouse | 100% | 90% | .100 |
| Auction | 0% | 0% | .000 |
| Marketing association or co-op | 0% | 10% | *** |
| Retail sales | 0% | 0% | .000 |
| Other | 0% | 0% | .000 |

| Question | Survey | Delphi | Error |
|---|---|---|---|
| Distance to marketing outlets: | | | |
| Broker, dealer warehouse | 14 | 10 | .286 |
| Auction | 0 | 0 | .000 |
| Marketing association or co-op | 0 | 15 | *** |
| Retail sales | 0 | 0 | .000 |
| Other | 0 | 0 | .000 |
| 22. Location of Processor: | | | |
| In county | 100% | 90% | .100 |
| Other valley counties | 0% | 10% | *** |
| Other in-state locations | 0% | 0% | .000 |
| Out-of-state | 0% | 0% | .000 |
| Another country | 0% | 0% | .000 |

*Question omitted from survey or ambiguous, see text.

**Inadequate data

***Error undefined because divisor zero or unity.

the typical utilization of a type of marketing. Accuracy was also quite high, .029 error, in defining the areal extent of overall farm size and field sizes. However, the error increased when determining the distance to rented or leased land and the distance a farmer would be willing to travel to rent or lease fields of a specific size and soil quality. Some of this error may have been the result of the small distances being estimated and the possible tendency to "round off" to inappropriately large intervals; in question 16 the survey distance of 2.3 miles compared to the Delphi rounded off distance of five miles gave an error of 1.174, the highest noted for all variables.

The ability of the Delphi to characterize the initial and annual expenditures of a typical grass seed operation was consistently lower than for other question categories. The error ranged from .204 to .538, not including the zero errors for livestock costs which were fundamentally "either-or" questions and not comparable to the quantification called for in the remaining variables. Questions on financial characteristics proved to be the most troublesome to the Delphi; the fewest panelists responded to these questions compared to the high survey response of farmers with access to records. In general, the Delphi underestimated the initial minimum investment necessary to start up a new operation and overestimated the annual operating costs.

The very accurate characterization of marketing outlets and processing locations largely reflects the previously noted ability of the Delphi to accurately identify qualitative

characteristics. This accuracy may also result from the way in which the error was calculated. For example, although the Delphi incorrectly estimates that up to 10 percent of a typical operation's production is marketed by a marketing association or cooperative (33 out of 36 farms in the survey did not), the other three possibilities in the question are correctly not selected and zero errors were tallied into the final error; undefinable errors, whenever the survey answer is zero and the Delphi is non-zero, result in some inaccuracy not being added into the average error and thus a tendency to inflate the overall accuracy. This latter problem occurred in six of the variables for the entire questionnaire and needs to be accounted for in assessing the accuracy of any given estimation.

The chance that the survey selected a population of grass seed farms which as a whole was significantly different from that characterized by the range of Delphi responses was examined statistically. Based on the Delphi response summary, i.e., the median, the expectation that one-half of the survey results would fall below the Delphi median and one-half above was tested across all variables except those requiring a non-numerical response or a percentage breakdown. The latter were excluded because of the constriction of the response distribution at either end of a zero to 100 percent scale. The Chi-square test criterion was consistent with the null hypothesis that the observed distribution of survey results was not significantly different from that expected from the Delphi (P=25%).

Three aspects of the Delphi process were analyzed with respect to their possible effect on the accuracy of the characterization, viz., questionnaire iteration, panelist self-rating, and panelist occupation. The results of Round II compared to Round I showed limited change: less than one-quarter of the medians shifted, 56 percent becoming more accurate and 44 percent less accurate; convergence of opinion occurred in 53 percent of the variables and divergence in 17 percent. However, as noted previously, the interpretation of the significance of convergence is open to question because of the artificial influence of panelist attrition. The effect of questionnaire iteration, then, was inconclusive.

The effect of panelist self-rating was examined for high and low minimum scores. Including all panelist estimations in the calculation of a group response by lowering the minimum self-rating to one had a negligible effect on the overall accuracy. This unexpected result was due to the high confidence of panelists: only one or two of them, depending on the specific question, rated their confidence below a three with the only consistent effect of their inclusion being to change the interquartile range. Similarly, a high minimum self-rating, greater than a three, had no consistent effect on accuracy; 12 percent of the variables were more accurate, 14 percent less accurate, and there was no association of a change in accuracy with any specific question category. Apparently, even though over half of the panel rated

themselves as highly confident, they were , in fact, no more accurate than those rating themselves moderately confident.

Six of the panelists on Round I were grass seed farmers and, interestingly, their estimations were slightly less accurate than the panel as a whole. They characterized 26 percent of the variables more accurately, 37 percent less so, and 37 percent the same. Also, these farmers, ostensibly the most knowledgeable group, did not characterize any of the three major question categories better than the full panel. On the other hand, the single most accurate overall characterization was provided by a grass seed farmer, and the most accurate response to any specific question category was provided by one or another of these farmers.

The other panelists participating in the characterization of Grass Seed included other types of farm operators, agricultural specialists, bankers, and businessmen associated with the production, marketing and processing of farm products. This diverse group also did not attain a higher accuracy than the panel as a whole and was even less accurate than the farmers. For this group, an agricultural extension agent achieved the highest overall accuracy, as well as, the highest accuracy for the physical characteristics question category. Appropriately, marketing and processing questions were best answered by a commodity buyer for a processing plant, and financial questions were best answered by a bank representative.

