Income Variability of Alternative Plans, Selected Farm and Ranch Situations, Rolling Plains of Northwest Oklahoma

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Preface

The work reported in this bulletin is a part of research being conducted jointly by Agricultural Experiment Stations in the Great Plains States, in cooperation with the U. S. Department of Agriculture. The regional project (GP-2) is entitled: "Organizing and operating dryland farms in the Great Plains to meet variable climatic and changing economic conditions." The contributing Oklahoma project is Agricultural Experiment Station Project 968, "An economic appraisal of alternative systems of farming and ranching in high risk areas of Oklahoma."

In Oklahoma Experiment Station Bulletin B-563, estimates of production, price, and income variability of individual major crop and livestock enterprises in northwest Oklahoma were provided. Input-output information for the area is presented in Processed Series P-390.

The analyses presented here used part of the research results in the above reports as a base from which to develop models to estimate variability arising from alternative farming and ranching systems. The cooperation of E. H. McIlvain, Superintendent, U.S. Southern Great Plains Field Station, Woodward, Oklahoma, contributed to the development of data for all of these studies.

Agricultural Experiment Station
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Contents

Summary

The primary purposes of this study were to estimate the income variability of different enterprise combinations and to determine the probable effect on capital accumulation and survival for farm operators using these alternative plans. Five land resource situations that included different sizes of farm units and combinations of range and cropland, typical of this area, were analyzed. Production alternatives considered included wheat, grain sorghum, barley, temporary grazing crops, reseeding to grass, forage crops, cow-calf enterprises, and steer grazing enterprises.

For all resource situations, the highest income plan was the one that included heavy-graze steers with a high capital level assumed. These plans also showed the most variability. The plans producing the lowest income and the least variability were those that included cow-calf units as the basic livestock enterprise. Lowering the level of capital for a given planning situation resulted in both lower and less variable income because of a reduction in the quantity of livestock produced and a shift from continuous wheat to a wheat-grain sorghum-fallow rotation.

The owner-operator received the highest returns from all plans, whereas the tenant-operator received the lowest returns. For the tenant-operator relative variability was greater than for the other tenure classes, since absolute variability was reduced at a slower rate than income through the payment of cropshare rent.

A farm operator in any of the tenure classes could financially survive an assumed unfavorable income sequence if he operated a large balanced farm unit or large cropland unit. With the same planning alternatives, survival of the small balanced firm appeared possible only for the owner-operator employing one of the high-risk buy-sell steer grazing plans.

For the range resource units the question of survival of the farm firm was not as apparent. However, financial survival on the two range units appeared unlikely with a tenant-operator. In order for the encumbered owner to make the amortized land payment with a cow-calf plan, annual family living expenditures would be at a level below $3,500 with some farm expenditures deferred for the amortization period. The operator, who was either a part owner or an owner-operator, could maintain average family living while meeting all annual business costs.

The plan chosen for a particular farm unit would vary depending upon the decision criterion used. The high capital level heavy-grazed

steer plan would be the plan chosen with a goal to maximize the gain in capital equity. The highest level of family living on the small balanced unit would also be derived from this plan. However, on the small ranch unit, large balanced unit, and large cropland unit, the low capital level heavy-graze steer plan could provide the highest level of family living. On the large ranch unit the three steer grazing plans all provided the same level of family living. With a criterion of lowest variability, the cow-calf plans would be preferred for all resource situations considered in this study.

The data implied the necessity of expansion in size of farm for the small balanced unit for all plans and for the range units for the lower income plans. For the small balanced unit, income may be supplemented by off-farm employment since surplus labor was available in all labor periods.

Income Variability of Alternative Plans, Selected Farm and Ranch Situations, Rolling Plains of Northwest Oklahoma[1]

Wallace G. Aanderud,* James S. Plaxico, and William F. Lagrone*****

Variable income is characteristic of Great Plains agriculture. Instability in gross income is due to fluctuations in yields caused by weather variability and other natural or physical hazards, and to changes in the prices of agricultural products. The result is that area and individual farm income is variable and uncertain, whereas cost commitments and living requirements are relatively fixed.

The income variability and uncertainty problem is further aggravated by the tendency of favorable and unfavorable years to bunch. Bunchiness may not be significant for the operator who owns land debt clear and who has operating capital reserves. However, for the operator with limited operating capital reserves and little equity in land, tne bunching of unfavorable income periods may be more significant than the degree of variability. Such operators may not be able to acquire the financing required to keep the farm firm in operation over a period of unfavorable years to secure the high income that may occur in later years.

Purpose and Objectives

The overall purpose of this study is to evaluate certain management strategies for meeting economic and climatic conditions of the Great Plains area of Oklahoma. The specific objectives are:

1. To derive alternative combinations of enterprises for selected land resource situations,
2. To calculate the expected variation in annual returns for the enterprises included in these alternative farm plans,

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[1] Comments and suggestions of Dr. Odell L. Walker and Dr. Larry J. Connor were helpful in preparing this report for Publication.

The research reported herein was done under Oklahoma Experiment Station Project 968.

3. To evaluate the nature of income variability associated with alternative combinations of enterprises for selected resource situations, and
4. To analyze the effects on capital accumulation and survival of the farm firm of these alternative organizations under selected tenure and equity situations.

