

AN ANALYTICAL MODEL FOR EVALUATING  
AND CLASSIFYING AGRICULTURAL OPERATIONS

by

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ABSTRACT. The purpose of Goal 3 in Oregon's statewide planning program is to conserve blocks of land suitable for commercial farm operations. Under state administrative rules, commercial means that which provides a substantial contribution to the regional agricultural economy. Application of this commercial standard by county governments has been inconsistent because of insufficient data on county agricultural land use. An analytical model was developed and tested for evaluating proposals and classifying farm operations. The model suggests economic farm unit sizes and income levels which make a substantial contribution to the markets. The model is operational within Oregon's legal framework, and could be adapted to other state farmland programs. A complete list of tables and figures with supporting data is contained in a separate addendum.

KEY WORDS: commercial agriculture, contribution to the market, agricultural land use.

## INTRODUCTION

### Background

In 1974, Oregon adopted statewide planning goals and guidelines. Goal 3 in the program expresses the desire to "preserve and maintain agricultural lands" (Oregon Land Conservation and Development Commission 1980). The goal defines agricultural land and requires local planning agencies to identify those lands within their jurisdictions. Goal 3 establishes farm and non-farm uses, and sets standards for land divisions and minimum lot sizes. Exclusive farm use (EFU) zoning is one tool used to preserve agricultural land (Oregon Land Development and Conservation Commission 1980).

Homesites proposed within an EFU must meet certain tests. If a proposed homesite is a farm dwelling, or if it cannot meet non-farm tests, it must meet a commercial agriculture standard. The state standard specifies that minimum lot sizes in EFU's "shall be appropriate for the continuation of the existing commercial agricultural enterprise in the area" (Oregon Land Conservation and Development Commission 1980, p. 6). The invocation of this standard created the need to define commercial agriculture.

An interpretation of the commercial agriculture standard was adopted by the Land Conservation and Development Commission (LCDC) in an administrative rule (LCDC 660-05-000, 1982). The interpretation states:

Commercial agricultural enterprise consists of farm operations 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.

When determining whether a farm is part of the commercial agricultural enterprise, not only what is produced, but how much and how it is marketed shall be considered. These are important factors because of the intent of Goal 3 to maintain the agricultural economy of the state.

This interpretation suggests that commercial agriculture is confined to the type and scale of operation that provides the substantial contribution necessary to support the farm markets and, thereby, the agricultural economy. However, at the time the administrative rule was adopted, data which detail the spatial and economic characteristics of agriculture on a county level were not readily available (Pease 1983).

Planners have wrestled with the "commercial agriculture problem" in order to comply with state law. Oregon's definition of what constitutes commercial agriculture is still vague, and the legal interpretation is evolving (Eber 1984). However, data now exist that can be used to address Oregon's farmland protection program.

### Research Objectives

The objectives of this research were threefold. First, the research attempted to link the language of Goal 3 (Agricultural

Lands) in Oregon's statewide planning program to county farmland data. Specifically, the contribution to the agricultural markets made by different sizes of operation was explored. Second, the research developed and tested a method for classifying agricultural operations. A classification method would allow planners to process land division proposals in a systematic and consistent way. Last, a generalized analytical model for evaluating and classifying agricultural operations was sought. The requirements for the model were that it must be directly applicable to Oregon's program, yet capable of adaptation to other state programs.

#### METHOD OF STUDY

##### Data Acquisition

In 1981, Oregon State University Extension researchers undertook a project to obtain needed data on the characteristics of commercial agriculture in the state (Pease and Huddleston 1981). Data were gathered via county agricultural land use surveys (Pease 1982a; 1983; see Appendix A for example of the survey instrument). County data were stored on magnetic tape; data analysis was performed by the Statistical Package for the Social Sciences (SPSS) (Nie et al. 1975).

The survey process has been completed and county data are published (for example, see Oregon State University Extension Service 1984b). Analysis of survey data indicated that the structure of agriculture varied between counties, and between landforms within a county. This research assumed that these relationships were true;

the formulation of an analytical model was based on a case study of District V, Umatilla County data.

### Study Area

The selection of Umatilla County as the study area was based on two factors. First, the county is of major importance to the agricultural economy of the state, ranking second or third in the last three years in terms of value of gross farm sales (OSU Extension Economic Information Office 1981; 1982; 1983). Second, selection was influenced by the variety of agricultural types found within the county and by the relatively large number of survey respondents.

Umatilla County is located in north central Oregon, bordering the Columbia River, and represents agricultural District 5 in the state. For survey purposes, the county was divided into five landforms, established on broad soil associations and locally-recognized physiographic units. Survey data show the spatial distribution of agricultural types within the county. Generally speaking, the more intensive types of agriculture, such as tree fruits and tree nuts, horticulture, intensive animal husbandry, and vegetable crops, are found on the valley floor and sandy terraces. Cash grains are concentrated on the rolling hills and foothills, while extensive livestock grazing occurs across all landforms. Livestock grazing is the dominant agricultural type on the mountain slopes and plateaus, but the higher-value grazing operations are located on the foothills (Oregon State University Extension Service 1984b).

For research purposes, the five survey landforms were aggregated into three landforms: bottomlands, hills, and mountain slopes and

tablelands. Valley floor and sandy terraces were combined to form bottomlands; rolling hills and foothills were combined to form hills. The aggregation of landforms was done for land use planning applications, not on the basis of soils data. Specificity of information was sacrificed for simplicity. It was assumed that the creation of new landforms maintained within-landform similarities and between-landform differences.

### Analysis of Agricultural Types

Agricultural operations classified as being on either "bottomlands" or "hills" were included in the study. Operations located on "mountain slopes and tablelands" were excluded from analysis because of small sample size. The research included 92% of all valid survey respondents.

On a given landform, analysis was performed on all agriculturalists as a group, and on selected dominant types. The selected dominant types made up 54% of all "bottomlands" respondents and 92% of all "hills" respondents. The dominant types included for individual study were tree fruits and tree nuts, field crop, and livestock grazing types on "bottomlands," and cash grain and livestock grazing types on "hills."

The selection of appropriate dominant agricultural types was based on survey data for Umatilla County. The first cut in the selection procedure was determined by the number of survey respondents for a type. An agricultural type was rejected if the sample size on a study landform was less than 10. Next, each type ranked as a dominant on a survey landform by value of products sold was assigned

a point value inverse to its rank. Assigned points were totalled across the aggregated landforms. Points were totalled for each agricultural type and divided by the number of total available points. Types that failed to accumulate 10% or more of the total available points were rejected. (For survey ranking of dominant types, see Oregon State University Extension Service 1984b, p. 6).

The dominants selected by this procedure were compared to published data on gross farm sales, by commodity, in Oregon counties (see OSU Extension Economics Information Office 1978a; 1978b; 1978c; 1983a; 1983b; 1984). These sources show that cash grains, cattle and calves, field crops, and vegetable crops have been most important to Umatilla County in terms of gross farm sales. These sources also show that cash grains, cattle and calves, and tree fruits and tree nuts have been most important to the economy of the district which Umatilla County represents. According to survey data, approximately 65% of the total value of farm products sold on "bottomlands" were attributable to the selected dominants, while approximately 85% of gross farms sales on "hills" were attributable to the selected dominants. Thus, selected dominants reflect actual dominants, with the exception of vegetable crop operations. These were excluded from this study because of an inadequate number of respondents. The sample size criterion was relaxed for livestock grazers on "bottomlands," in recognition of their importance to both the county and the district agricultural economy.

## Contribution to the Market

Oregon state law specifies that a commercial agricultural enterprise is one which will "contribute in a substantial way to the area's existing agricultural economy, and help maintain agricultural processors and established farm markets." To address this requirement, this research calculated the cumulative percent contribution to the market made by different sizes of operation.

In order to determine the contribution to the market, first, the total value of farm products sold on a landform was found (see Appendix A, question 9). Then, farms were grouped into income or acreage categories (Table 1). The value of products sold in each category was calculated. This sum was compared to the total value of products sold on the landform in order to determine the relative percent contribution to the market made by each category. Categories were then ordered by descending rank (highest to lowest, with rank 1 being highest). The cumulative percent contribution to the market was calculated by successively adding relative percents from one category to the next in order of descending rank. This procedure was carried out for aggregated types and for the selected dominant types on each landform.

Income and acreage categories used in the procedure are given in Table 1. The income categories were taken directly from the Umatilla County Survey (see Appendix A, question 9). The midpoint of the survey category was used for calculations. The acreage categories were based on those proposed by Extension researchers for use in a special tabulation of Census of Agriculture data, and thus provide the opportunity for subsequent comparison.

Table 1. Definition of income and acreage categories.

<u>Rank</u>	<u>Income Category (\$1000)</u>	<u>Acreage Category</u>
1	$\geq 500$	$\geq 2560$
2	350-499	1280-2559
3	200-349	640-1279
4	100-199	320-639
5	40-99	240-319
6	20-39	160-239
7	10-19	80-159
8	2.5-9.9	40-79
9	$< 2.5$	20-39
10		6-19
11		$\leq 5$

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### Relationship Between Net Farm Income and Value of Investments

As previously mentioned, agricultural operations which make a "substantial contribution" and which "help maintain agricultural processors and established farm markets" are defined as commercial. State law gives little guidance as to how to implement the "substantial" criterion; implicit in the "maintenance" criterion is the desire to protect agricultural operations in economically viable units. This researcher believed that insight into economically viable farm units would shed light on criteria for defining the "substantial contribution" language of the law.

To this end, it was hypothesized that there is a relationship between the size of farm operation as measured in acres, and return on investment as expressed by the ratio of net farm income to the value of owned land and farm buildings (i.e., net farm income/value of (land + buildings)). Such a relationship would be useful as both a descriptive and predictive device in evaluating farm operations. However, correlation analysis found no relationship existed between the two variables (Harrison 1985). For most farmers, net farm income varied widely but approached zero regardless of the type or size of operation. Division of net farm income by the value of land and buildings simply accentuated the approach to zero. Other researchers have shown that, for a given agricultural type, this ratio also fluctuates widely over time (Trede 1981).

### Development of Analytical Model

While correlation between size of operation and return on investment did not exist, certain farm sizes and gross farm incomes

are thought to be characteristic of commercial operations as defined by Oregon state law. A procedure for describing those traits and for distinguishing between those farms which are unquestionably commercial and those that make little contribution to the markets was sought. A tiered analytical method was developed, whereby farms in the upper tier encompass acreage or generate gross farm income necessary to make a substantial contribution to the markets. These farms are found to exert a primary influence on the regional agricultural economy. Those farms in the next tier exert a secondary influence, while those in the lowest, or tertiary, tier provide little contribution to the markets and may be too small to continue the existing agricultural economy. Classes in the model are defined as "Primary," "Secondary, and "Tertiary;" operations are assigned to one of these classes.

#### Ratio of Total Cash Costs to Gross Income

To define economic farm units, an economies-of-size approach was used. In typical farm commodity production analysis, total cash costs plus non-cash costs equals total costs of production (and, by definition, gross income). Total cash costs include cash production costs, depreciation on machinery, real estate taxes, and general farm overhead. Non-cash costs encompass returns to owned land, equity capital, operator inputs, and management. Any or all non-cash costs may be designated as the claimant to residual income, income after total cash costs have been met. Thus, for any given year, gross income may be positive, negative, or zero.

The ratio of total cash costs to gross income (hereafter called Ratio) is a measure of the economic position of the farm. Those farms with a Ratio equal to, or less than, 1 show "survivability" in that total cash costs are at least covered. Farms with a Ratio greater than 1 must pay some portion of their cash costs with income not generated by farm sales. Thus, the "breakeven" size" is estimated by a Ratio value of 1. For farms grouped by income categories, and on the average, it represents the smallest size at which farms are able to continue operation without augmenting their farm income, since gross income just covers cash costs at this point. This is not the most efficient size, nor is it a long-run average cost curve since costs are averaged and not minimized at a given size. (For a thorough discussion of economies-of-size analysis see Madden 1967; Miller, Rodewald, and McElroy 1981).

The Ratio values were calculated for aggregated and for dominant agricultural types on each landform. Cases were sorted by income categories shown in Table 1. The value of the Ratio was calculated by dividing total expenses (see Appendix A, question 11) by gross income (see Appendix A, question 9). Thus, it was assumed that the expense categories used in the survey cover all cash costs normally used in farm enterprise data sheets.

#### Defining Class Thresholds

In order to define class thresholds, farms were sorted by income categories, and statistics generated for variables in each category. Variables included total acres operated, Ratio, and net farm income.