Time and Cost Comparison

Because the operationalization of the Delphi and the survey in this study did not necessarily reflect the most efficient methods, rigorous comparisons of the time and costs between the Delphi and the survey processes were not possible. With this caveat in mind, some general comparisons were made. Questionnaire development took close to the same amount of time, but production costs heavily favored the Delphi, which were approximately 85 percent less than the survey. The Delphi distribution costs, which included the banquet and questionnaire mail back, were about one-half as much as the coding, envelope stuffing, mailing, and follow-up costs of the survey. Data processing costs, even with a less than efficient system used in Round I, incurred by the Delphi were around one-half as much as coding, keypunching, and analyzing the survey data. The time of implementation and data analysis was about 75 percent less for the Delphi, and had the iterations been concluded in one evening, as originally planned, it would have taken less than 2 percent of the time required to conduct a survey.

## CONCLUSIONS

This study set out to test an alternative system of characterizing commercial agriculture: the Delphi Expert Opinion Method. Whether or not this technique has done a satisfactory job is necessarily based on the judgement of what level of accuracy is acceptable. Clearly, the method is very accurate

with respect to identifying qualitative characteristics and of variable accuracy with respect to quantitative characteristics. The value of this research, then, lies not so much in conclusively validating or invalidating the technique, but rather in providing potential users with a basis for judging its value and for refining future applications.

The results suggest several conclusions regarding subsequent applications of the Delphi in characterizing commercial agriculture: (1) reduce the number of farm types under consideration at one time, (2) conclude all iterations in a single session, (3) maintain the size and diversity of the panel, (4) simplify the questionnaire format and avoid ambiguous or overly general questions, (5) specify maximum measurement intervals to control potential round-off error, (6) provide for panelist access to detailed information, and (7) develop efficient means of processing the data between iterations.

In order to avoid the problems of panel attrition between successive iterations by mail, the Delphi should be conducted in a single session. Such a session would require that the number of farm types considered by a panel be reduced, possibly to only one. Several separate panels could be organized to characterize each of the farm types. Completing the iterations in a single session would also have several other advantages: encouragement of the maximum participant interest as the evolution of the panel consensus is actively followed; provision of an opportunity to quickly clear-up question

interpretations or to restructure the questionnaire content in light of direct panel feedback; and reduction of overall operational costs. A number of sessions would be required to characterize the gamut of farm types, but the process could be streamlined by conducting separate panels, each treating a selected set of farm types, at the same meeting. The logistics of such an arrangement would be complicated by certain panelists who may be needed for more than one panel.

The accuracy of the group estimation appears to be dependent on maintaining a diversity of expertise on the panel. As noted, the characterization by a farmers-only group was less accurate, possibly because actual operators of a specific type of farm may represent a collective bias, i.e., their estimates may be skewed from what is typical of the class and in the direction of their own operations. The non-farmer experts, also less accurate than the panel as a whole, combined with the farmers to produce a group estimation of increased accuracy. Another important consideration is a panel of sufficient size to provide for a range of occupations and backgrounds. The major occupation represented should, however, probably be farmers, from both a practical and political perspective. Finally, the careful selection of each expert is essential to the quality of the final results; a pre-selection interview might be considered to insure against possible biases.

Many of the Delphi questions called for quite detailed estimates and the quality of the responses might be improved if the participants were given access to outside information. To

that end, some form of pre-meeting work sheet could be sent to each panelist indicating either the general question categories or specific variables to be covered. The requirement that outside preparation needs to be accomplished independently would have to be stressed if the Delphi anonymity and controlled communication between participants is to be maintained.

The format of the questionnaire should be made more attractive and less involved than a complex matrix. Reduction in the number of farm types under consideration at one time would accomplish much of this simplification, but the question layout could be structured to be more user-friendly. Overly general questions should be avoided by itemizing all major categories and leaving a space for other responses to be specified by the panelists. If a number of panelists identify something missed in the first round, then it could be added in successive iterations. The same direct feedback could be used to modify ambiguous question wording or to add entirely new questions. The format might also be expanded to include space for reasons to be provided in those cases where the panelist's estimate remains outside the interquartile range over successive iterations. Generally, an increase in the precision of measurement should be attainable from these recommendations and also from such fine tuning as the specification of maximum round-off intervals.

Successful completion of the Delphi in a single session would require careful planning and the use of automated data processing equipment at the meeting site. The speed of data

input and response summary calculation, while not important in this study using a mail-back iteration, would be of critical importance. Display of group estimations between rounds would require some other format than transcription to a blank questionnaire and could involve the use of visual projection equipment.

In summary, the Delphi may provide local jurisdictions with an economical alternative to traditional information-gathering methods in their process of meeting the state mandated goal of preserving agricultural lands to maintain the established agricultural economic system. The quality of the information collected will depend on the care taken to develop a set of procedures in light of the recommendations from this and other Delphi studies.