Study Area

The inferences of this study apply to the area shown in Figure 1. The U.S. Southern Great Plains Field Station, Woodward, Oklahoma, is near the center of this area. Records indicate that the average annual precipitation at the Woodward Station is 23 inches with a range in annual rainfall of from about 10 to 42 inches. Seventy percent of the precipitation occurs in the summer months. The most severe drought in 77 years of recorded weather occurred during 4 of the 16 years included in this study. Precipitation for these 4 years averaged about 15.5 inches with less than 10 inches in 1954.

Approximately 97 percent of the study area is in farms and ranches, with nearly 65 percent of the farm and ranchland in native or reseeded grasses. About 50 percent of the agricultural income is derived from livestock, primarily beef cattle, 35 percent from wheat, 10 percent from sorghum, and five percent from other crops.

The area is characterized by high winds, a high evaporation rate, and intermittent drought resulting in relatively variable crop produc-

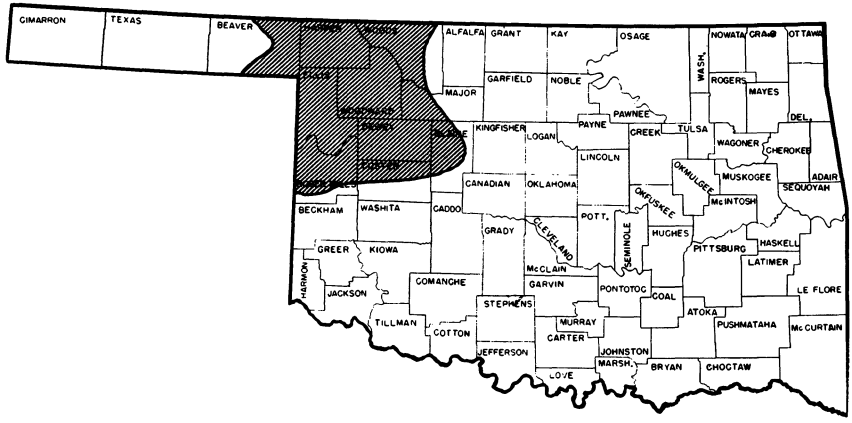

Figure 1. General area with farming and ranching operations similar to the typical resource situations analyzed.

tion. Soils are predominantly of the lighter type and are subject to wind and water erosion.

Method of Analyses

The farm plans analyzed in this study were derived by the use of linear programming. The plans included in these analyses were selected from a larger group of programmed plans for northwestern Oklahoma.[2] These plans represent eight different planning situations for five different representative farm units.

In general, technical coefficients were obtained from published sources and estimates of agricultural workers. Where data were not available, estimates were derived by statistical techniques and checked for logical relationships with professional agricultural workers. The resource requirements, costs, and expected returns, which served as the basic input-output data for deriving the farm plans analyzed, are from Greve, Plaxico, and Lagrone (6).

For the variability analyses, the value of the cow herd was assumed to be constant. However, the prices of calves and yearling steers were assumed to have the same variability as the deflated prices for the 1942-57 period. Annual cash costs of production were assumed to be constant.

Activity Restrictions

The full linear programming model used in deriving the farm plans analyzed, involved 80 activities and 19 resources. Cash grain crops selected for inclusion were continuous wheat, barley, and grain sorghum.

Cropland grazing for livestock included forage sorghum, Sudan grass, Johnson grass, Weeping Love grass, Sandyland mix, wheat to graze out, and "go back" grass. Forage sorghum harvested was the source of forge for supplemental harvested feed. Sagebrush control was included as a range improvement practice.

The livestock enterprises in the model were buy-sell steer grazing activities and cow-calf activities. Three grazing intensities for both steer and cow-calf activities were included for native range and cropland reseeded to permanent grass. Other livestock activities, using forage sorghum hay and/or temporary grazing, included five steer activi-

[2] The plans analyzed in this study are part of a group of plans programmed cooperatively with Robert W. Greve, Agricultural Economist, USDA.

ties and three cow-calf activities. Other activities in the program provided for hiring labor, borrowing capital, and buying forage.

In the programming process, the model was modified so as to eliminate specified activities. These different alternative enterprise combination for discussion purposes are denoted by the letters A, B, C, and D, as shown in Table I.

Capital Limitation

The absolute level of capital used was changed by requiring different marginal value products for capital. If a high rate of interest is required on capital, the amount of capital used will be lower than when a low rate of interest is required. In effect, the interest rate acts as a predetermined marginal-value product for capital with only those activities which return at least this rate in the optimum plan (1).

Each of the four enterprise planning situations was programmed at a six percent and an 18-percent annual cost of capital. The reduction in the use of capital by increasing the charge for capital from six to 18 percent is shown in Appendix A, Table II.

Labor Assumptions

Family labor available was assumed to be the same for a given resource situation regardless of tenure status. However, the number of hours available was reduced as farm size was increased. The assumption was made that more of the operator's time would be required for management and decision making as farm size increased. Table II shows the three levels of family labor assumed for this study. Additional labor was assumed to be available for hire at $1.25 per hour.