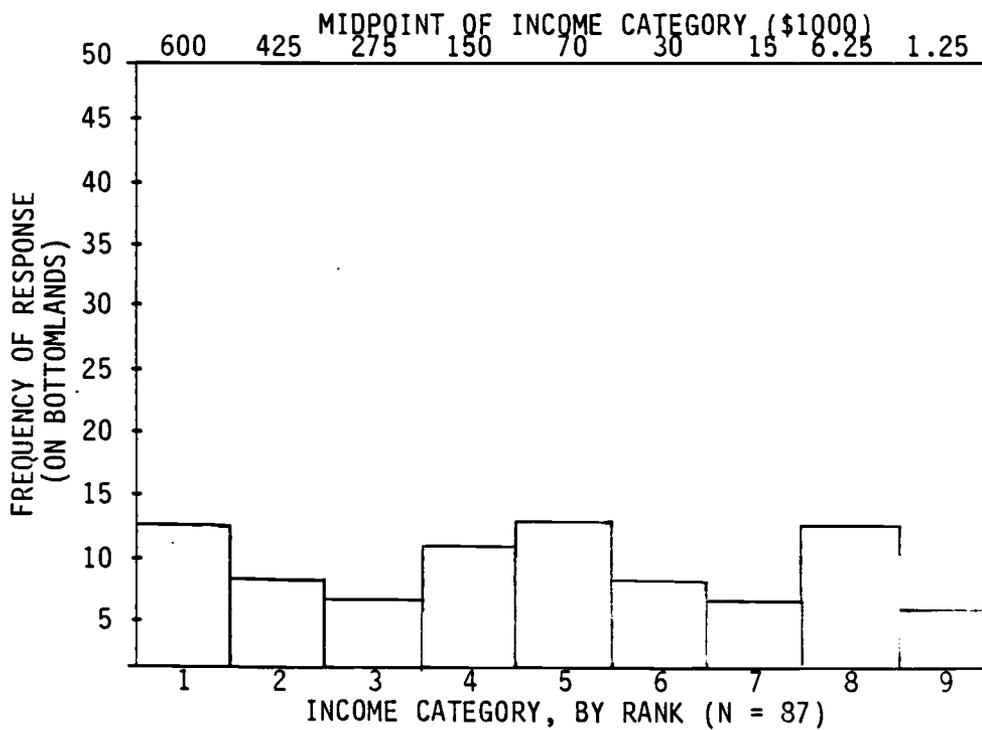
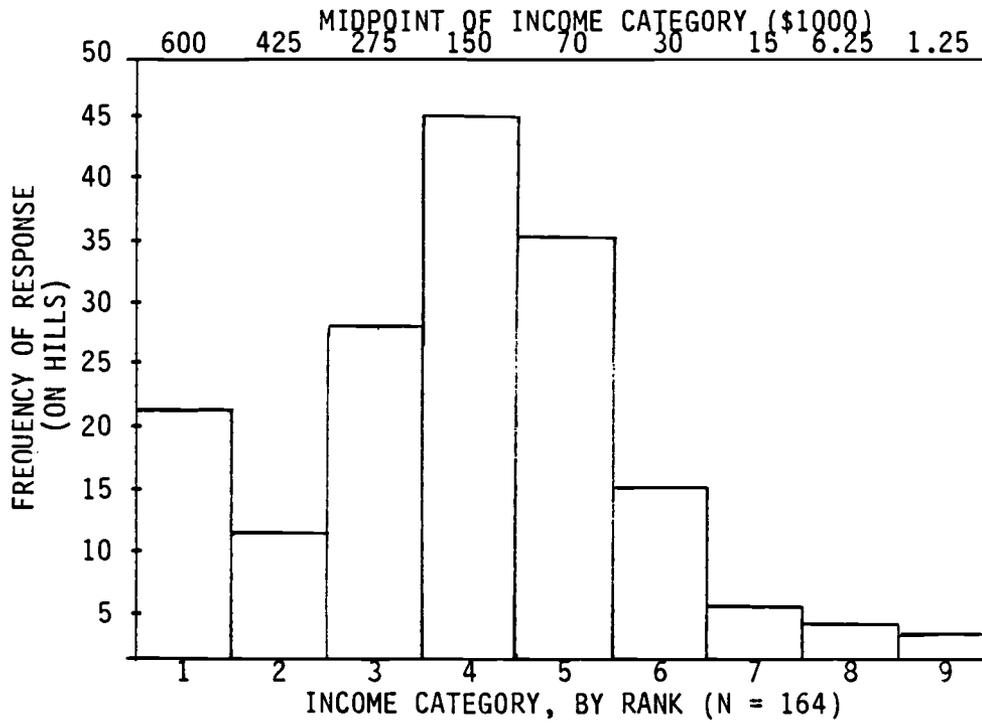
The Ratio was plotted for each income category; the intersection of the Ratio and the breakeven line set the income requirement for "Primary" operations. The median farm size associated with this income category was translated into an acreage category via Table 1. The low values of these income and acreage categories were used to indicate the thresholds for the class.

The contribution-to-market curve was interpreted to determine the boundary between "Secondary" and "Tertiary" classes. The income category associated with a definite break, or flattening, of the curve defined the threshold. The median farm size associated with this income category was found and used to set the acreage criterion. Again, the low values of the designated income and acreage categories set the boundary between the classes. Farms meeting or exceeding either the income or the acreage criterion were classified as "Secondary;" farms falling below both criteria were classified as "Tertiary."

## RESULTS OF THE STUDY

The regrouping of survey landforms into the three study landforms appeared to maintain between-landform diversity; the characteristics of the agricultural types changed between landforms. Grouped by income categories, the distribution of farms varied strongly from one landform to the next (Figure 1). The pattern of distribution of farms on "hills" approached a normal curve and was centered at the \$100,000-199,000 income category. Farms on "bottomlands" were distributed relatively evenly across all income categories and

Figure 1. Distribution of farm operations by gross income category.



exhibited no strong central tendency (Figure 1). This latter situation may reflect differences in the levels of management in the "bottomlands" operations.

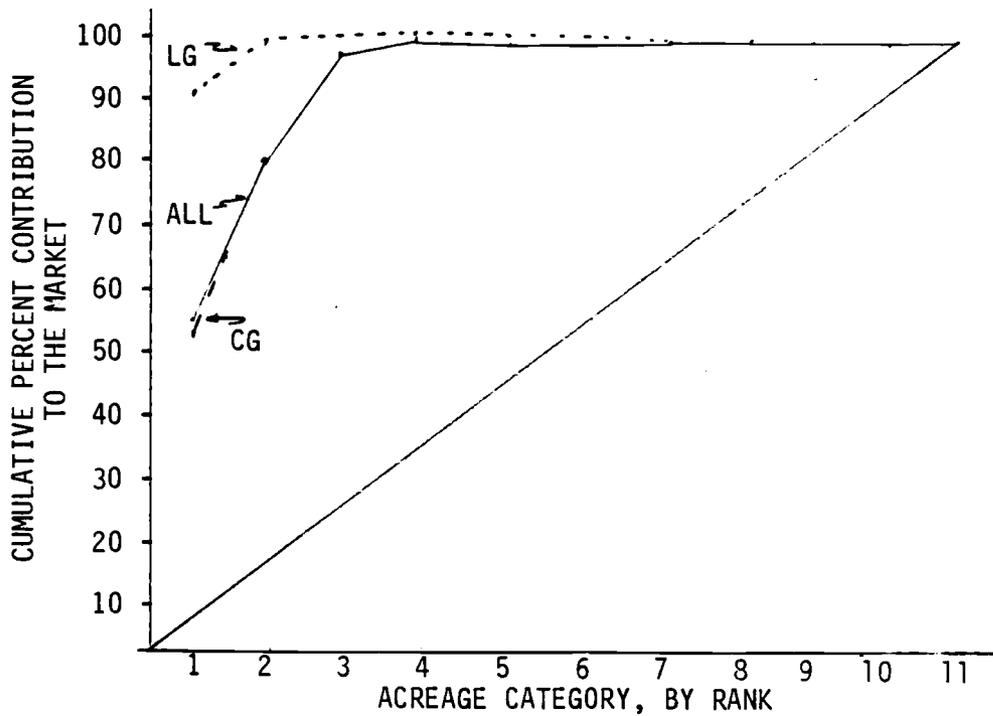
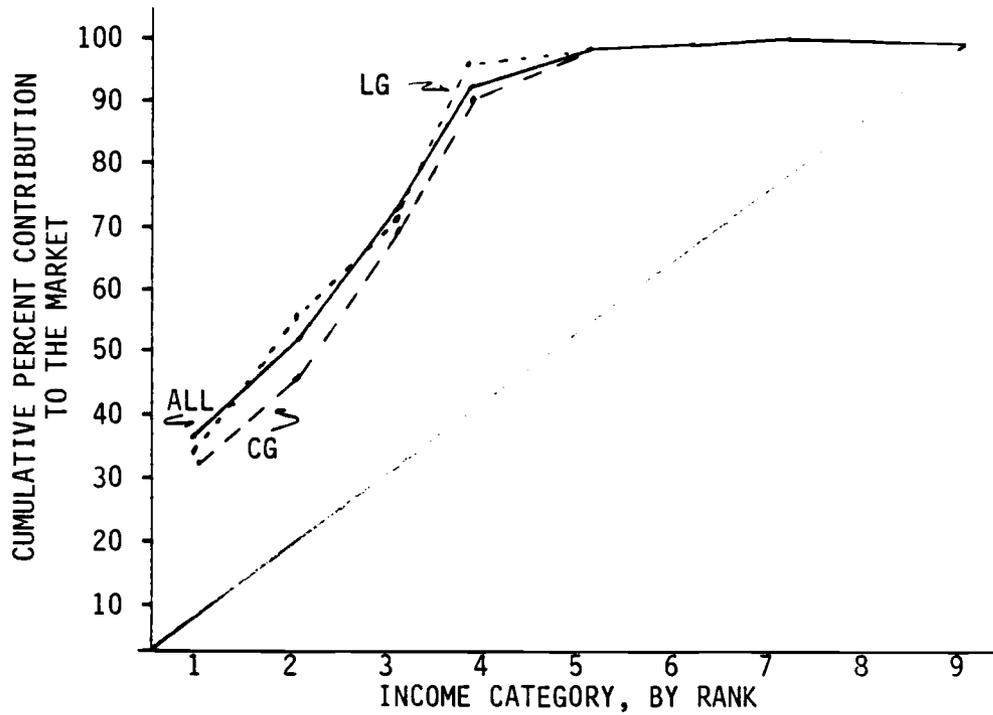
The data from Figure 1 shows that minimum lot sizes based on a county-wide standard may be inappropriate. In light of this finding, the analysis of agriculture was conducted on a landform-by-landform basis, using income and acreage criteria conjunctively. Analysis began on "hills" operations because of the simpler agricultural structure on the landform.

#### Farm Operations on "Hills"

The data indicated there was a high degree of conformity in the contribution made to the market by different agricultural types generating the same gross income (Figure 2). Data based on aggregated agriculturalists appeared to be representative of the individual types.

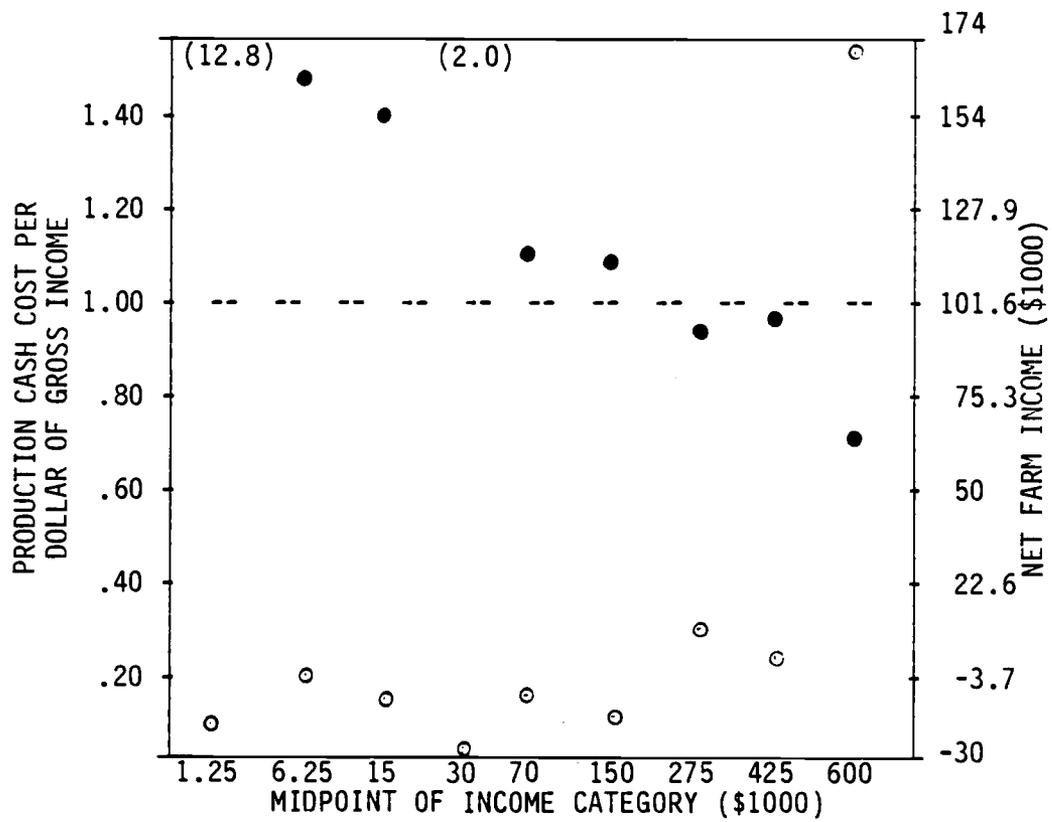
Figure 3 presents the Ratio and net farm income for all agriculturalists on "hills" as sorted by income category. The left side of the figure defines the ratio between total cash costs and gross income. Thus, it measures the production cost per dollar of gross income. The right side of the figure indicates the average net farm income that accrued to operations in the different income categories. This measure translates the difference between the ratio and the breakeven line, from the left side of the figure, into dollars. The income category with a midpoint of \$275,000 (rank 3) was the minimum income requirement for sustainable agricultural operations on the landform (Figure 3). Table 2 provides selected data

Figure 2. Contribution to the market made by agricultural types on "hills."



KEY: ALL = aggregated agricultural types; CG = cash grain types; LG = livestock grazing types

Figure 3. Ratio of total cash costs to gross income and net farm income for all types on "hills."



KEY: ● = Ratio  
 ○ = Net farm income  
 ( ) = Values that fall outside the figure

corresponding to operations in the income categories, thus linking Figures 2 and 3. At income category \$200,000-350,000, the median farm size was 2450 acres and the median net farm income was \$17,780 (Table 2).

Relating median farm size to income categories refined the definition of "Primary" operations to those that received a minimum gross income from farm sales of \$200,000, or those whose total farm unit was greater than or equal to 1280 acres, which are the low ends of the categories containing these values. Any operation that met either of these criteria was classified as "Primary." In this class, approximately 84% of the total value of products sold, and approximately 57% of "hills" operations were accounted for. Median net farm income was \$5,310 (Table 3).