## NOTES

1. The "Cheshire" automated mailing system greatly facilitated the process of preparing mailing labels for the surveys, tracking responses, and sending follow-up reminders to non-respondents.
2. The survey results were analyzed with aid of the Statistical Package for Social Scientists (Nie,et. al., 1975) which included programs to structure data files, manipulate the raw data, and to calculate some of the descriptive statistics.
3. The .90 confidence interval was calculated using the finite population factor which reflects the survey sample proportion of the known population as reported by the Bureau of the Census. Therefore, the calculation using the Student's $t$ curve for small samples became:

$$.90 \text{ C.I.} = \bar{x} t_{.10} \left(1 - \frac{n}{N}\right) \text{S.E.}$$

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# APPENDICES

# APPENDIX A

## Delphi Questionnaire

| SECTION I | Cash Grains | Field Crops | Grass Seed Crops | Vege-tables & Melons | Berries & Grapes/Tree Fruits & Tree Nuts | Christ-mas Trees | Horti-cultural Special-ities | General Farms Primarily Crop | Intensive Animal Husban-dry | Dairy Farms | General Farms Primarily Livestock | Extensive Animal Grazing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q-1 What do you think is the annual value of total farm sales of a typical commercial farm? | | | | | | | | | | | | |
| Self-rating | | | | | | | | | | | | |
| Q-2 What do you think is the minimum number of acres required to sustain a commercial farm operation? | | | | | | | | | | | | |
| Self-rating | | | | | | | | | | | | |
| Q-3 How many acres are there in a typical commercial farm? (Rented or leased) | | | | | | | | | | | | |
| Self-rating | | | | | | | | | | | | |
| Q-4 Refer to the map of districts in Linn County. Considering the 4 most common types of agriculture encountered in each farm district, rank them on a scale of 1-4, one being the most dominant and 4 being the least dominant<br>Farm District I | | | | | | | | | | | | |
| Farm District II | | | | | | | | | | | | |
| Farm District III | | | | | | | | | | | | |
| Self-rating | | | | | | | | | | | | |

| | Cash Grains | Field Crops | Grass Seed Crops | Vege-tables & Melons | Berries & Grapes/Tree Fruits & Tree Nuts | Christ-mas Trees | Horti-cultural Special-ities | General Farms Primarily Crop | Intensive Animal Husban-dry | Dairy Farms | General Farms Primarily Livestock | Extensive Animal Grazing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q-5 If the size of the farm unit is different from the typical size shown in Q-3 for any type of agriculture, indicate the number of acres typical for that farm district:<br>Farm District I | | | | | | | | | | | | |
| Farm District II | | | | | | | | | | | | |
| Farm District III | | | | | | | | | | | | |
| Self-rating | | | | | | | | | | | | |
| Q-6 Refer to the list of landforms and soils in Linn County. What is the dominant landform/soil type on which each type of farming occurs? (Write both letter and number if you can; otherwise the letter will do.) | | | | | Berries /Grapes \| Tree Fruits & Nuts | | | | | | | |
| Self-rating | | | | | | | | | | | | |
| Q-7 What is the most typical, owner-operated field size on the most common soil for this enterprise? | | | | | | | | | | | | |
| Self-rating | | | | | | | | | | | | |

| | Cash Grains | Field Crops | Grass Seed Crops | Vege-tables & Melons | Berries & Grapes/Tree Fruits & Tree Nuts | Christ-mas Trees | Horti-cultural Special-ities | General Farms Primarily Crop | Intensive Animal Husban-dry | Dairy Farms | General Farms Primarily Livestock | Extensive Animal Grazing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q-8 What is the minimum field size on the most common soil which can be farmed, considering equipment or other limitations? | | | | | | | | | | | | |
| Self-rating | | | | | | | | | | | | |
| Q-9 If a commercial farm is located on soils better than the most common soils, how large is a typical, owner operated field? | | | | | | | | | | | | |
| Q-10 If a commercial farm is located on soils poorer than the most common soils, how large is a typical, owner-operated field? | | | | | | | | | | | | |
| Self-rating | | | | | | | | | | | | |
| Q-11 For a commercial farm of typical size, what percentage of the total acres operated is rented or leased land? | | | | | | | | | | | | |
| Self-rating | | | | | | | | | | | | |

| | Cash Grains | Field Crops | Grass Seed Crops | Vege-tables & Melons | Berries & Grapes/Tree Fruits & Tree Nuts | Christ-mas Trees | Horti-cultural Special-ities | General Farms Primarily Crop | Intensive Animal Husban-dry | Dairy Farms | General Farms Primarily Livestock | Extensive Animal Grazing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q-12 How far away from the home farm is the rented land in a typical commercial farm? | | | | | | | | | | | | |
| Adjacent _____% | | | | | | | | | | | | |
| Less than 5 miles ____% | | | | | | | | | | | | |
| 5 to 10 miles ____% | | | | | | | | | | | | |
| More than 10 miles ____% | | | | | | | | | | | | |
| Self-rating | | | | | | | | | | | | |
| Q-13 How far can a person afford to travel to rent a parcel of typical size on the most commonly used soil for this type of commercial farming? | | | | | | | | | | | | |
| Self-rating | | | | | | | | | | | | |
| Q-14 How far can one afford to travel to rent a field of minimum size on the most common soil? | | | | | | | | | | | | |
| Self-rating | | | | | | | | | | | | |