Tenure Classes

The initial programmed farm plans assumed an owner-operator with full land equity. Four of these plans were analyzed for an encumbered owner with 50 percent land equity and 50 percent being purchased, a part owner with 50 percent land equity and 50 percent rented, and a tenant-operator.

Interest Rates

In all of the cost and returns analyses, an interest rate of six percent was used for annual operating capital. Returns on land capital were calculated at an annual rate of 5 percent. Payments on land purchased were amortized at an interest rate of 5 percent for a 33-year period.

Rental Rates

The rental rate assumed for cash crops is based on a one-third landlord crop share. The rental rate for range and feed crops was assumed to be at a level which would give the landlord about the same return per dollar invested in rangeland and feed cropland as the one-third crop share return yields per dollar invested in cash cropland. The rate used was derived from the optimum crop plan for the large cropland unit with all livestock activities excluded. The computed average rental rates were $5.44 per acre of cropland and $2.05 per acre of rangeland.

Overhead Costs

Some costs which are difficult to prorate to individual enterprises were grouped under the term overhead costs. These costs were assumed to be primarily nondeferable annual operating costs. Included were the costs of owning and operating a farm truck, telephone service, bookkeeping and tax service, and building and machinery insurance. Appendix A, Table I shows the two levels of these costs assumed. For resource situations I and II, $696 was assumed to be the total cost for these items while for resource situations III, IV, and V, the assumed total was $1,157.

Real estate taxes were based on observed average tax rates in the area. For this study, the rate used was 88 cents per acre for cropland and 24 cents per acre for rangeland.

In addition to farm operating expenses, the farm family must meet certain minimum living expenses. The money to pay these required disbursements must come from annual farm income or savings from previous years; $3,500 was assumed to be the minimum average annual farm family outlay for necessary living.

Physical Resource Situations

Table III shows five land resource situations selected as being typical in the area. Cropland soils in the area were derived into five productivity classes on the basis of topography, depth, and texture of topsoil (6).

Land Values

The land values used in this study were calculated on the basis of marginal value product coefficients for the five different classes of cropland, rangeland marginal value product, and the average census value of all farmland in Woodward County (14). The marginal value product coefficients used were those for the large balanced unit with only the cow-

calf enterprises allowed as livestock alternatives in the plan. The computed value of a composite acre of cropland was $88.23, with rangeland valued at $35 per acre.

Programmed Static Farm Plans

For each of the five farm and ranch land resource situations, enterprise combinations that would provide the highest net returns to available resources were determined by linear programming techniques. Other enterprise combinations were derived by assuming four different enterprise planning situations at two capital levels.

The programmed farm plans provide estimates of the optimum combinations of enterprises, returns over specified costs, annual operating capital requirements, and the hired labor required. Imputed returns were derived only after making assumptions with respect to returns to family labor, real estate taxes, and levels of general overhead costs that were not included in the enterprise budgets.

Activities in the Plans

For the plans analyzed in this study, ten different cash income-producing enterprises entered significantly into one or more of the optimum plans. These ten enterprises were wheat for harvest, wheat-grain sorghum-fallow rotation, five steer grazing alternatives, and three cow-calf alternatives (6).

To support the livestock alternatives, part of the cropland was used to produce forage for winter feed. Johnson grass, Sudan grass, and wheat for grazing were used by the temporary grazing enterprises. Additional grazing was also available for temporary graze activities in the October-February grazing period from wheat for harvest. Weeping Love grass was used to supply permanent range on cropland as an additional source of grazing for the native range enterprises. If the Weeping Love grass activity is excluded from the program, Sandyland grass mix replaces it with a very small reduction in income.

In general, when operating capital was limited, the plan derived included less continuous wheat, more wheat-grain sorghum-fallow, less livestock, and a less variable but lower gross income. When the livestock alternatives were restricted so as to change the livestock produced from heavy graze steers to moderate graze cow calf units with a given rate of interest on operating capital, a shift also took place from continuous wheat to the wheat-grain sorghum-fallow rotation. At the same time the

proportion of cropland devoted to livestock was reduced resulting in a reduction in income and variability of income.

Expected Returns and Expenditures

For the analyses of allocation of income, average annual living expenditures were assumed to be $3,500. An alternative assumption is that $3,500 represents wages for family labor used on the farm. After family living cost, cash farm expenditures, real estate taxes, depreciation, six percent returns on annual operating capital, and five percent returns to land capital were deducted from gross income, the residual was imputed to management. For analyses with other tenure classes, part or all of the returns to land capital were replaced by either a charge for rent paid to the landlord or an amortized land payment.

Four of the farm plans for each resource situation were analyzed for three tenure classes in addition to the owner-operator. These tenure classes are the encumbered owner, part owner, and tenant.[3] The four plans analyzed for these three tenure classes are the high capital level moderate graze steer plan (6C), the high capital level cow-calf plan (6D), and both the high capital level plan (6A) and the low capital level plan (18A) when the full programming model is used.

In a static framework, whether or not the plan is preferred depends upon the level of income from this plan in relation to income from alternative plans. Of the plans considered in these analyses, plan 6A consistently showed the highest net income (Table IV). When the goal is highest average returns over costs, and with unlimited capital, this would be the best plan to follow. However, when variability is considered other plans may be preferred.