The cut-off for "Secondary" operations was established by interpreting the slope of the contribution to the market curve (e.g., Figure 2). The curve shows a natural break at rank 5 of the income categories. This rank is defined as gross incomes between \$40,000 and \$100,000 (Table 1). At this point, an additional 14% of total value product was accumulated. This income category corresponds to acreage category 640-1279 (from Table 2). Conjunctively, the two criteria define this class of operation as those that received between \$40,000 and \$199,000 in gross farm sales or whose total farm unit was between 640 and 1279 acres. Farms that are not "Primary" must meet either of these criteria to be classified as "Secondary." Data on this group show that approximately 99% of the total value of farm sales on the landform were attributable to the union of "Primary" and "Secondary"

Table 2. Selected data for "hills" types, by gross income category (N = 164).

Gross Income Category (\$1000)		Total Acres Operated	Production Cost/Dollar Gross Income	Net Farm Income (\$1000)
< 2.5	Mean	"s"	"s"	"s"
	SE			
	Median			
	VC/MC			
2.5-9.9	Mean	319.00	1.55	-3.42
	SE	191.21	.87	5.45
	Median	157.00	1.20	-1.25
	VC/MC	3/0	3/0	3/0
10-19	Mean	233.80	1.39	-5.90
	SE	77.68	.34	-5.14
	Median	270.00	1.33	-5.00
	VC/MC	5/0	5/0	5/0
20-39	Mean	364.40	2.00	-29.90
	SE	59.90	.97	29.21
	Median	285.00	1.02	-.63
	VC/MC	15/0	15/0	15/0
40-99	Mean	1354.06	1.07	-5.13
	SE	202.25	.15	10.17
	Median	1020.00	.98	1.26
	VC/MC	35/0	35/0	35/0
100-199	Mean	2695.76	1.06	-9.44
	SE	463.52	.11	16.43
	Median	1600.00	.84	24.62
	VC/MC	45/0	45/0	45/0
200-349	Mean	3309.37	.95	14.40
	SE	519.37	.09	25.42
	Median	2450.00	.94	17.78
	VC/MC	27/0	25/2	25/2
350-499	Mean	7587.27	.98	6.82
	SE	2927.85	.05	21.34
	Median	3825.00	1.01	-5.56
	VC/MC	11/0	11/0	11/0
≥ 500	Mean	9492.76	.71	173.75
	SE	2464.97	.03	16.96
	Median	5200.00	.74	156.94
	VC/MC	21/0	20/1	20/1

"s" = data are suppressed for data items with < 3 individuals

SE = standard error

VC/MC = valid survey cases/missing cases

Table 3. Characteristics of farm operations on "hills."

		Class Criteria		
		Primary	Secondary	Tertiary
		> \$200 or ≥ 1280	\$40-199 or 640-1279	< \$40 and < 640
Data Item				
1. Size of total farm unit (includes rented and leased lands)	Mean	5282.66	896.58	248.91
	SE	716.35	38.24	35.01
	Median	2999.50	955.00	199.75
	VC/MC	96/0	50/0	21/0
2. Gross value of products sold (1981-84 average)*	Mean	309.26	100.54	21.43
	SE	19.11	6.44	2.37
	Median	270.56	78.41	28.13
	VC/MC	94/2	49/1	21/0
3. Leased or rented acres	Mean	2376.92	457.48	72.63
	SE	400.88	62.37	25.79
	Median	1323.50	401.00	4.09
	VC/MC	96/0	50/0	21/0
Number of respondents with leased or rented acres		75	30	10
4. Value of owned land and buildings (1984)*	Mean	2221.38	953.88	231.00
	SE	149.81	150.29	50.00
	Median	3057.50	612.50	155.00
	VC/MC	87/9	40/10	15/6
5. Value of owned land (1984)*	Mean	1996.11	851.67	201.00
	SE	131.23	131.11	35.35
	Median	2941.67	590.63	131.00
	VC/MC	90/6	45/5	20/1
6. Annual expenses (1981-84 average)*	Mean	280.30	99.58	20.57
	SE	16.35	11.89	2.35
	Median	275.66	70.62	20.00
	VC/MC	93/3	50/0	21/0
7. Net farm income (1981-84 average)*	Mean	30.25	.35	.86
	SE	13.78	12.57	2.52
	Median	5.31	1.43	- 1.98
	VC/MC	91/5	49/1	21/0

\* in thousands of dollars

operations (Table 3). These two classes also accounted for approximately 87% of "hills" farms. Median net farm income in the "Secondary" class was \$1,430 (Table 3).

Operations receiving gross incomes of less than \$40,000 and whose total farm units were less than 640 acres, made little contribution to the market and appeared unable to remain solvent without substantially augmenting their farm income. These operations were classified as "Tertiary." Table 3 provides a profile of these operations. Median net farm income was -\$1,980.

In order to gauge the representativeness of the classification, identical analyses were conducted on data of dominant agricultural types. The corresponding tables and figures are contained in a separate report (see Harrison 1985).

Data on livestock grazing were inconclusive because of the limited number of respondents. The evidence suggested that grazing operations with gross income greater than \$100,000 were economically viable. However, the acreage criterion, previously mentioned, admitted operations into the "Primary" class that accounted for approximately 91% of the value of products sold by livestock grazers. The second cut-off included virtually all of the livestock grazers as well as their contribution to the market.

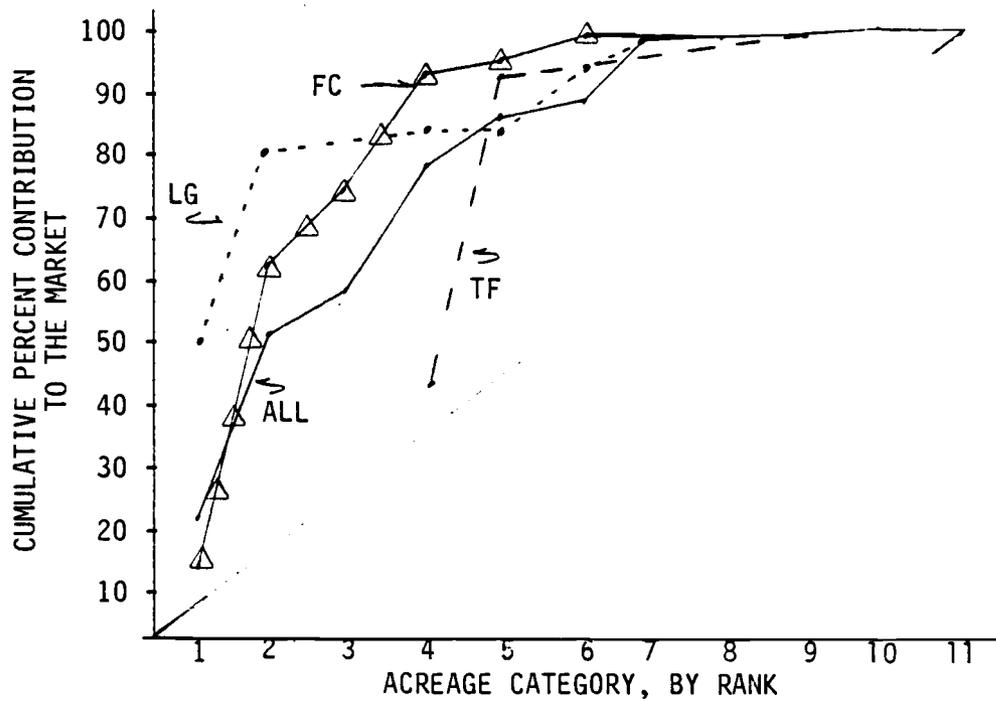
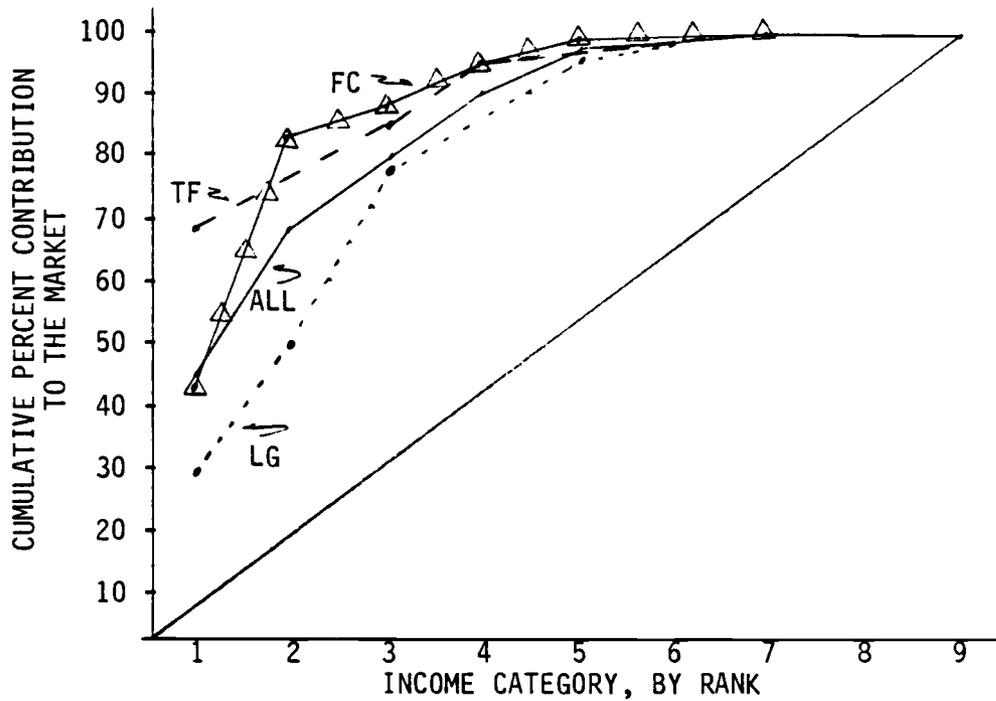
Data on cash grain types mirrored those generated for the aggregate. However, about 15% of the operators in this type were classified as "Tertiary."

## Farm Operations on "Bottomlands"

Agriculture on "bottomlands" is more complex than on "hills." Figure 4 graphically shows the complexity. The figure also shows that if evaluation of agricultural operations is based on a single criterion, income, it will be biased against livestock grazing, and if based on acreage, it will be biased against tree fruits and tree nuts. Furthermore, the figure offers a good visual comparison of two measures of farm size: gross income and acreage. It is evident that, given a choice between the two measures, income is the more effective.

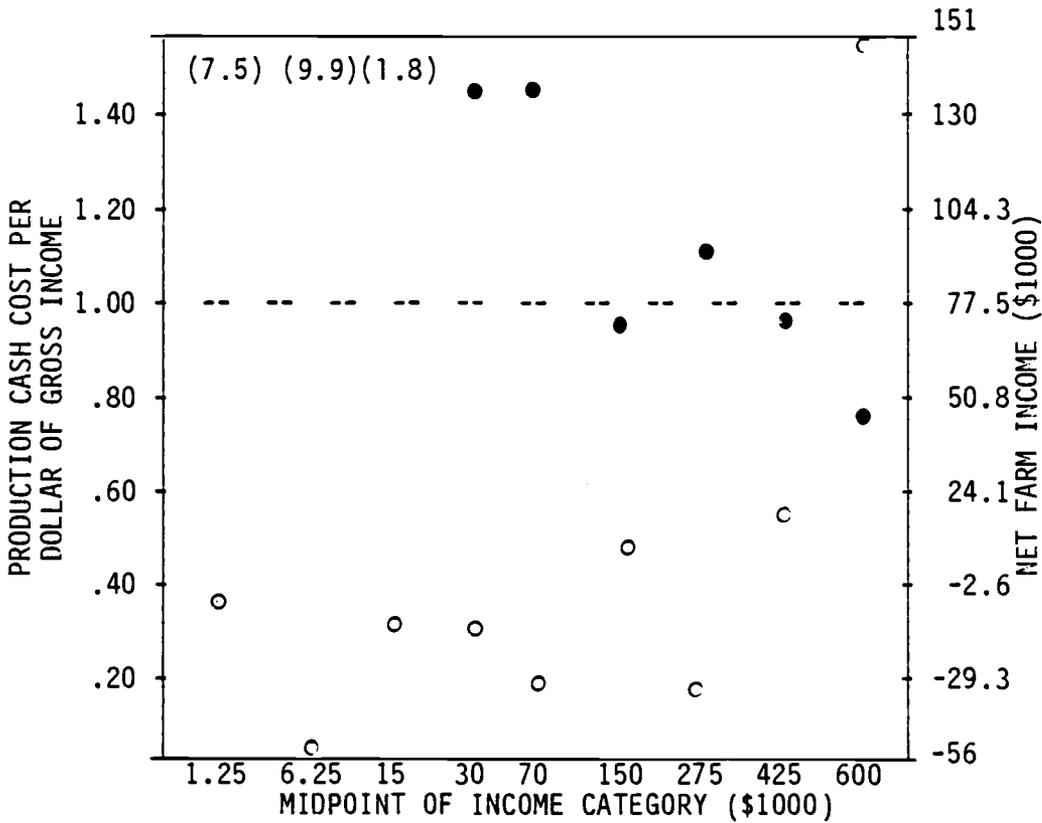
Analysis of "bottomlands" operations proceeded as it did on "hills." Data indicated \$150,000 as the midpoint of the income category (rank 4), showing the minimum requirements for economic survival (Figure 5). The Ratio value for the \$200,000-349,000 category may well deviate from the breakeven line because of data from one respondent. Relating income category to acreage category (Tables 1 and 4) set the threshold for "Primary" operations at gross farm sales greater than or equal to \$100,000, or size of total farm unit greater than or equal to 320 acres. If a farm met either criterion, it was classified as a "Primary" operation. While preparing data sheets for "bottomlands" operations, it was found that aggregated data masked the characteristics of tree fruits and tree nuts types. Thus, one data sheet was prepared for tree fruits and tree nuts types (Table 5), and one was prepared for all other types (Table 6). "Bottomlands" farms classified as "Primary" accounted for 57% of all operators and almost 94% of the total value of products

Figure 4. Contribution to the market made by agricultural types on "bottomlands."