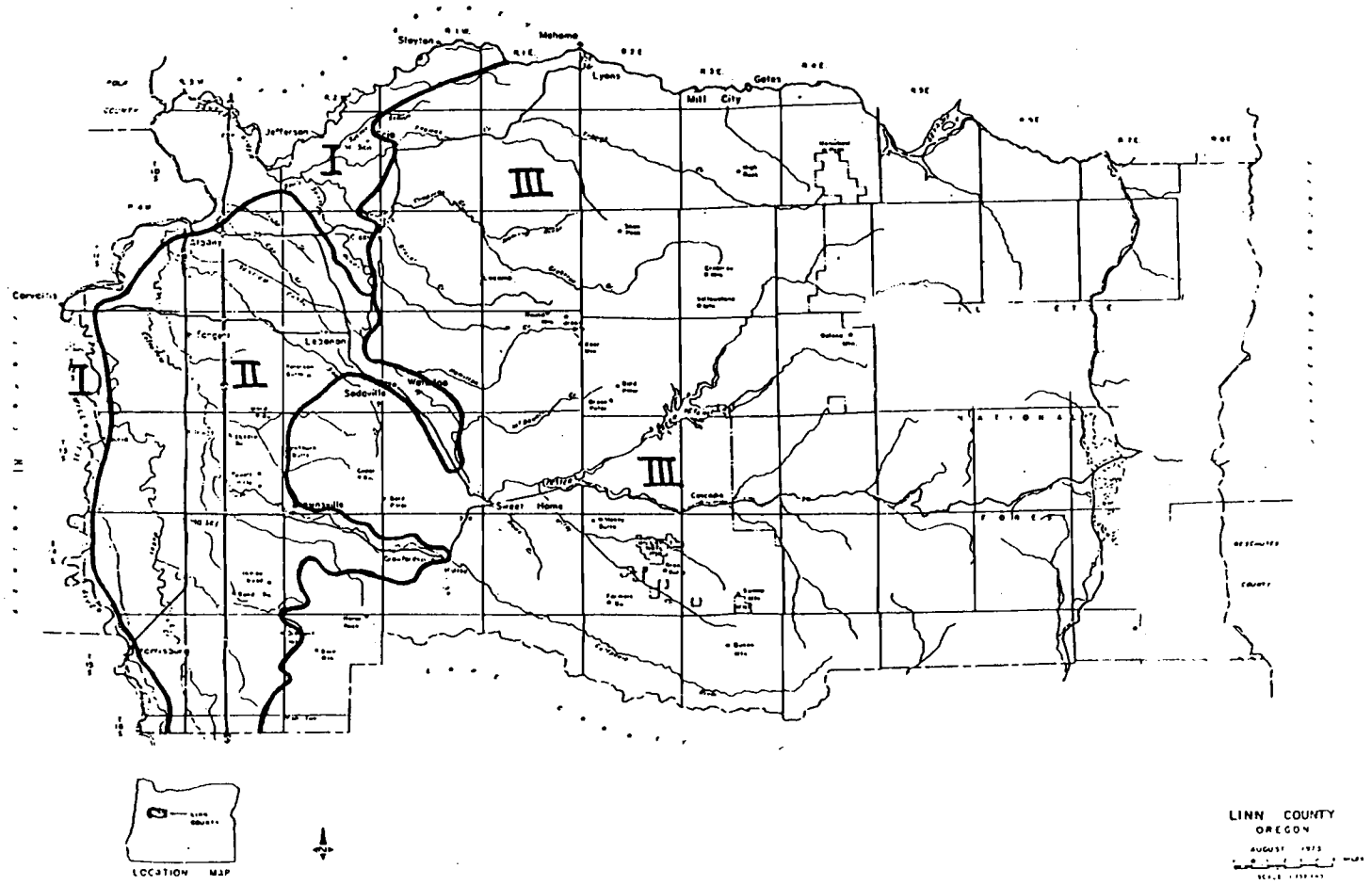
| SECTION II | Cash Grains | Field Crops | Grass Seed Crops | Vege-tables & Melons | Berries & Grapes/Tree Fruits & Tree Nuts | Christ-mas Trees | Horti-cultural Special-ities | General Farms Primarily Crop | Intensive Animal Husban-dry | Dairy Farms | General Farms Primarily Livestock | Extensive Animal Grazing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q-17 For a typical commercial farm, how much must a farmer spend for the minimum initial investment on the following: | | | | | | | | | | | | |
| a) Land | | | | | | | | | | | | |
| b) Buildings | | | | | | | | | | | | |
| c) Machinery & Equipment (new or used) | | | | | | | | | | | | |
| d) Livestock | | | | | | | | | | | | |
| Self-rating | | | | | | | | | | | | |
| Q-18 How much money must a typical commercial farmer spend each year for each of the following items: | | | | | | | | | | | | |
| a) Livestock Replacement | | | | | | | | | | | | |
| b) Energy | | | | | | | | | | | | |
| c) Labor (excluding operator's) | | | | | | | | | | | | |
| d) Repairs & Maintenance | | | | | | | | | | | | |
| e) Taxes & Insurance | | | | | | | | | | | | |
| f) Interest on Equipment | | | | | | | | | | | | |
| g) Miscellaneous (including marketing costs) | | | | | | | | | | | | |
| h) Replacement Machinery or Equipment | | | | | | | | | | | | |
| Self-rating | | | | | | | | | | | | |