Potential Investment Funds

Potential investment funds constitute the fraction of farm income that may be available for reserves, debt payment, and/or expansion. The sources of these funds are returns to owned sources including management.[4] In this section, the production of potential investment funds for selected plans was computed, assuming full equity in annual operating capital. Later, this assumption is relaxed to analyze the effects of starting with less than full equity in annual operating capital on firm survival and capital accumulation.

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[3] The encumbered owner was defined as having full equity in 50 percent of his land and purchasing 50 percent of his land. The part owner has full equity in 50 percent of his land and rents 50 percent. The tenant rents all of his land and may also be referred to as a tenant-operator.

[4] These funds include returns to annual operating capital, land equity, and management.

Returns to owned resources were highest for the owner-operator tenure class. For this tenure class, all plans except the low capital level cow-calf plan (18D) on the small balanced unit showed positive long-run returns to owned resources. Even with 100 percent equity in both land and capital assumed, the owner-operator's return over annual expenditures from this plan was less than average family living. In the long-run, this plan would result in a reduction in equity if family living were maintained at $3,500.

As shown in Table IV, none of the plans for the small balanced unit produced enough income to maintain the tenant-operator's family at the average level of living assumed. In the long run, the tenant-operator on this unit faces a lower level of living and/or a reduction in equity.

The part owner on this unit could have some returns to capital available when plan 6A was followed. With the low capital plan (18A), family living could be maintained at $3,500 with only $11 allocated to returns to capital per year. The moderate graze steer plan (6C) and the cow-calf plan (6D) did not produce enough income to maintain average family living. For the encumbered owner, only plan 6A returned a surplus of returns over the land payment, other annual expenditures, and average family living on the small balanced unit.

The large balanced farm unit showed significant returns to annual operating capital, land equity, and management for these four plans regardless of tenure. The owner-operator had the possibility of the highest returns to these factors ($11,404) if he followed plan 6A. The lowest returns ($2,130) were shown for the tenant-operator if he used plan 6D. The returns for all plans for the encumbered owner and the partial tenant on the large balanced unit were between the above extremes, as shown in Table IV.

For the two ranch units, the only plan of the four analyzed that showed negative returns to capital was the cow-calf plan (6D), when the tenant-operator class of tenure was assumed. For these two units, if all the land were rented with the range used for a cow-calf operation, an average level of living lower than $3,500 would have to be accepted or else the tenant-operator's equity in annual operating capital would be reduced. This reduction would occur at the rate of at least $35 per year for the large range unit and at least $221 per year on the small range unit as shown in Table V. With less than full equity in annual operating capital, the tenant-operator's level of family living would be further reduced by the amount of interest on capital borrowed to carry out plan 6D.

The tenant-operator's return to annual operating capital with full equity for planning situation 18A on the large range unit was only 2.2 percent. If his average equity were less than 65 percent, his family living level would have to be decreased with no funds available for reserves. The average returns to annual operating capital, if plan 6C were chosen by a tenant-operator on the range units, would be 5.3 percent on the large range unit and 4.8 percent on the small range unit.

For the part owner on either of the range units, all four plans indicate the possibility of accumulating reserves. Assuming a six percent return to annual operating capital, the average return to the operator's land equity would be less than one percent if plan 6D were followed. Similarly, returns to the operator's land equity would be less than 3 percent if plan 18A were used on the large range unit. The part owner using plan 6C on either of the range units would realize a return of less than 4.5 percent on his land equity, with a slightly higher rate of return to land from the smaller unit. The rate of return to land was higher for the small range unit than for the larger range unit because of the higher proportion of cropland on the smaller unit and due to the fact that less hired labor was needed on the smaller unit for a given planning situation.

The long-run total returns to the encumbered owner's equity is higher than the return to the part owner's equity for any of the specified plans. His average rate of return to land equity is also higher than for the part owner. However, even with these higher returns, problems of short-run survival could arise because of the annual land payments required and the fact that these funds may not be as easy to transfer as other types of reserves.

The fifth resource situation analyzed was the large cropland unit (Table VI). The returns from this unit were high enough so that regardless of the tenure situation, all plans showed a significant level of returns for reserves.

Enterprise Variability

The estimated variability of income from the enterprises producing cash income in the plans are shown in Table VII. Because the actual price series overestimates the degree of price variability when there is an upward trend in all prices, a deflated price series was used.

The actual level of income per acre would be about twice the deflated mean income shown in Table VII for the type of land that was

usually assumed for these enterprises in the programmed plans. For example the average programmed gross returns per acre for wheat was nearly $23. With a coefficient of variation of 35.2 percent the actual standard deviation would be $8.10. On this basis gross income from wheat per acre would be expected to be between $14.90 and $31.10 two-thirds of the time. Theory tells us that over one-third of the incomes will be within one standard deviation above the average and one-third of the incomes will be within one standard deviation below the average.

Of these enterprises, the most stable enterprise was cow-calf units grazed on Johnson grass. The most variable enterprise was the temporary graze steer enterprise grazed on wheat and Sudan grass. Of the two grain enterprises, wheat had a lower relative variability of returns than grain sorghum.