KEY: ALL = aggregated agricultural types; FC = field crop types; LG = livestock grazing types; TF = tree fruits/tree nuts types

Figure 5. Ratio of total cash costs to gross income, and net farm income for all types on "bottomlands."



KEY: ● = Ratio  
 ○ = Net farm income  
 ( ) = Values that fall outside the figure

Table 4. Selected data for "bottomlands" types, by gross income category (N = 87).

Gross Income Category (\$1000)		Total Acres Operated	Production Cost/Dollar Gross Income	Net Farm Income (\$1000)
< 2.5	Mean	26.67	7.47	-8.08
	SE	7.37	1.93	2.41
	Median	24.50	6.00	-6.25
	VC/MC	6/0	6/0	6/0
2.5-9.9	Mean	236.14	9.90	-55.64
	SE	103.03	5.43	33.96
	Median	39.50	3.24	-14.00
	VC/MC	14/0	13/1	13/1
10-19	Mean	71.29	1.81	-12.14
	SE	27.05	.51	7.65
	Median	44.00	1.44	-6.56
	VC/MC	7/0	7/0	7/0
20-39	Mean	256.63	1.44	-13.21
	SE	104.26	.32	9.62
	Median	75.00	1.08	-2.50
	VC/MC	8/0	7/1	7/1
40-99	Mean	411.29	1.46	-32.32
	SE	113.56	.41	28.37
	Median	239.00	1.01	-.69
	VC/MC	14/0	14/0	14/0
100-199	Mean	891.91	.94	8.46
	SE	306.81	.13	19.14
	Median	405.25	.98	3.63
	VC/MC	11/0	11/0	11/0
200-349	Mean	1649.43	1.12	-32.14
	SE	547.47	.15	40.72
	Median	1320.00	1.06	-15.63
	VC/MC	7/0	7/0	7/0
350-499	Mean	7312.50	.96	18.75
	SE	5834.27	.07	28.64
	Median	810.00	.99	4.17
	VC/MC	8/0	8/0	8/0
≥ 500	Mean	2092.33	.75	150.00
	SE	533.97	.00	.00
	Median	1808.50	.75	150.00
	VC/MC	12/0	11/1	11/1

SE = standard error

VC/MC = valid survey cases/missing cases

Table 5. Characteristics of tree fruits and tree nuts operations on "bottomlands."

		Class Criteria		
		Primary	Secondary	Tertiary
Gross Income*		> \$100	\$20-99	< \$20
Total acres		or ≥ 320	or 40-319	and < 40
Data Item				
1. Size of total farm unit (includes rented and leased lands)	Mean	327.50	29.33	14.67
	SE	41.91	5.21	8.17
	Median	265.00	30.00	7.00
	VC/MC	4/0	3/0	3/0
2. Gross value of products sold (1981-84 average)*	Mean	406.25	30.00	7.50
	SE	114.74	.00	4.02
	Median	337.50	30.00	6.25
	VC/MC	4/0	3/0	3/0
3. Leased or rented acres	Mean	23.75	NC	NC
	SE	19.08		
	Median	7.50		
	VC/MC	4/0		
Number of respondents with leased or rented acres		2	NC	NC
4. Value of owned land and buildings (1984)*	Mean	2003.75	"s"	98.33
	SE	869.03		46.22
	Median	972.50		95.00
	VC/MC	4/0		3/0
5. Value of owned land (1984)*	Mean	1743.75	126.67	73.33
	SE	740.24	41.87	33.71
	Median	1212.50	125.00	85.00
	VC/MC	4/0	3/0	3/0
6. Annual expenses (1981-84 average)*	Mean	300.00	"s"	20.00
	SE	86.60		.00
	Median	300.00		20.00
	VC/MC	4/0		3/0
7. Net farm income (1981-84 average)*	Mean	106.25	"s"	-12.50
	SE	35.90		4.02
	Median	137.50		-13.75
	VC/MC	4/0		3/0

\* in thousands of dollars

NC = no cases

"s" = data are suppressed for data items with < 3 individuals

Table 6. Characteristics of all other farm operations on "bottomlands."

		Class Criteria		
		Primary	Secondary	Tertiary
		> \$100	\$20-199	< \$20
		or	or	and
		≥ 320	40-319	< 40
Data Item				
1. Size of total farm unit (includes rented and leased lands)	Mean	2442.22	136.65	20.36
	SE	1032.14	18.19	2.99
	Median	827.50	109.00	19.75
	VC/MC	46/0	20/0	11/0
2. Gross value of products sold (1981-84 average)*	Mean	282.94	38.56	6.48
	SE	31.61	6.72	1.44
	Median	267.08	30.00	5.83
	VC/MC	46/0	20/0	11/0
3. Leased or rented acres	Mean	1677.67	66.35	2.36
	SE	1032.45	26.09	1.85
	Median	282.00	4.00	.67
	VC/MC	46/0	20/0	11/0
Number of respondents with leased or rented acres		30	10	"s"
4. Value of owned land and buildings (1984)*	Mean	1703.10	267.06	85.71
	SE	253.07	53.74	12.27
	Median	887.50	210.00	85.00
	VC/MC	42/4	17/3	7/4
5. Value of owned land (1984)*	Mean	1343.02	199.74	77.78
	SE	189.98	43.70	10.84
	Median	826.56	130.00	76.67
	VC/MC	43/3	19/1	9/2
6. Annual expenses (1981-84 average)*	Mean	271.93	48.70	13.15
	SE	25.28	9.38	2.97
	Median	275.00	32.50	8.25
	VC/MC	45/1	20/0	10/1
7. Net farm income (1981-84 average)*	Mean	3.96	-10.14	- 6.65
	SE	19.05	7.10	2.98
	Median	-.67	- 2.88	- 5.63
	VC/MC	45/1	20/0	10/1

\* in thousands of dollars

"s" = data are suppressed for data items with < 3 individuals

sold. Median net farm income for tree fruits and tree nuts types was \$137,500, while that for all others was -\$670 (Tables 5 and 6).

The selection of the second threshold was again based on interpretation of the slope of the curve showing cumulative percent contribution to the market by income categories (Figure 4). Unquestionably, the slope of the curve flattens at rank 6 (income category \$20,000-39,000). The aggregate curve does not underestimate the contribution of any individual type at this point. Table 4 was used to link income category to the appropriate acreage category in Table 1. "Secondary" operations were thus defined as those that received between \$20,000 and \$99,000 in gross income from farm products sold or whose total farm unit was between 40 and 319 acres. Data were suppressed for tree fruits and tree nuts respondents found in this class; median net farm income for all other types in this class was -\$2,880 (Table 6).

Conjunctively, the first two classes of farms accounted for more than 99% of the contribution to the market and approximately 84% of all operators (Tables 5 and 6). It is apparent that, based on this procedure, the remaining operations on the landform contributed very little to the market.

Those farms that generated less than \$20,000 in gross farm sales and whose total farm unit was less than 40 acres were classified as "Tertiary." Characteristics of these farms are displayed in Tables 5 and 6.

Comparison of data between aggregated agricultural types and those for selected dominant types yielded favorable results. The minimum

survivable size for field crops also occurred at the \$100,000-199,000 income category (Harrison 1985). Approximately 94% of field crop sales were generated by "Primary" operations. Combined "Primary" and "Secondary" classes accounted for almost 99% of the contribution to field crop sales and 95% of all operations in this type.

Data for livestock grazing types were inconclusive. Farm operations of this type which generate sales of \$40,000 or more may be economically viable. The "Primary" class provided close to 85% of livestock grazing sales. Together, "Primary" and "Secondary" operations made approximately 99% of the contribution to the market, even though 18% of livestock operations were classified as "Tertiary" (Harrison 1985).

Analysis of tree fruits and tree nuts types showed correspondence with the survivable size indicated by aggregated statistics. Tree fruits and tree nuts farms classified as "Primary" produced approximately 94% of the value of products sold by the type. However, only 40% of the operators of this type were in this class. Combined "Primary" and "Secondary" operations made approximately 99% of the contribution to the market. Thus, about 6% of the contribution to the market and 30% of the operations fell within the "Tertiary" class (Table 5).

#### Summary of the Analytical Model

Figures 6 and 7 depict the analytical model used in this study. In the figures, threshold criteria for classification of "hills" and "bottomlands" operations are described. General requirements for performance standards are also indicated.

Figure 6. Summary of the analytical model: hills.

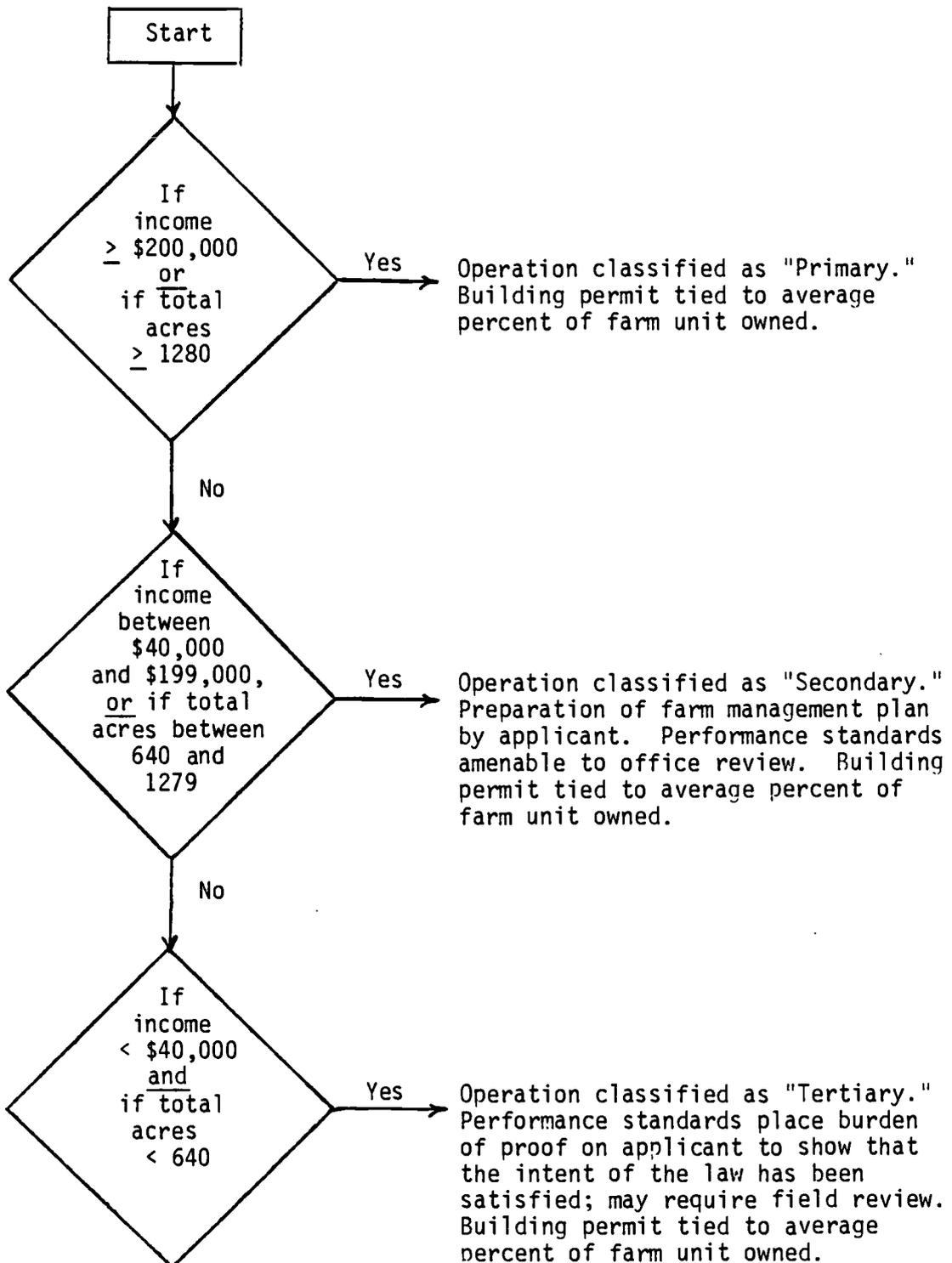
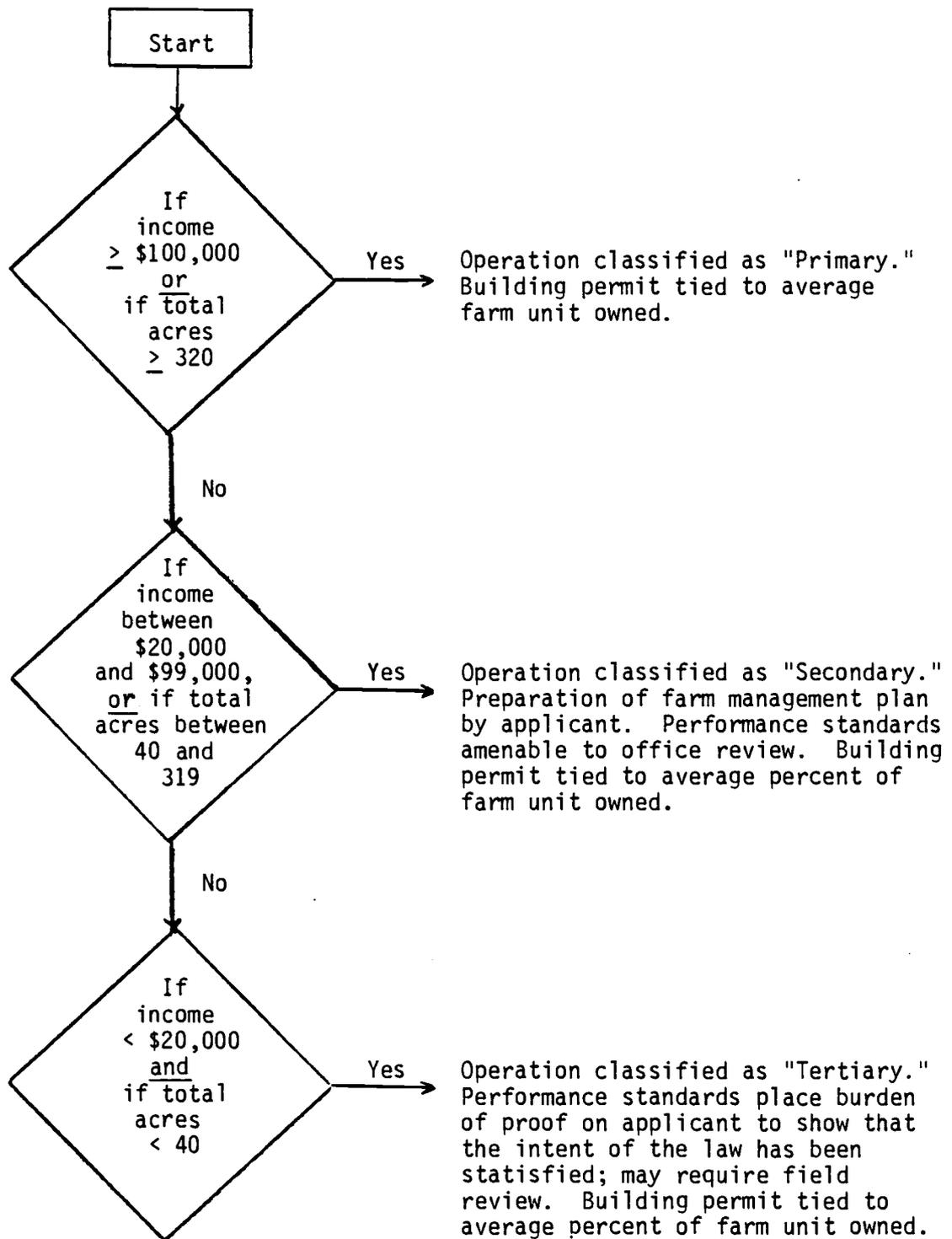