| | Cash Grains | Field Crops | Grass Seed Crops | Vege-tables & Melons | Berries & Grapes/Tree Fruits & Tree Nuts | Christ-mas Trees | Horti-cultural Special-ities | General Farms Primarily Crop | Intensive Animal Husban-dry | Dairy Farms | General Farms Primarily Livestock | Extensive Animal Grazing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q-15 Given the same rent price, would the distances travelled to rented land be different if the soil was better or poorer than common? | | | | | | | | | | | | |
| Self-rating | | | | | | | | | | | | |
| Q-16 If you answered yes to Q-15, how far would one be willing to travel to the following combinations? | | | | | | | | | | | | |
| Typical Size--Better Soil | | | | | | | | | | | | |
| Typical Size--Poorer Soil | | | | | | | | | | | | |
| Minimum Size--Better Soil | | | | | | | | | | | | |
| Minimum Size--Poorer Soil | | | | | | | | | | | | |
| Self-rating | | | | | | | | | | | | |

| | Cash Grains | Field Crops | Grass Seed Crops | Vege-tables & Melons | Berries & Grapes/Tree Fruits & Tree Nuts | Christ-mas Trees | Horti-cultural Specialities | General Farms Primarily Crop | Intensive Animal Husban-dry | Dairy Farms | General Farms Primarily Livestock | Extensive Animal Grazing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q-19 If applicable, what is the minimum number of acres necessary to arrange a contract with a buyer or processor? | | | | | | | | | | | | |
| # acres | | | | | | | | | | | | |
| Self-rating | | | | | | | | | | | | |
| Q-20 How would you characterize the openness of the market to purchase of products from new farm operations? | | | | | | | | | | | | |
| Very limited | | | | | | | | | | | | |
| Somewhat limited | | | | | | | | | | | | |
| Open | | | | | | | | | | | | |
| Self-rating | | | | | | | | | | | | |

| | Cash Grains | | Field Crops | | Grass Seed Crops | | Vege-tables & Melons | | Berries & Grapes/Tree Fruits & Tree Nuts | | Christ-mas Trees | | Horti-cultural Specialities | | General Farms Primarily Crop | | Intensive Animal Husban-dry | | Dairy Farms | | General Farms Primarily Livestock | | Extensive Animal Grazing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q-21 Estimate the percentage of production that is marketed by each outlet and the distance to that market. | % of total sales | miles | % of total sales | miles | % of total sales | miles | % of total sales | miles | % of total sales | miles | % of total sales | miles | % of total sales | miles | % of total sales | miles | % of total sales | miles | % of total sales | miles | % of total sales | miles | |
| Broker, Dealer or Warehouse (Includes contract sales) | | | | | | | | | | | | | | | | | | | | | | | |
| Auction | | | | | | | | | | | | | | | | | | | | | | | |
| Marketing Association or Co-op | | | | | | | | | | | | | | | | | | | | | | | |
| Retail Sales (e.g. roadside stands) | | | | | | | | | | | | | | | | | | | | | | | |
| Other Means, Specify | | | | | | | | | | | | | | | | | | | | | | | |
| Self-rating | | | | | | | | | | | | | | | | | | | | | | | |
| Q-22 What percentage of products are processed in the following locations: | | | | | | | | | | | | | | | | | | | | | | | |
| In the county % | | | | | | | | | | | | | | | | | | | | | | | |
| Other Valley counties % | | | | | | | | | | | | | | | | | | | | | | | |
| Other in-state locations % | | | | | | | | | | | | | | | | | | | | | | | |
| Out-of-state % | | | | | | | | | | | | | | | | | | | | | | | |
| Another country % | | | | | | | | | | | | | | | | | | | | | | | |
| Self-rating | | | | | | | | | | | | | | | | | | | | | | | |

# FARM DISTRICTS IN LINN COUNTY



LANDFORMS AND SOILS OF LINN COUNTY

A. Bottomland soils on floodplains

A1. Well drained silty and sandy soils

Chehalis - Cloquato - Newberg

A2. Wet, clayey soils

McAlpin - Waldo
Bashaw

B. Soils on major terraces of the main valley floor

B1. Wet, clayey soils on broad, level terraces

Dayton - Amity - Holcomb
Awbrig - Conser

B2. Wet, gravelly soils

Clackamas - Courtney

B3. Well drained silty and clayey soils - nearly level to gently rolling

Willamette - Woodburn
Malabon - Salem - Coburg

C. Hill soils

C1. Red, clayey, well drained

Jory - Nekia - Bellpine

C2. Dark brown to black, clayey

Dixonville - Hazelair - Philomath

D. Don't know

# APPENDIX B

## Round I Delphi Instructions

THE STRUCTURE OF COMMERCIAL
AGRICULTURE IN LINN COUNTY

QUESTIONNAIRE INSTRUCTIONS

The following questionnaire is divided into two sections: Section I deals with the physical characteristics of commercial farms in Linn County and Section II deals with the financial and marketing characteristics. Each section consists of a column of questions for which you will provide an answer for each type of commercial farm listed accross the top of the page.