Correlation coefficients indicate the proportion of the time that series of income change together. A positive correlation indicates that if one increases the other increases. A minus correlation indicates that they tend to change in opposite directions. The income from enterprises in this study tended to change together as shown in Table VIII. The two grain enterprises had a low correlation with each other as well as with the livestock enterprises. The livestock enterprises were quite highly correlated with each other.

Variability of Whole Farm Income

The relative variability of the gross income from each of the programmed farm plans was calculated.[5] These calculations indicated that for resource situations I, II, and V, plan 6D which restricted the livestock to the cow-calf activities had the lowest coefficient of variation (Table IX). In the case of resource situations II and IV, the coefficient of variation was lowest when the 18-percent capital opportunity cost rate was used in deriving the cow-calf plan (18D). In terms of returns, plan 18D with capital restricted by the higher opportunity cost and the livestock activities restricted to the cow-calf alternatives yielded the lowest income and had the smallest standard deviation for all resource situations.

The highest coefficient of variation of gross income for resource situations I and III was for plan 6A. A high proportion of the income was from steers for this plan. For resource situations II, IV, and V, the maximum coefficient of variation occurred when the temporary graze steer activity was restricted (6B). For resource situations IV and V, plan 6B had the highest standard deviation of gross income. This higher variabili-

[5] For a discussion of the procedure used to calculate the variance of gross income for each plan, see Appendix C.

ty resulted for these two situations because a high proportion of the income was from the heavy graze steer enterprise which is the most variable enterprise.

Disposable Income Opportunity Curves[6]

If the farm firm is to survive, the level of disposable income must be high enough to provide a desirable level of living for the farm family. Funds must also be provided for increases in business equity and for reserves to meet the financial requirements of unfavorable years. Variability associated with the disposable income from alternative enterprise combinations is also a significant factor in the choice of farm plan to follow.

Income opportunity curves may serve as a method of studying the relationships between income levels and variability of income from selected resource and planning situations. Figure 2 shows the disposable income opportunity curves for each of the typical resource situations. These curves were constructed by plotting the average disposable income and its standard deviation for eight plans derived for each resource situation. The five curves shown represent smooth lines drawn through these plotted points for each typical farm (See Appendix F).

Each operator's evaluation of income levels and variability would result in some indifference curve which would be tangent to the income opportunity curve at some point. If this point of tangency is toward the right portion of the income opportunity curve, a plan which includes the more concentrated livestock such as heavy graze steers is selected. The plan would also include all or most of the wheat allotment as continuous wheat. If the point of tangency falls toward the left portion of the income opportunity curve, the plan will be one which includes less intense livestock enterprises, such as cow-calf units, and a wheat-grain sorghum-fallow rotation on most of the cropland.

Although only eight different plans were plotted to draw these income opportunity curves, theoretically, there are combinations of livestock and crops which will form a continuum of plans all along these curves. Each of these plans is a possible alternative which could be selected as the management plan to follow by an individual farmer after evaluation of the alternative incomes, variability, and his ability to survive the variability based on his equity position and living requirements.

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[6] These income levels include $3,500 that was allocated for family living plus returns available for reserves or debt payment with average family living. Since annual operation costs were assumed constant for the variable costs of operation, the standard deviation of disposable returns for the owner-operator are the same as for gross income. The level of the curves would be shifted down for the owner-operator with less than full equity in annual operating capital.

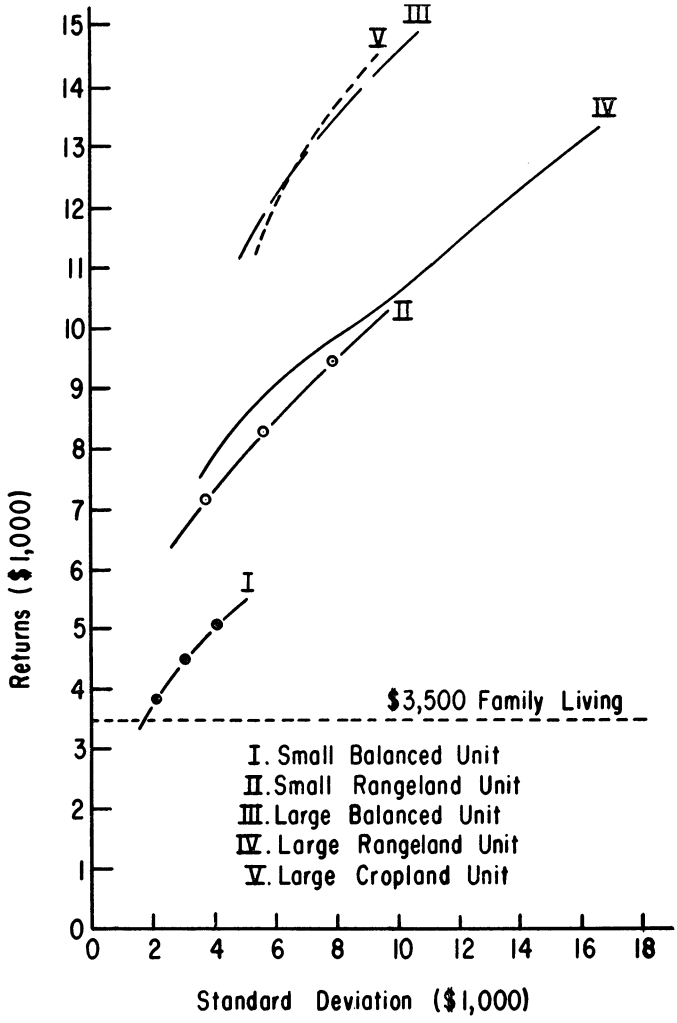

Figure 2. Disposable income opportunity curves, owner-operator with full equity in annual operating capital, selected farm and ranch resource situations.