Figure 7. Summary of the analytical model: bottomlands.



## IMPLICATIONS AND LIMITATIONS OF THE STUDY

### Study of Commercial Agriculture

The weight of evidence from the surveys suggest that the structure of agriculture changes between landforms within a county, and between counties (Oregon State University Extension Service 1983a; 1983b; 1983c; 1984a; 1984b; 1984c). Thus, criteria for evaluating agricultural land division proposals should be regionalized at the sub-county level. For planning purposes, regions within a county should be kept to a manageable number. This study used three landforms which appeared to maintain within-landform similarities and between-landform differences at the county level. A scheme for grouping survey landforms into planning landforms is presented in an addendum to this report (Harrison 1985). The names used in the scheme can be applied to data gathered by the Oregon State University Extension Service, previously cited.

This study used the individual farm as the basic unit of analysis. It is recommended that future analyses retain this focus. Farms were identified by type (see Oregon State Extension Service 1984b, p. 2), landform, gross value of farm products sold, and total acreage operated. Additional information on leased or rented land, value of owned land and buildings, and total expenses was collected. These data are sufficient for conducting a monitoring program. The calculation of the Ratio values for agriculturalists on a landform offered a systematic method for determining a first cut in the evaluation procedure; sorting farms by income categories and generating statistics on that basis offered a means to tie income to

acreage categories. However, the use of the Ratio has limitations and should not be confused with an economies-of-size analysis (Madden 1967; Miller, Rodewald, and McElroy 1981).

The calculation of Ratio values should really only be done for a specific agricultural type, not a collection of different types. Analysis of the Ratio values for dominant agricultural types showed general conformance with the aggregate Ratio values except for livestock grazing, which seemed to have lower income requirements for economic viability. A more appropriate measure of size for this type might be the number of cows and calves per farm unit.

Operator inputs, equity capital, owned land, and management were designated as residual claimants to gross income. The choice of residual claimant may affect both the level of Ratio values and the slope or tilt of these relationships (Miller, Rodeway, and McElroy 1981). This is of greater importance to actual economies-of-size studies, where the most efficient size is determined. This study merely analyzed the slope of the line to find its intersection with the breakeven line and, thus, to estimate economic farm sizes.

The expense data used in this study lacked information on gains (losses) to firms based on inventory increases (decreases). There is always the possibility of inaccurate cost data. Also, an empirical study is usually applicable only to the area and type of farming for which it was conducted. Production techniques, yields, and costs change rapidly. Thus, empirical studies are time-dated (Madden 1967). Data collection should take place on a regular basis, say, every five

years, in order to monitor changing structure of agriculture.

#### Rationale for the Analytical Model

Others have discussed the reasons for, and the difficulty in, defining commercial agriculture (Eber no date; Benner 1985). Because of the diversity in scale and type of agriculture found within Oregon, a standard minimum lot size for land use decisions may be untenable. A case-by-case review may be a more realistic, and a more politically acceptable, approach for evaluating land division proposals on farm land. The analytical model described in this paper offers one way county officials can efficiently process cases based on farm data and systematic analysis.

A farm evaluation procedure must confront the problem of determining indicators which are sensitive to the characteristics of both intensive, relatively high-value operations, and extensive, relatively low-value operations. The joint use of income and acreage criteria appeared to meet this challenge. For example, the model successfully handled tree fruits and tree nuts types amid more extensive types. The Census of Agriculture indicates that other relatively intensive types, such as animal husbandry and vegetable crop, occur in the county. The data indicate that, for both types, more than 75% of the contribution to the market is made by operations greater than or equal to 320 acres (Census of Agriculture 1978). Thus, the model appears capable of handling the variety of types found in Umatilla County.

The use of a commercial standard is a unique feature of Oregon's program (Pease 1983). Hobby farms are basically prohibited in

commercial farm zones. This model classifies farms on the basis of gross income and acreage operated. The contribution made to the markets by different classes of farms can then be calculated, as required by state law. It does not necessarily indicate what is, or is not, a "real" farm--one that is operated for the purpose of making a profit. Many operators of small farms are restricted to part-time farming and show low farm incomes because of limited resources, not lack of motivation (McCuaig and Manning 1982).

The model shown offers flexibility to local planners operating under the guidelines of Oregon's planning program in that thresholds and performance standards are developed at the local level. Local control allows for efficient modification of thresholds and standards with changing agricultural structure, and the provision of greater options to proposals from local landowners.

The model is also adaptable to other state programs. Changes in planning goals and definitions, thresholds, and performance standards are all that are necessary for addressing other programs.

The development and testing of the model was accomplished on data obtained via a mail survey. The survey process was based on the "Total Design Method" (Dillman 1978). Mail surveys are subject to a variety of errors, from a number of sources, so that the reliability of the data can be questioned. The use of income and expense categories, with midpoints representing the value of those categories, could be a pervasive source of error. The ranges used in each category could also be challenged. There is no pat answer to criticism on survey methodology. On the other hand, there are no

better data available in Oregon for a detailed analysis of agriculture on a sub-county level.

#### Recommendations for Future Research

If there is interest in a systematic procedure for evaluating agricultural operations, then a logical first step is to apply the model described herein to Umatilla County land division proposals. A field test would indicate whether the model works, what, if any, areas need fine-tuning, and whether it is politically acceptable.

Given a workable model, it should be applied to data for a Willamette Valley county. The structure of agriculture in the Valley is more complex, with greater variation in farm characteristics. There is also greater pressure on Valley agricultural lands for non-agricultural purposes, so hobby farms are prevalent (see Benner 1985). If the model is sensitive enough to sort through this complexity, it should be usable throughout Oregon.

At the "Tertiary" levels, the challenge becomes one of developing performance standards that differentiate between small farm operators that are interested in farming as a commercial activity, and those that are primarily interested in rural residences. Research in two countries suggests that the number of days worked off-farm by the operator may be a useful gauge (McCuaig and Manning 1982; Brooks 1984).

Last, assuming that the model is both workable and acceptable, research is needed to test the correlation between the characteristics of identical agricultural types, found on the same landform, in different counties. If correlation exists, criteria could be

regionalized at the sub-state level for individual agricultural types on specific landforms.

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APPENDIX

# APPENDIX A

## Umatilla County AGRICULTURAL SURVEY

1.  If the addressee is deceased or no longer farming, please check this box and return the survey in the envelope provided. DO NOT COMPLETE THE REST OF THIS FORM.
- 
2. Please indicate which ONE of the following agriculture 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 the general farm category. (CHECK ONE)
- CASH GRAINS (wheat, barley, pea (dry field and seed), oats, field corn, etc.)  
 FIELD CROPS (seed crops, potato, mint, hay, etc.)  
 TREE FRUITS (orchards)  
 VEGETABLE AND MELON CROPS (green peas, sweet corn, asparagus, cukes, onions, etc.)  
 INTENSIVE ANIMAL HUSBANDRY (feedlots, swine, poultry, etc.)  
 DAIRY FARMS  
 LIVESTOCK GRAZING (cattle, sheep, horses, etc.)  
 HORTICULTURE AND NURSERY STOCK  
 BERRIES, GRAPES  
 GENERAL FARMS, PRIMARILY CROP (Check if no other type produces 50% of income)
3. \_\_\_\_\_ How many acres do you operate (including land rented or leased from others)?  
 \_\_\_\_\_ How many of these acres, if any, are rented or leased from a PUBLIC AGENCY?(inc.grazing allot.)  
 \_\_\_\_\_ How many of these acres, if any, are rented or leased from PRIVATE PARTIES (not family or trust)?  
 \_\_\_\_\_ How many of these acres, if any, are operated for a family member or estate?  
 \_\_\_\_\_ How many of these acres, if any, are operated from a trust?
4. About how many head of livestock have you had in inventory PER YEAR during the last 3 years?
- |  |                                       |  |
|--|---------------------------------------|--|
| <input type="checkbox"/> BEEF CATTLE (cow-calf=1 unit) | <input type="checkbox"/> DAIRY CATTLE | <input type="checkbox"/> SWINE                 |
| <input type="checkbox"/> SHEEP                         | <input type="checkbox"/> HORSES       | <input type="checkbox"/> OTHER (SPECIFY) _____ |
| <input type="checkbox"/> POULTRY                       | <input type="checkbox"/> GOATS        | _____  |
5. Listed below are the major landforms in Umatilla County. Please indicate the number of acres in each landform for your farm or ranch (including rented or leased land). (See enclosed map)
- A. \_\_\_\_\_ (ACRES) VALLEY FLOOR (River bottomlands and benches)  
 B. \_\_\_\_\_ (ACRES) SANDY TERRACES (Northwest area of county)  
 C. \_\_\_\_\_ (ACRES) ROLLING HILLS (North-central, west-central, south-central area)  
 D. \_\_\_\_\_ (ACRES) FOOTHILLS (East and southeast areas)  
 E. \_\_\_\_\_ (ACRES) MOUNTAIN SLOPES AND HIGH PLATEAUS (Bordering on and including national forest areas)
6. Which of the landforms listed in question 5 produces the most income for your farm or ranch? (CHECK ONE)
- A       B       C       D       E

7. Check the irrigation district the majority of your operation is in (include leased or rented lands).

- Harwiston Irrigation District                       Westland Extension Irrigation District  
 Stanfield Irrigation District                       One of the Ditch Company service areas in the Walla Walla Valley  
 West Extension Irrigation District                       Umatilla Indian Reservation

8. Please indicate the NUMBER of separate fields or pasture units (separated by natural boundaries, roads, or ownership) you operate and the DISTANCE you travel from your home farm or ranch. Note: several fields or units may make up one owned or leased parcel. Count them separately if they are operated as separate farm or ranch units.

		ACREAGE CLASSES									
		< 5 ac.	5-9.9 ac.	10-19.9 ac.	20-39.9 ac.	40-59.9 ac.	60-99.9 ac.	100-199.9 ac.	200-299.9 ac.	300-399.9 ac.	400+ ac.
FOR EACH ACREAGE CLASS WRITE IN:											
A.	# of OWNED fields or pasture units										
	# of miles to owned fields or pasture units (longest distance for each category)										
B.	# of RENTED OR LEASED fields or pasture units										
	# of miles to rented or leased fields or pasture units (longest distance for each category)										

9. During the last 3 years, what was the AVERAGE GROSS value PER YEAR of total income from your farm or ranch operation? (Include sales, PIK and other govt. programs, deficiency and storage payments, etc.) (CHECK ONE)

- Less than \$2,500                       \$20,000 to \$39,999                       \$200,000 to \$349,999  
 \$2,500 to \$9,999                       \$40,000 to \$99,999                       \$350,000 to \$499,999  
 \$10,000 to \$19,999                       \$100,000 to \$199,999                       \$500,000 or more

10. How much do you think you would need to spend, at a minimum, to buy a farm or ranch operation similar to yours in today's market?