For the purpose of this study a commercial farm is defined as one which:

1. Contributes in a substantial way to the area's existing agricultural economy, and
2. Helps maintain agricultural processors and established farm markets.

The typical commercial farm, then, referred to in the questionnaire represents the most commonly encountered type of farm which meets this definition. Please remember to apply this definition when answering questions.

In answering the questions we are looking for your best estimates. Recognizing that different panelists have different backgrounds, a self-rating is included with each question. For each question and farm type rank your confidence in the accuracy of your response from 1, low confidence, to 5, high confidence. You do not have to answer every question, but if you can make an informed estimate, please do so.

You will be considering the complete range of farming operations in Linn County. However, in order to reduce the number of types of commodities to a manageable size, the following classification system is used:

1. Cash Grains (e.g. wheat, barley, oats)
2. Field Crops (e.g. sugar beet seed, mint, hay)
3. Grass Seed (e.g. ryegrass, bentgrass)
4. Vegetable Crops (e.g. carrots, green beans, sweet corn)
5. Berries, Grapes/Tree Fruits & Tree Nuts (e.g. strawberries, vineyards, peaches, filberts)

6. Christmas Trees
7. Horticultural Specialities (e.g. greenhouses, nurseries)
8. General Farms Primarily Crop (no single crop predominates)
9. Intensive Animal Husbandry (e.g. feedlots, hog barns, rabbits)
10. Dairy Farms
11. General Farms Primarily Livestock (mixed farms with emphasis on livestock)
12. Extensive Animal Grazing (cattle, sheep, horses, llamas)

A farm would be classified as being in that category which represents 50% or more of the total sales for that farm. Classify as general those farms which do not produce a crop or livestock that contributes 50% of the total farm sales, but which produces primarily crop or livestock products.

It is understood that there are differences in the land, expenditure, and marketing requirements of a commodity in a single category; however, the similarities should outweigh the differences. Also, the resultant data will be comparable to other sources which use the same classification system.

If you have any questions or need clarification of the wording of a question, please don't hesitate to ask.

Thank you for lending your time and expertise to this project.

# APPENDIX C

## Round II Delphi Instructions

### INSTRUCTIONS

As I mentioned at the June 1 meeting, the Delphi Expert Opinion method, which we are testing in this project, requires that panelists reconsider their responses to questions by comparing their responses of the other panelists. Accordingly, I am enclosing a copy of your original questionnaire and another copy of the questionnaire which displays the median and inter-quaritle range of all responses for each question. To explain, the median is the middlemost response of all the responses, and is a value which may well be different from the average of all the responses. The inter-quartile range means that one quarter of the responses fell below the lower number and one quarter fell above the upper number. The range, therefore, indicates that half of all the responses fell between the lower and upper quartile numbers, centering on the median number.

What we would like you to do is review your responses against the panel median and inter-quartile range for each question. You may wish to change your response, or if you feel your answer is an accurate estimate, you may want to leave it alone. If you are very uncertain or somewhat uncertain of the answer, you may want to reconsider and make some change. Remember that the median is not necessarily an accurate estimate. It merely shows the middlemost response of all the panelists.

Please write any changes, using the red pen enclosed, on the copy of your original questionnaire, and return to us as soon as possible in the self-addressed envelope. You may also want to answer some questions you left unanswered on the first round. Please return your original questionnaire even if there are no changes. You may keep the copy showing the median and range. Please call Jim Pease at 754-3141 if you have any questions.

# APPENDIX D

## Survey Questionnaire

EXTENSION SERVICE
Linn County

Oregon State University

Linn Co. Armory Bldg.
4th and Lyon
P.O. Box 765
Albany, OR 97321

Phone: 967-3871

June 17, 1982

Dear Linn County Farmer:

The OSU Extension Service is conducting a survey of farm operators to learn more about the physical, financial, and marketing characteristics of commercial agriculture in the county. In order to do this we are asking you to help by completing and returning the enclosed questionnaire.

You were chosen for our survey by random methods, and since you are a vital part of our cross-section of farmers, your participation is essential for the accuracy of the study. There is no way for us to substitute for the answers that only you can provide. All the information you give us is strictly confidential and the results are tabulated for the entire sample, not for any one farmer. Your participation is, of course, voluntary and if you have any questions about the study, please call Jim Pease at 754-3141.

A final note. You will see that your questionnaire is numbered. This number is to provide a way by which reminders may be sent, if necessary, without further imposing upon those who have completed and returned their questionnaire. We assure you that your responses will not be linked to your name in any way.

The questionnaire is prepared so that it may be easily returned. Please use the self-addressed envelope which is enclosed, no stamp is required. We would appreciate receiving your completed questionnaire as soon as possible.

We realize that this is a busy time of year and thank you for your interest and help.