In terms of all the possible plans that could be followed for a given resource situation, those plans that are plotted below the income opportunity curve are inferior to plans on the curve. For a plan which falls below the curve, there is some plan on the curve with a lower variability and the same income. There is also a plan on the curve with the same variability but a higher income than the plan fall-

ing below the curve. Similarly, when the income opportunity, line is drawn as a smooth curve, there will be some plans that will be plotted above the curve. Any plan above the curve may be considered superior to a plan on the curve with either the same standard deviation or the same income level.

Of the five resource situations programmed, the large balanced farm unit yields the highest level of disposable returns for six of the eight assumed planning situations. For two planning situations (6D and 18D) that restrict the livestock activities to a cow-calf operation, the large cropland unit yields a higher disposable income than the large balanced unit. However, the coefficients of variation for these two planning situations were lower for the large balanced unit than for the cropland units.[7]

Although the large range unit showed a lower level of disposable returns for the eight planning situations than the large balanced farm unit or the cropland unit, the level of variability was higher for six of the planning situations. For the two cow-calf planning situations, the level of variability was lower for the large range unit than for the balanced or cropland units.

However, the coefficient of variation of even these two planning situations was higher for the large range unit due to the high proportion of the total farm income derived from the relatively more variable livestock enterprises, rather than from the less variable cash grain enterprises.

Further observations of the disposable income opportunity curves indicate the relative levels of income and variability for the five different land resource situations. A high level of variability was noted in the range units compared with the large balanced unit and the large cropland unit. For a given level of standard deviation, the range units produced a lower income than the cropland unit or large balanced unit. For a given standard deviation, such as $8,000, the intersection of the income opportunity by a vertical line from this point varies from $9,400 for the small range unit to $13,700 for the cropland unit. In Figure 4, the income opportunity curves for the large balanced unit and the large cropland unit cross at an income of about $12,200 with a standard deviation of $6,100. This intersection point corresponds to the approximate income and variability for the high capital level moderate graze steer plan (6C) on the cropland unit and the low capital level moderate graze steer plan (18C) on the large balanced unit.

[7] The calculated coefficient of variation for planning situation 6D was 43, compared with 46, and for planning situation 18D, it was 44, compared with 47.

Effects of Tenure on Income Opportunity Curves

The effects of tenure on income and variability of income were analyzed for four of the eight plans derived for each resource situation. Since the same basic plans were used for all tenure classes, there was no change in the gross income opportunity curves for the farm units. When income remaining after any combination of expenses that included rent was considered for the tenant or part owner, changes occurred in both the level and variability of the income opportunity curves. The payment to the landlord by the tenant was assumed to vary with the annual level of production of cash grain crops. Since the payment of rent to the landlord is lowest when cash grain income is lowest and highest when cash grain income is highest, the absolute variability of income to the tenant was less than the variability of total gross income from the farm units (Appendix D). The greater the proportion of cropland, the more income variability was reduced for the tenant-operator compared with income variability for an owner-operator. Obviously, the level of returns to land was lower for the operator who rented all or part of his land, although the rate of return allocated to land equity was the same.

The variability of income for the encumbered owner was the same as for the owner with full- and equity. The significant difference for the encumbered owner was the level of unallocated disposable returns after making a principal payment on land. The analysis for all land resources situations showed that disposable levels of returns to the encumbered owner were lower than for the owner and part owner, due to this land payment.

In Figure 2, relationships between the income opportunity curves were shown for the farm operator with full equity in selected land resource units. Using the data for four of the planning situations, Figure 3 shows the differences in income opportunity and variability when different tenure classes were considered on the balanced farm units.[8] When tenure is considered, the variability reduction produced by the correlation of rent payments with grain income shifts the curves to the left for the operators renting land. The higher the proportion of rented land, the farther the curve shifts to the left, due to the degree of reduction in standard deviation. The income opportunity curve for the operator renting land was also shifted down as a function of his lower equity in land, compared to the owner-operator of a similar unit. For the encumbered

[8] The four planning situations included were the high and low capital level plans with heavy graze steers, the high capital level moderate graze steer plan, and the high capital level cow-calf plan. The four tenure classes may be denoted by the following notation: 00 owner-operator, EO encumbered owner, PO part owner, (50 percent owned, 50 percent rented), and TO tenant-operator.

Table I

Enterprise Planning Situations Used For Programming Each Farm Unit

Plan[a]	Program Model Activities Excluded As Alternative Enterprises
A	None
B	Temporary Graze Steers
C	Heavy Graze Steers Temporary Graze Steers
D	All Steer Activities

[a]The plans analyzed are also later identified by a number indicating the interest rate used in deriving the plan.