	Less than \$19,999	\$20,000-\$39,999	\$40,000-\$69,999	\$70,000-\$99,999	\$100,000-\$149,999	\$150,000-\$249,999	\$250,000-\$499,999	\$500,000-\$699,999	\$700,000-\$999,999	\$1,000,000 or more
CONSIDER THE FOLLOWING CATEGORIES AND CHECK THE APPROPRIATE BOX:										
LAND (exclude leased or rented lands)										
BUILDINGS (excluding home)										
MACHINERY & EQUIPMENT (new and used)										
START UP INVENTORY AND LAND PREPARATION (e.g. nursery stock, orchard seedlings, livestock, irrigation, etc)										
TOTAL COSTS										

11. During the last 3 years, about how much did you typically spend PER YEAR for each of the following items? (Check the appropriate box)

	Less than \$2,999	\$3,000-\$5,999	\$6,000-\$8,999	\$9,000-\$14,999	\$15,000-\$24,999	\$25,000-\$39,999	\$40,000-\$99,999	\$100,000-\$199,999	\$200,000-\$349,999	\$350,000 or more
HIRED LABOR (and related costs)										
REPAIRS AND MAINTENANCE										
INTEREST ON EQUIPMENT AND OPERATING LOANS (exclude loans for real estate purchase)										
RENT OR LEASE OF LANDS										
ANIMAL EXPENSES (animal health costs; breedings; feed)										
INVENTORY REPLACEMENT (e.g. seeds; plants; livestock)										
FERTILIZERS AND CHEMICALS										
ENERGY (fuel, electricity)										
PROPERTY TAXES AND PROPERTY INSURANCE										
REPLACEMENT OF EQUIPMENT; MACHINE HIRE										
MISCELLANEOUS (supplies; storage; freight; truckings etc.)										
<b>TOTAL EXPENSES</b>										

12. Please indicate what percentage of your products is sold by you to the following and give the distance in miles one way from your farm or ranch to that outlet.

	PERCENT %	DISTANCE (miles, one way)
BROKER, PROCESSOR, WAREHOUSE (Includes contract sales)	_____	_____
AUCTION	_____	_____
MARKETING ASSOCIATION OR CO-OP	_____	_____
DIRECT TO CONSUMER (U-pick, private sales)	_____	_____
OTHER MEANS (SPECIFY) _____	_____	_____
<b>TOTAL</b>	<b>100%</b>	

13. For the locations listed below, please indicate what percentage of your production (in dollar value) is processed (changed from its raw field form; for example, packaged, slaughtered, etc.,) in each:

	PERCENT %
IN THE COUNTY	_____
OTHER IN-STATE LOCATIONS	_____
ANOTHER STATE	_____
ANOTHER NATION	_____
DON'T KNOW	_____
<b>TOTAL</b>	<b>100%</b>

14. How open or limited is the market to the purchase of products from new farm or ranch operations of your type as checked in question 2? (CHECK ONE)

VERY LIMITED                       OPEN  
 SOMEWHAT LIMITED               DON'T KNOW

15. As you consider your concerns with making your operation a more profitable venture, please indicate your concerns by checking H for High Concern; M for Moderate Concern; N for No Concern.

H	M	N		H	M	N	
			TECHNICAL FARM PRACTICE ASSISTANCE				CONFLICTS WITH URBAN AND RESIDENTIAL USES
			BUSINESS MANAGEMENT ASSISTANCE				TECHNICAL FARM PRACTICE ASSISTANCE
			MARKETING KNOW-HOW ASSISTANCE				MORE AVAILABLE LAND FOR PURCHASE OR LEASE
			CREDIT AVAILABILITY				OTHER (SPECIFY) _____

Thanks for your cooperation!  
We'll send you a summary of results.

ADDENDUM TO:  
AN ANALYTICAL MODEL FOR EVALUATING  
AND CLASSIFYING AGRICULTURAL OPERATIONS

by

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Oregon State University

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## FOREWORD

This report contains material supporting the research described in An Analytical Model for Evaluating and Classifying Agricultural Operations. Included are data for selected dominant agricultural types in Umatilla County, a proposal for reclassifying survey landforms for planning applications, and sample statistics generated during hypothesis testing. Conjunctively, this addendum and the longer report comprise the total research effort.

Figure 1. Contribution to the market made by livestock grazing types on "hills."

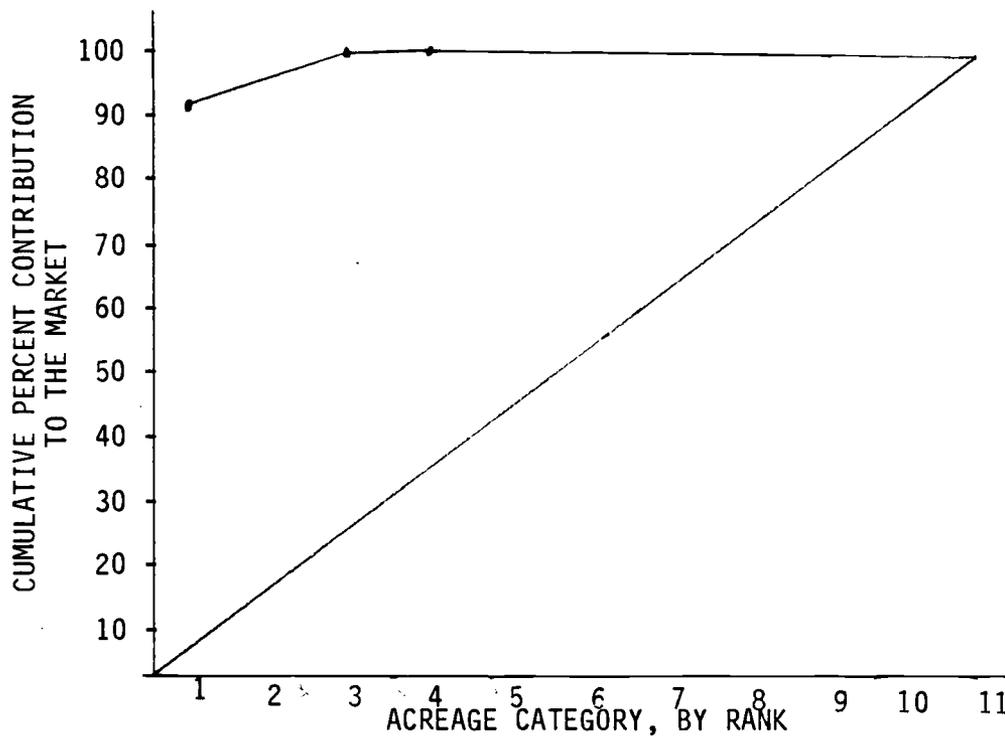
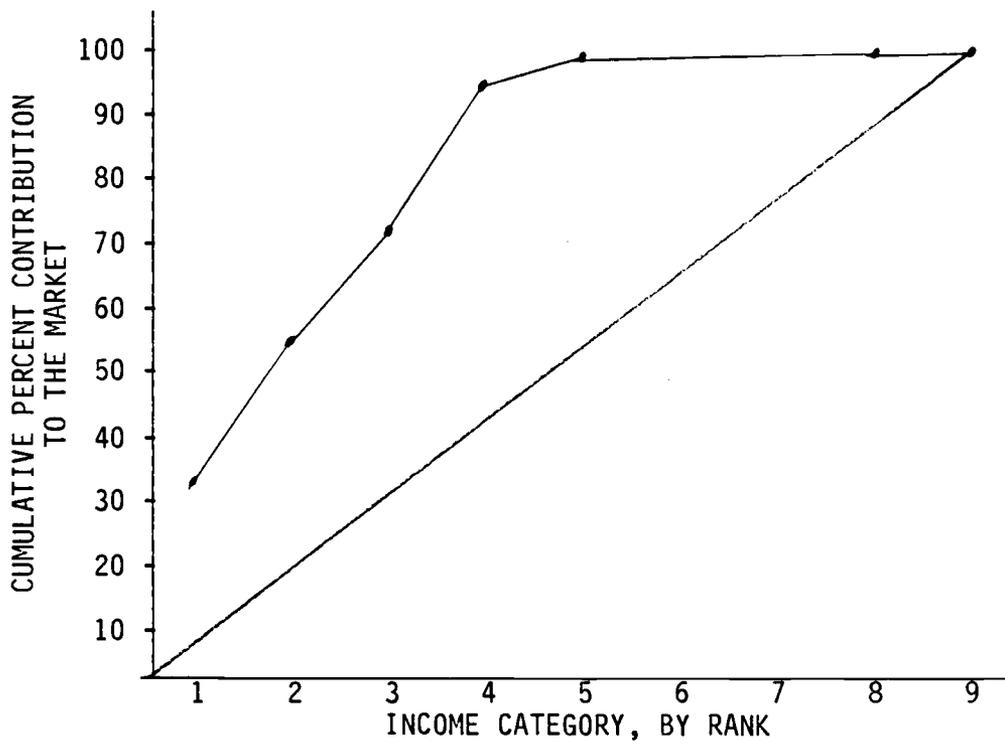
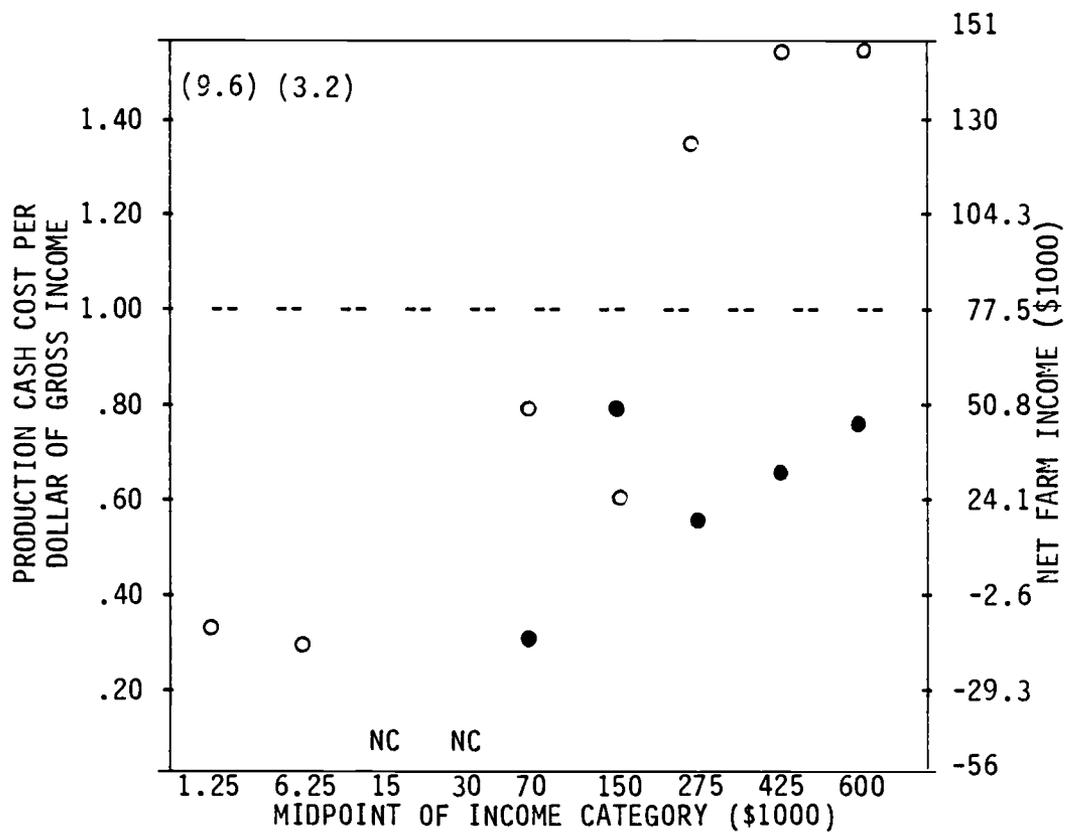


Figure 2. Total cash cost to income ratio and net farm income for livestock grazing types on "hills."



KEY: ● = Ratio  
 ○ = Net farm income  
 ( ) = Values that fall outside the figure  
 NC = No cases

Figure 3. Contribution to the market made by cash grain types on "hills."