Sincerely yours,

Hugh Hickerson
Chairman Agent

HH:cm

# FARM SURVEY

1. Please indicate which one of the following farm types best represents your operation. If your production occurs in more than one type, choose the type which contributes 50% or more of your total sales. If you do not produce a commodity which contributes 50% or more in sales, choose one of the last two general farm categories. (CHECK ONE)

   _____ CASH GRAINS (WHEAT, BARLEY, OATS, ETC.)
   _____ FIELD CROPS (SUGAR BEET SEED, MINT, HAY, ETC.)
   _____ GRASS SEED (RYEGRASS, BENTGRASS, ETC.)
   _____ VEGETABLE CROPS (CARROTS, SQUASH, SWEET CORN, ETC.)
   _____ BERRIES, GRAPES, TREE FRUITS AND TREE NUTS
   _____ CHRISTMAS TREES
   _____ HORTICULTURAL SPECIALTIES (NURSERIES, GREENHOUSES, ETC.)
   _____ INTENSIVE ANIMAL HUSBANDRY (FEEDLOTS, RABBITS, ETC.)
   _____ DAIRY FARMS
   _____ EXTENSIVE ANIMAL GRAZING (CATTLE, SHEEP, HORSES, ETC.)
   _____ GENERAL FARMS, PRIMARILY CROP
   _____ GENERAL FARMS, PRIMARILY LIVESTOCK

2. How many years have you been farming:

   (a)_____ IN LINN COUNTY

   (b)_____ ALTOGETHER

3. How many acres do you farm? (Including rented and leased land)

   (a)_____ ACRES

   How many of these acres, if any, are rented or leased?

   (b)_____ ACRES

4. Farmed acreage may be located any number of miles from a "home farm." Using your home farm as the starting point, please indicate what percentage of your farm land falls in each of the categories listed below.

   _____% ADJACENT TO HOME FARM

   _____% LESS THAN FIVE MILES

   _____% FIVE TO TEN MILES

   _____% MORE THAN TEN MILES

5. Referring to the enclosed map of farm districts in Linn County, in which district (I, II, OR III) is your farm located?

   _____ FARM DISTRICT

6. Listed below are the landforms and associated soils in Linn County. Please indicate which is the most common landform and soil association for your farm. Check only one landform and then only one associated soil for that landform.

| LANDFORM (CHECK ONE) | SOIL ASSOCIATION (CHECK ONE) |
|---|---|
| _____ BOTTOMLAND SOILS ON FLOODPLAINS | _____ WELL DRAINED SILTY AND SANDY SOILS CHEHALIS - CLOQUATO - NEWBERG<br>_____ WET, CLAYEY SOILS -- MCALPIN - WALDO - BASHAW<br>_____ DON'T KNOW |
| _____ SOILS ON MAJOR TERRACES OF THE MAIN VALLEY FLOOR | _____ WET, CLAYEY SOILS ON BROAD, LEVEL TERRACES DAYTON - AMITY - HOLCOMB - AWBRIG - CONSER<br>_____ WET, GRAVELLY SOILS -- CLACKAMAS - COURTNEY<br>_____ WELL DRAINED SILTY AND CLAYEY SOILS - NEARLY LEVEL TO GENTLY ROLLING -- WILLAMETTE - WOODBURN - MALABON - SALEM - COBURG<br>_____ DON'T KNOW |
| _____ HILL SOILS | _____ RED, CLAYEY, WELL DRAINED -- JORY - NEKIA - BELLPINE<br>_____ DARK BROWN TO BLACK, CLAYEY -- DIXONVILLE - HAZELHAIR - PHILOMATH<br>_____ DON'T KNOW |
| _____ DON'T KNOW | |

6. (a) What is your most typical individual field size, in acres, on this landform/soil association?

_____ ACRES

(b) What is your smallest field, in acres, on this landform/soil association which can be farmed, considering equipment and other limitations?

_____ ACRES

(c) How far can you afford to travel, one way, to rent a field of typical size (6a) on this landform/soil association?

_____ MILES ONE WAY

(d) How far can you afford to travel to rent a field of minimum size (6b) on this landform/soil association?

_____ MILES ONE WAY

7. Please indicate how many miles one way you would be willing to travel to rent fields with each of the following combinations:

| | MILES ONE WAY |
|---|---|
| (a) Typical field size - Better soil | _____ |
| (b) Typical field size - Poorer soil | _____ |
| (c) Minimum field size - Better soil | _____ |
| (d) Minimum field size - Poorer soil | _____ |

8. On the average, what is the approximate annual gross value of total farm sales from your farm operation?

$_____

9. How much do you think you would need to spend, at a minimum, to buy a farm operation similar to yours in today's market? Consider the following categories:

| | |
|---|---|
| (a) LAND . . . . . | $_____ |
| (b) BUILDINGS (excluding home) . . . . . | $_____ |
| (c) MACHINERY & EQUIPMENT (new or used) . . . . . | $_____ |
| (d) LIVESTOCK . . . . . | $_____ |

10. On the average, how much do you spend for each of the following items per year?

(a) LIVESTOCK REPLACEMENT . . . . . $_____

(b) ENERGY . . . . . $_____

(c) LABOR (excluding your own) . . . . . $_____

(d) REPAIRS & MAINTENANCE . . . . . $_____

(e) TAXES & INSURANCE . . . . . $_____

(f) INTEREST ON EQUIPMENT . . . . . $_____

(g) MISCELLANEOUS . . . . . $_____

(h) REPLACEMENT OF MACHINERY & EQUIPMENT $_____

11. Please indicate what percentage of your production is marketed by each outlet listed below, and give the distance in miles one way to that outlet.