Table II

Operator and Family Labor Available for Farm Labor

Labor Period	Hours Available for Each Resource Situation		
	I	II	III, IV, V
January - April	710	624	581
May - July	638	572	539
August - September	440	396	374
October - December	594	528	495

Table III

Assumed Land Resource Combinations for Linear Programming Model

Farm Type	Cropland[a]	Range	Farmstead and Waste	Total	Classification
			- Acres -		
I	320	288	32	640	Small Balanced
II	320	1,200	80	1,600	Small Range
III	960	864	96	1,920	Large Balanced
IV	160	2,348	132	2,640	Large Range
V	1,240	90	70	1,400	Large Cropland

[a]Wheat allotment was assumed to be 50 percent of the cropland for each resource situation.

Table IV

Estimated Annual Returns to Annual Operating Capital, Land Equity and Management; Four Selected Planning Situations for Two Balanced Farm Units; Four Tenure Classes

Planning Number	Size of Balanced Farm Unit[a]	Tenure Class: Owner Operator	Encumbered Owner	Part Owner	Tenant Operator
			- Dollars -		
6A	640	1,891	659	904	-82
	1,920	11,404	7,708	8,445	5,486
6C	640	807	-425	-180	-1,166
	1,920	9,204	5,508	6,245	3,286
6D	640	177	-1,055	-810	-1,796
	1,920	8,048	4,352	5,089	2,130
18A	640	998	-234	11	-975
	1,920	9,305	5,609	6,346	3,387

[a]For these balanced units, it was assumed that 50 percent of the land was cropland.

Table V

Estimated Annual Returns to Annual Operating Capital, Land Equity, and Management; Four Selected Planning Situations for Two Ranch Units; Four Tenure Classes

Planning Situation	Size of Ranch Unit[a]	Tenure Class: Owner Operator	Encumbered Owner	Part Owner	Tenant-Operator
	(Acres)		- Dollars -		
6A	1,600	6,969	4,687	5,163	3,357
	2,640	9,812	6,659	7,338	4,865
6C	1,600	4,905	2,623	3,099	1,293
	2,640	7,012	3,859	4,538	2,065
6D	1,600	3,391	1,109	1,585	-221
	2,640	4,912	1,759	2,438	-35
18A	1,600	5,948	3,666	4,142	2,336
	2,640	5,551	2,394	3,077	604

[a]Includes 320 acres of cropland for the 1,600 acre unit and 160 acres of cropland for the 2,640 acre unit.

Table VI

Estimated Annual Returns To Annual Operating Capital, Land Equity, and Management; Four Selected Planning Situations For A Large Cropland Unit; Four Tenure Classes

Planning Situation[a]	Tenure Class: Owner-Operator	Encumbered Owner	Part Owner	Tenant-Operator
		- Dollars -		
6A	10,975	7,382	8,074	5,174
6C	8,720	5,127	5,819	2,919
6D	8,318	4,725	5,417	2,517
18A	8,525	4,932	5,624	2,724

[a]All plans analyzed are for a 1,400 acre farm unit with 1,240 acres of cropland.

Table VII

Estimated Adjusted Gross Returns, Dollars Per Acre, Based on Deflated Prices, 1942-57

Base Period	Wheat	Grain Sorghum	P61 Steers Moderate Graze Native	P62 Steers Heavy Graze Native	P67a Steers Johnson Grass Native	P67b Steers Wheat Sudan Native	P69 Cow-Calf Native	P73a Cow-Calf Johnson Grass Native	P73b Cow-Calf Wheat Sudan Native
(Year)				-Dollars -					
1942	10.01	11.64	2.34	3.92	9.08	12.25	1.84	3.66	4.75
1943	13.39	8.64	1.68	2.73	4.69	10.05	1.76	3.26	4.55
1944	20.84	6.98	3.44	5.38	8.20	11.63	2.03	3.58	4.69
1945	15.95	11.83	3.67	5.52	8.55	12.41	2.10	3.68	4.83
1946	17.16	2.48	4.34	6.52	8.91	11.79	2.35	4.01	5.17
1947	11.92	11.65	2.68	3.49	6.56	12.15	2.10	3.81	5.21
1948	9.60	5.22	2.87	3.85	10.95	14.19	2.13	4.38	5.63
1949	13.66	2.49	2.53	3.71	7.26	9.98	2.21	4.03	5.21
1950	12.98	11.61	6.96	10.37	16.23	20.68	2.98	5.29	6.79
1951	13.30	16.46	5.19	7.91	8.74	10.09	3.10	5.09	6.45
1952	21.38	7.50	0.47	-1.07	2.21	2.84	2.04	3.46	4.47
1953	6.97	12.64	0.96	0.69	1.79	1.50	1.42	2.46	3.10
1954	9.79	5.86	3.71	4.41	6.56	7.64	1.30	2.63	3.31
1955	6.79	4.44	1.90	2.10	2.86	2.39	1.42	2.68	3.36
1956	6.81	10.92	1.69	1.64	3.28	3.66	1.10	2.24	2.84
1957	14.45	6.23	2.32	3.92	7.34	8.39	1.43	3.17	3.98
Mean	12.81	8.54	2.92	4.07	7.08	9.48	1.96	3.59	4.65
S.D.[a]	4.51	4.02	1.63	2.76	3.67	5.02	0.56	0.87	1.14
C.V.[a]	35.2	47.0	55.7	67.9	51.9	53.0	28.7	24.2	24.5

[a]S.D. = Standard Deviation, C.V. = Coefficient of Variation.