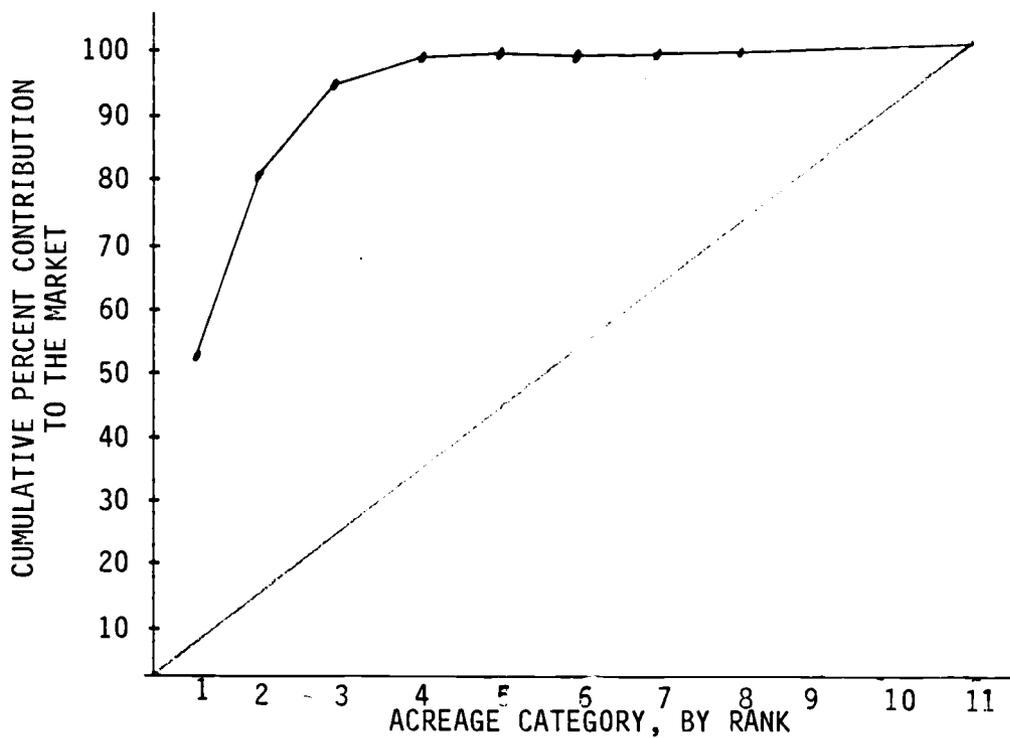
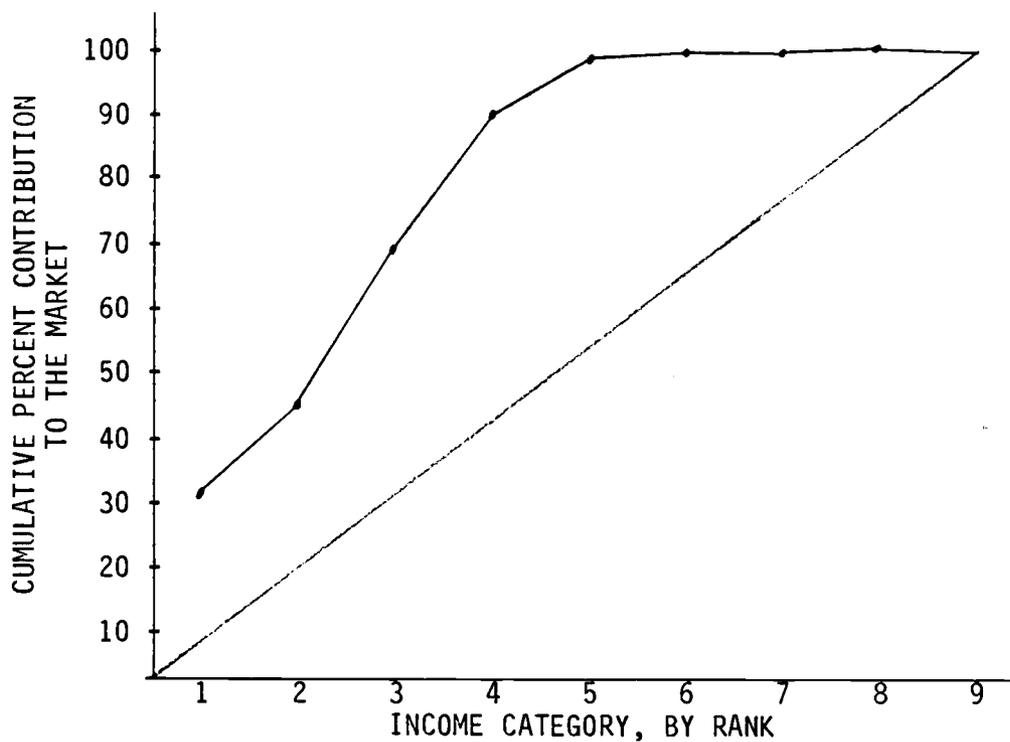




Figure 5. Contribution to the market made by tree fruits and tree nuts types on "bottomlands."

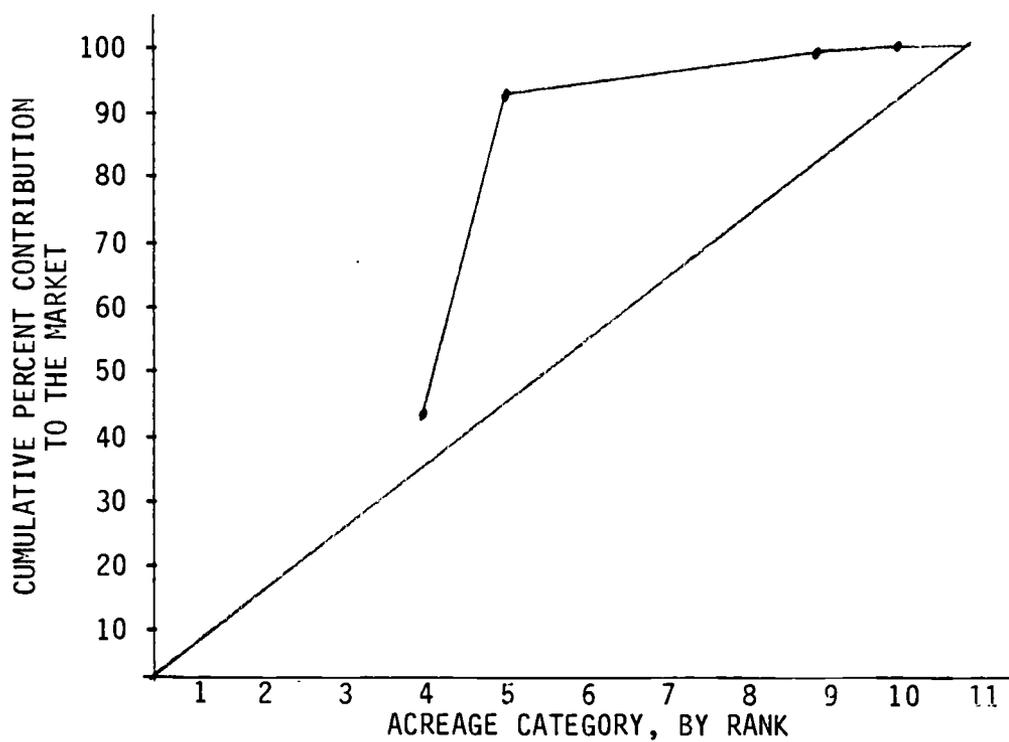
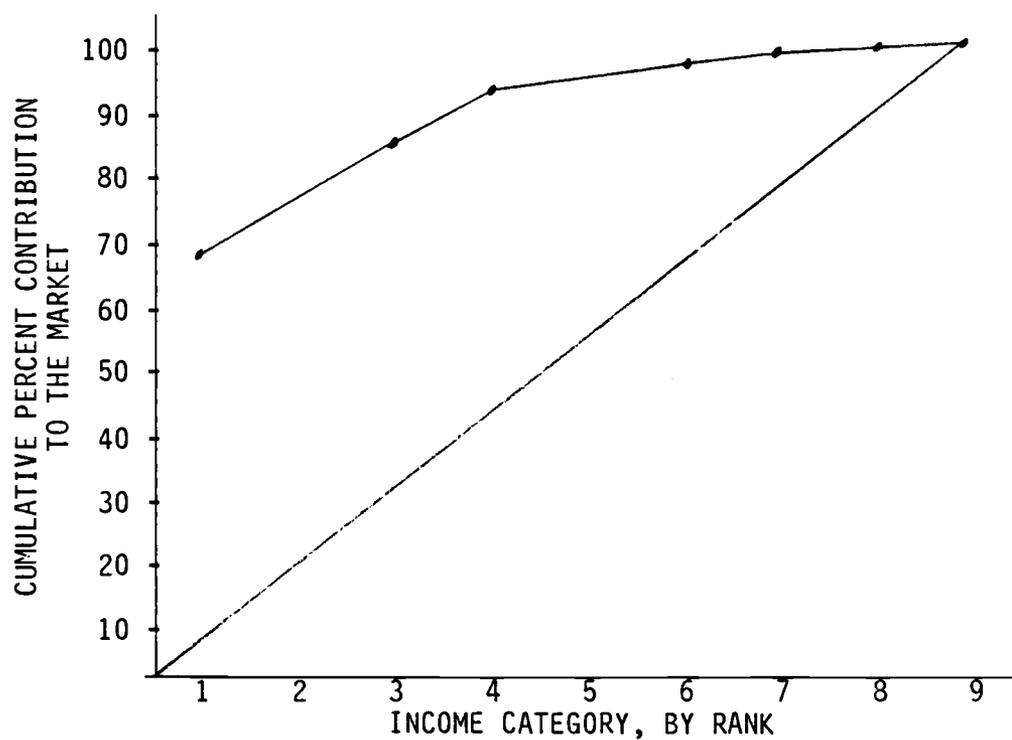
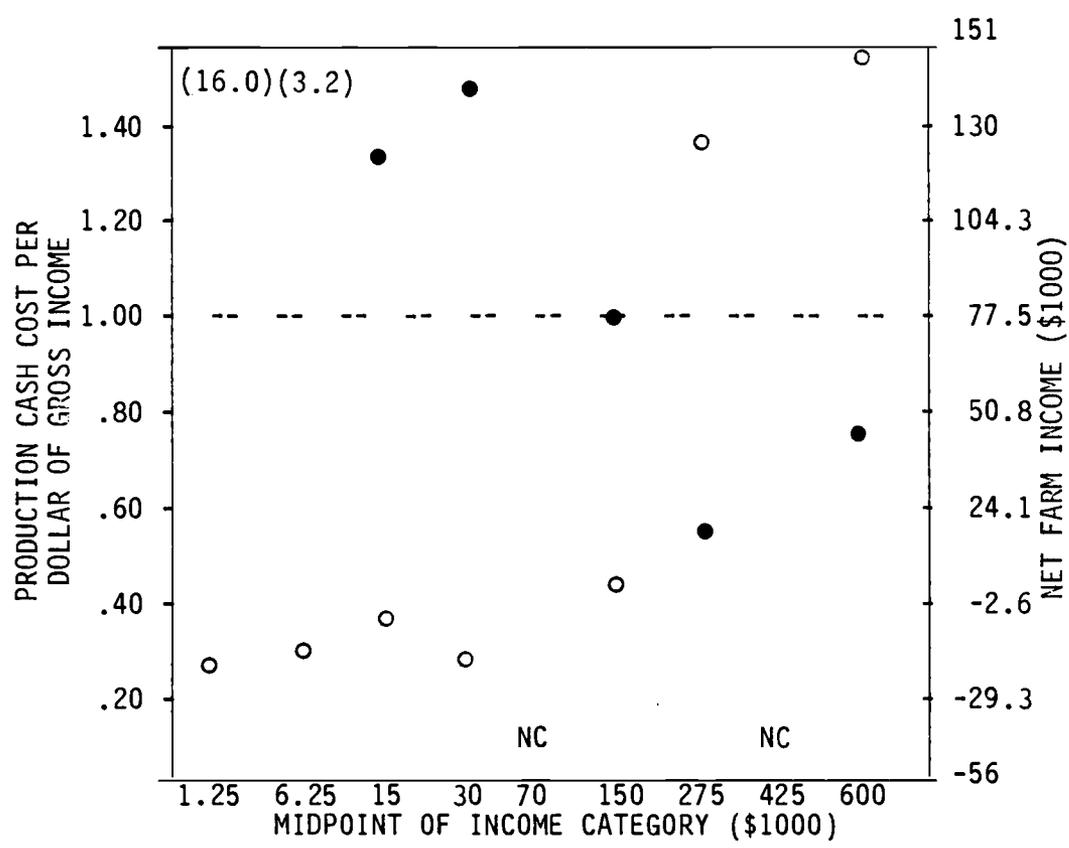


Figure 6. Total cash cost to income ratio and net farm income for tree fruits and tree nuts types on "bottomlands."



KEY: ● = Ratio  
 ○ = Net farm income  
 ( ) = Values that fall outside the figure  
 NC = No cases

Figure 7. Contribution to the market made by field crop types on "bottomlands."