| | PERCENT (%) | DISTANCE MILES ONE WAY |
|---|---|---|
| (a) BROKER, DEALER WAREHOUSE . . . . . (Includes contract sales) | _____ | _____ |
| (b) AUCTION . . . . . | _____ | _____ |
| (c) MARKETING ASSOCIATION OR CO-OP . . . | _____ | _____ |
| (d) RETAIL SALES . . . . . (for example, a roadside stand) | _____ | _____ |
| (e) OTHER MEANS, SPECIFY_____ . | _____ | _____ |
| TOTAL | 100% | |

12. For the locations listed below, please indicate what percentage of your production is processed (changed from its raw field form) or packaged in each:

(a) IN THE COUNTY . . . . . _____%

(b) OTHER VALLEY LOCATIONS . . . . . _____%

(c) OTHER IN-STATE LOCATIONS . . . . . _____%

(d) OUT OF STATE . . . . . _____%

(e) ANOTHER COUNTRY . . . . . _____%

13. If applicable, what is the minimum number of acres you must farm in order to arrange a contract with a buyer or processor?

_____ ACRES

14. Would you say that the openness of the market to the purchase of products from new farm operations of your type is: (CHECK ONE)

VERY LIMITED . . . . . _____

SOMEWHAT LIMITED . . . _____

OPEN . . . . . _____

15. Is there anything else you would include to better understand the physical and financial characteristics of your type of farming in Linn County?

16. If you would like a copy of the results of this survey, check here _____.

(THANK YOU FOR YOUR COOPERATION)

APPENDIX E

Survey Reminders

THE LINN COUNTY EXTENSION

ASCS BULLETIN

JULY 1982

OREGON STATE UNIVERSITY EXTENSION SERVICE

Old Armory 4th & Lyons 967-3871 Albany, Oregon Vol. I, No. 3

## FARM SURVEY TO BE TAKEN

In a few days a number of randomly selected farmers will be receiving a questionnaire to fill out concerning the characteristics of agriculture in Linn County. We understand that this is a busy time of year and regret that this is survey could not have been conducted at a better time. However, the utility of the information requires that we get a high rate of return, so we ask that you please help us on this project. It shouldn't take more than about 20 or 30 minutes to fill out.

The questionnaire you receive will explain the project more fully, but basically we are seeking more complete information concerning the physical, financial, and marketing characteristics of commercial farming in the county. Such items as field size, distance to leased lands, machinery costs, and methods of marketing will be covered.

Again, we ask that if you are one of the farmers who receives a questionnaire to please complete it and return it as soon as possible. Thanks for your cooperation.

COOPERATIVE EXTENSION WORK IN AGRICULTURE AND HOME ECONOMICS
OREGON STATE UNIVERSITY AND U. S. DEPARTMENT OF AGRICULTURE COOPERATING

Dear Linn County Farmer:

Two weeks ago a questionnaire seeking your input on a study of the characteristics of commercial agriculture in Linn County was mailed to you. Your name was drawn in a random sample of Linn County farmers.

Because this survey was sent to only a small, but representative, sample of farmers, it is extremely important that yours be included in the study if the results are to accurately represent your type of operation. If you have not already completed and returned the survey to us, please take the time to do so. If you have responded, please accept our sincere thanks.

If by some chance you did not receive the questionnaire, or if it got misplaced, please call collect (503-754-3141) and I will get another one in the mail to you today.

Sincerely,

Hugh Hickerson

Hugh Hickerson
Chairman Agent

EXTENSION SERVICE
Linn County

Oregon State University

Linn Co. Armory Bldg.
4th and Lyon
P.O. Box 765
Albany, OR 97321

Phone: 967-3871

July 30, 1982

Dear Linn County Farmer:

About four weeks ago we wrote to you seeking your input on the characteristics of farming in Linn County as they apply to your operation. We have not yet received your completed questionnaire.

The OSU Extension Service has undertaken this study of agriculture in Linn County in order to provide better information for public decisions which affect the future of farming in your area. Without accurate statistics on the physical, financial, and marketing characteristics of your type of operation, such decisions may be in error and do irreparable harm to the agricultural base of the county.

We are writing to you again because of the significance of each questionnaire to the usefulness of this study. Your name was drawn through a scientific sampling process similar to the national surveys you see reported in the news. In order for the results of this survey to be truly representative of your type of agriculture, it is essential that each person in the sample return the questionnaire. Even if you are no longer farming, or if for some reason you do not think the questionnaire applies to the use of your land, please indicate this and return the questionnaire in the envelope provided. This information, too, is important.

Again, we recognize that this is a busy time of year, but scheduling and budgetary constraints make it necessary to complete this study by mid August. So please take the 20 minutes to complete and return the questionnaire.

In the event that your questionnaire has been misplaced, a replacement and a return envelope have been enclosed.

Your cooperation is greatly appreciated.

Sincerely,

Hugh Hickerson

Hugh Hickerson, Chairman Agent

P.S. Based on responses received so far, it would be helpful if you itemize such major expenditures as land rental, fertilizer, chemicals, etc., under the miscellaneous category of question 10(g).

The results of the study will be published in the monthly Extension/ASCS newsletter as soon as the remaining questionnaires are returned.

EXTENSION SERVICE

Agriculture, Home Economics, 4-H Youth, Forestry, Community Development, and Marine Advisory Programs Oregon State University, United States Department of Agriculture, and Linn County cooperating