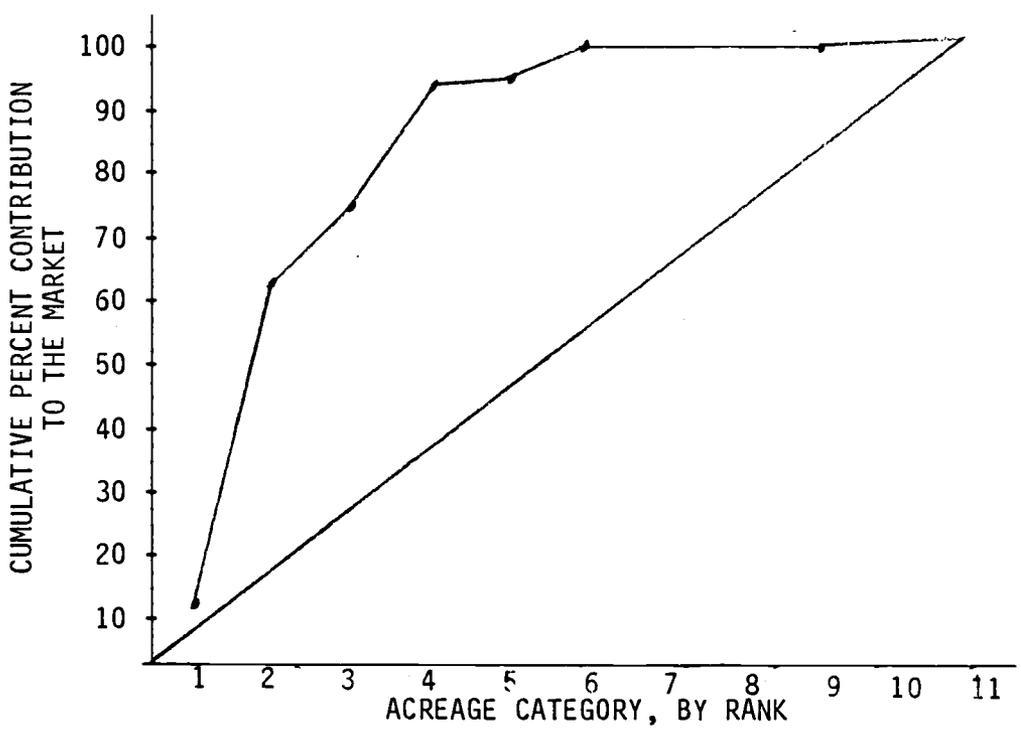
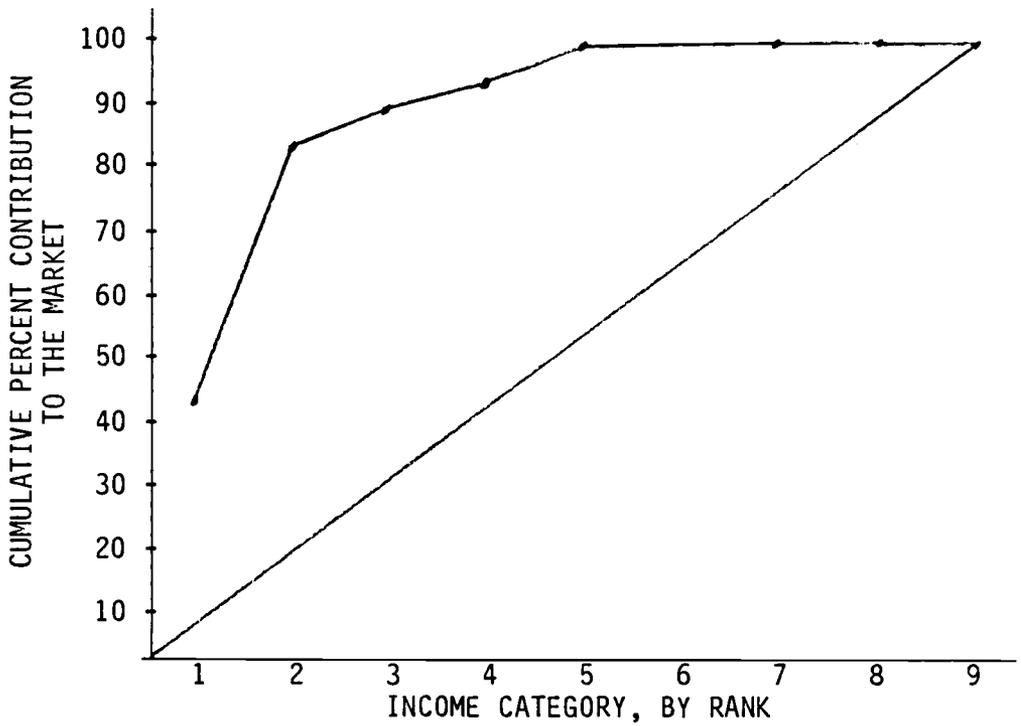
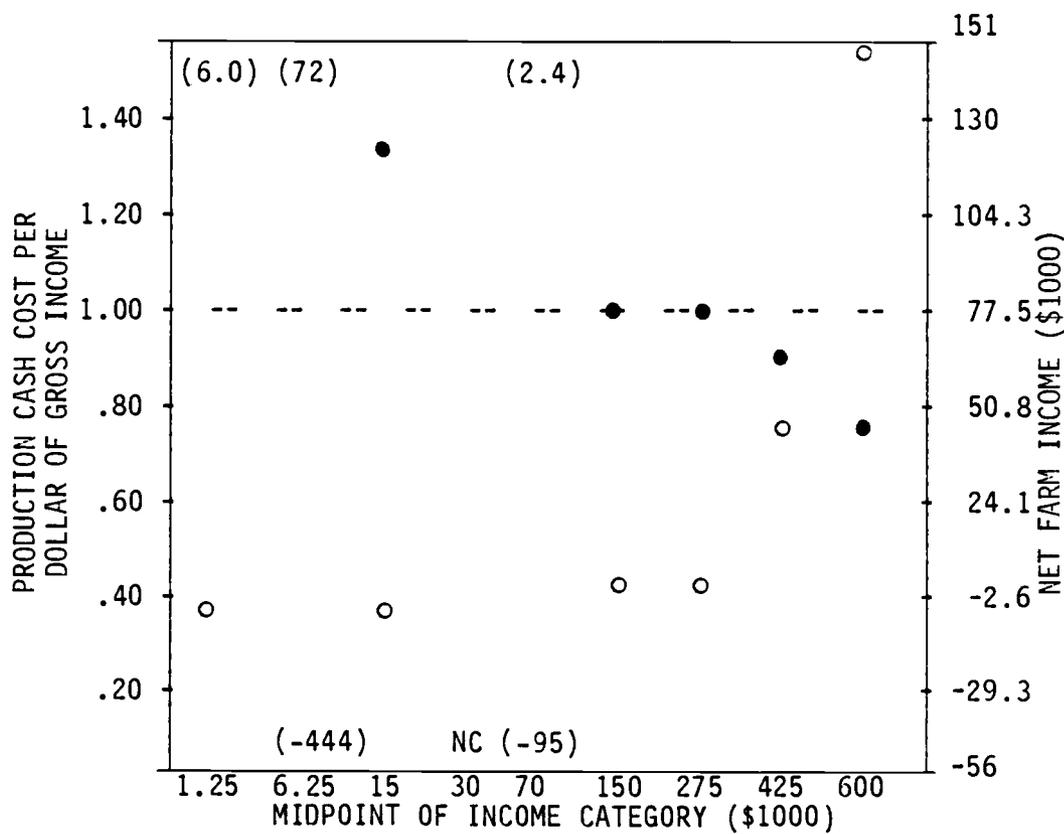


Figure 8. Total cash cost to income ratio and net farm income for field crop types on "bottomlands."



KEY: ● = Ratio  
 ○ = Net farm income  
 ( ) = Values that fall outside the figure  
 NC = No cases

Figure 9. Contribution to the market made by livestock grazing types on "bottomlands."

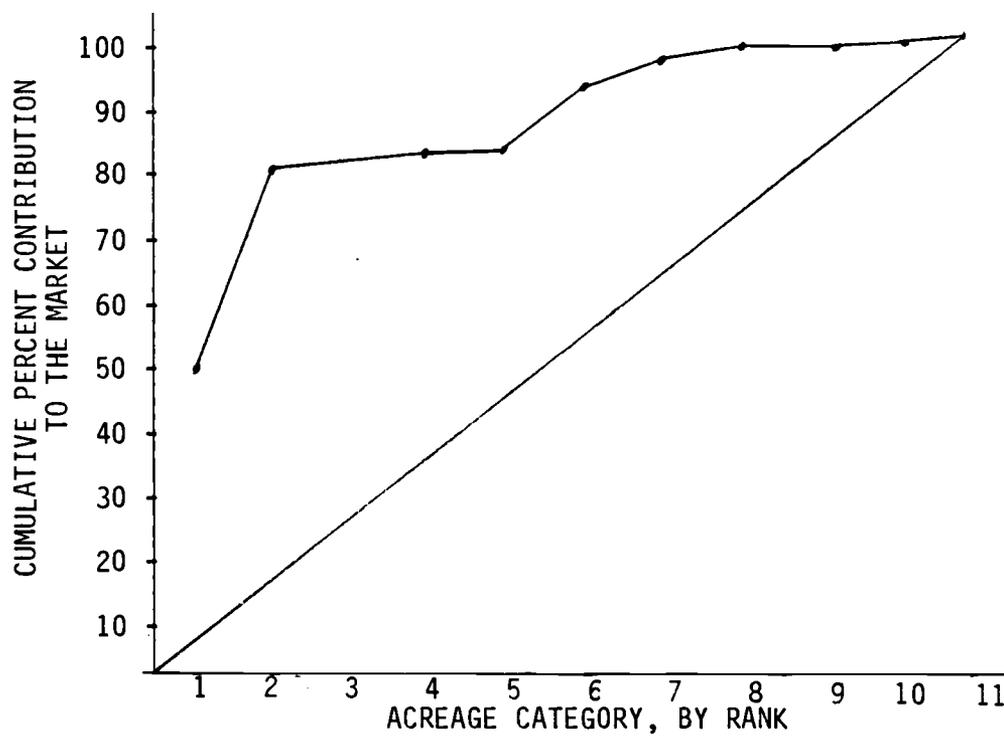
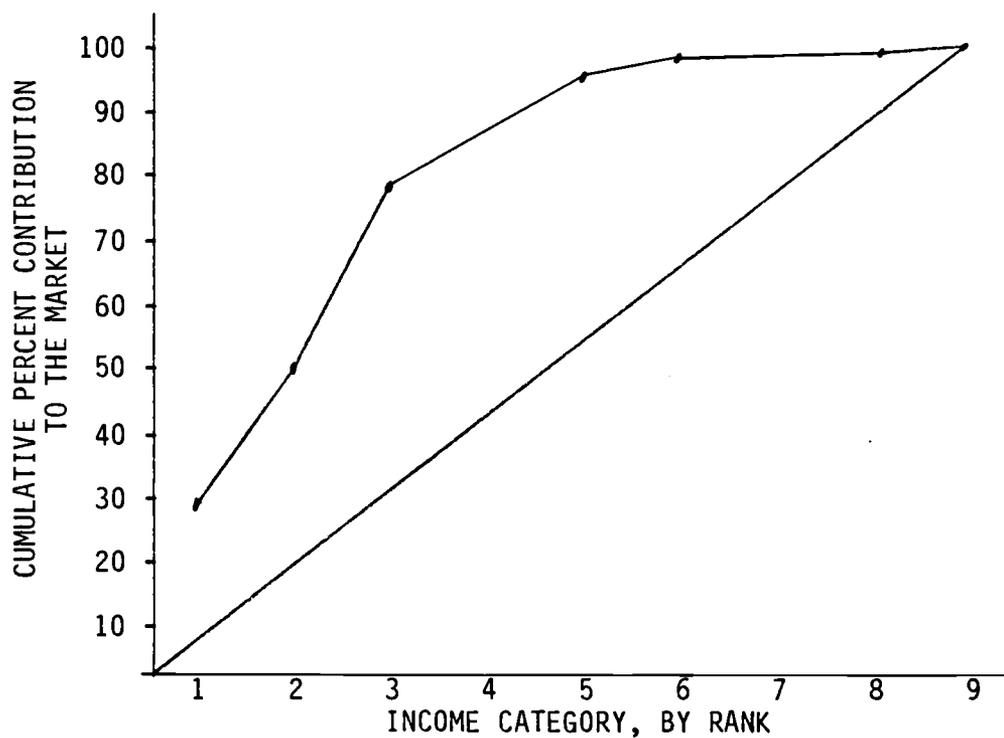
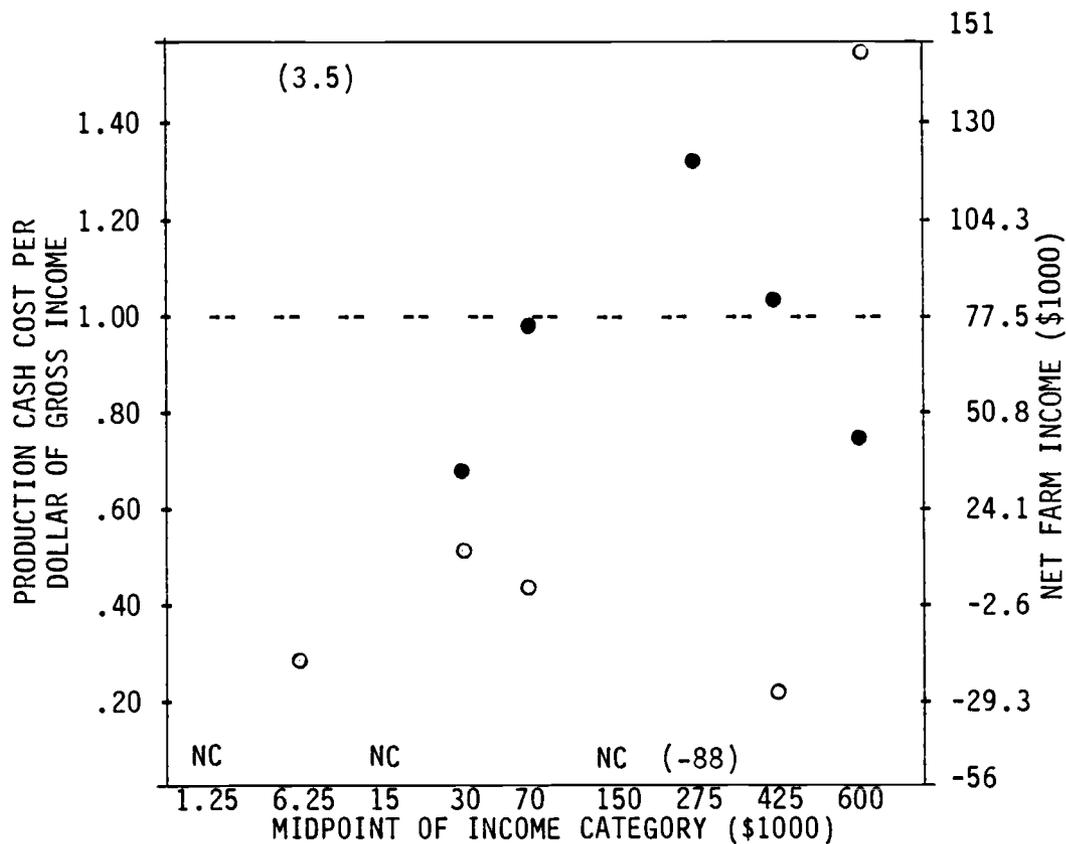


Figure 10. Total cash cost to income ratio and net farm income for livestock grazing types on "bottomlands."



KEY: ● = Ratio  
 ○ = Net farm income  
 ( ) = Values that fall outside the figure  
 NC = No cases

Table 1. Reclassification of survey landforms for planning applications.

Survey Landform Name	Planning Landform Name
Bottomlands, Terraces, Basins, Valley floor	Bottomlands
Hills, Foothills, Rolling Hills	Hills
Mountain Slopes, Uplands, Plateaus, Tablelands, Ridges, Slopes	Mountain Slopes and Tablelands

Table 2. Sample statistics from correlation analysis of the ratio of net farm income to value of investment in land and buildings (independent variable), and total acres operated (dependent variable) for cash grain types on "hills."

R	.00348
R <sup>2</sup>	.00001
Significance of R	.48555
Intercept (A)	2157.47274
Slope (B)	47.75095
Standard Error of A	185.10624
Standard Error of B	1314.70277
Standard Error of Estimate	1945.37867

N = 111