Table VIII

Estimates of Simple Correlation Coefficients for Delated Gross Returns Per Acre, Selected Enterprises

Item	Wheat	Grain Sorghum	P61 Steers Moderate Graze Native	P62 Steers Heavy Graze Native	P67a Steers Johnson Grass Native	P67b Steers Wheat Sudan Native	P69 Cow-Calf Native	P73a Cow-Calf Johnson Grass Native	P73b Cow-Calf Wheat Sudan Native
Wheat	1,000	-.1773	.1457	.1611	.1790	.2510	.4362	.3668	.3900
G. S.		1.0000	.1868	.1884	.0726	.0881	.2660	.1911	.1981
P61			1.0000	.9789	.8622	.7770	.7180	.7367	.7084
P62				1.0000	.8847	.8193	.7121	.7464	.7250
$P67_a$					1.0000	.9493	.6887	.8106	.7954
$P67_b$						1.0000	.6818	.7953	.8172
P69							1.0000	.9640	.9591
$P73_a$								1.0000	.9931
$P73_b$									1.0000

Table IX

Levels of Gross Income, Standard Deviations, and Coefficients of Variation; Five Specified Resource Situations; Selected Alternative Enterprise Combinations

Plan	Item	Unit	Resource Situation I-Small Balanced	II-Small Range	III-Large Balanced	IV-Large Range	V-Large Cropland
6A	Income	dol.	10,178	18,744	27,352	26,432	26,727
	S.D.[a]	dol.	4,832	10,102	10,780	16,506	9,234
	C.V.[a]	pct.	47.5	53.9	39.4	62.4	34.6
6B	Income	dol.	10,178	18,532	26,632	26,340	26,447
	S.D.[a]	dol.	4,832	10,088	10,232	16,514	9,240
	C.V.[a]	pct.	47.5	54.4	38.4	62.7	34.9
6C	Income	dol.	8,557	15,068	23,112	19,727	22,478
	S.D.[a]	dol.	3,203	6,695	7,051	9,884	6,097
	C.V.[a]	pct.	37.4	44.4	30.5	50.1	27.1
6D	Income	dol.	7,014	11,888	20,413	15,746	20,959
	S.D.[a]	dol.	1,690	2,927	5,026	4,210	5,450
	C.V.[a]	pct.	24.1	24.6	24.6	26.7	26.0
18A	Income	dol.	8,372	16,184	22,493	16,130	21,446
	S.D.[a]	dol.	2,904	8,005	6,968	7,762	5,613
	C.V.[a]	pct.	34.7	49.5	31.0	48.1	26.2
18B	Income	dol.	8,032	15,869	22,384	16,050	20,996
	S.D.[a]	dol.	2,725	7,831	7,280	7,754	5,601
	C.V.[a]	pct.	33.9	49.4	32.5	48.3	26.7
18C	Income	dol.	7,232	13,784	21,655	16,050	20,549
	S.D.[a]	dol.	2,034	5,375	6,081	7,754	5,413
	C.V.[a]	pct.	28.1	39.0	28.1	48.3	26.3
18D	Income	dol.	6,426	10,463	19,187	13,061	20,150
	S.D.[a]	dol.	1,610	2,568	4,812	3,454	5,355
	C.V.[a]	pct.	25.0	24.5	25.1	26.5	26.6

[a]S.D. = Standard Deviation, C.V. = Coefficient of Variation.

Table X

Expected Frequency Distribution of Returns to Annual Operating Capital Land, and Management, for Planning Situations, Five Land Resource Units, Owner-Operator Tenure Class, 16 Production Periods[a]

Return Interval ($1,000)	Land Resource Planning Situations																			
	Small Balanced Unit Plans				Small Range Unit Plans				Large Balanced Unit Plans				Large Range Unit Plans				Large Cropland Unit Plans			
	6A	18A	6C	6D	6A	18A	6C	6D	6A	18A	6C	6D	6A	18A	6C	6D	6A	18A	6C	6D
33-48	-	-	-	-	-	-	-	-	1[b]	-	-	-	1[c]	-	-	-	-	-	-	-
30-33	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-
27-30	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
24-27	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-
21-24	-	-	-	-	-	1	-	-	2	1	1	-	-	-	1	-	1	-	-	-
18-21	-	-	-	-	1	-	1	-	2	1	1	-	2	-	-	-	2	-	1	-
15-18	-	-	-	-	1	1	-	-	-	2	3	1	-	1	1	-	1	2	2	2
12-15	1	-	-	-	2	1	1	-	2	1	-	4	-	1	1	2	1	3	3	2
9-12	-	-	-	-	-	2	2	-	3	1	-	1	2	2	2	-	6	2	-	2
6-9	3	1	1	-	4	-	2	3	2	5	5	5	4	1	1	5	1	4	3	5
3-6	1	4	3	-	1	6	4	5	1	2	3	2	-	3	4	4	-	2	4	2
0-3	6	5	5	9	1	1	2	5	-	1	1	2	1	2	-	3	-	2	2	2
-3-0	2	4	6	7	1	2	3	3	-	2	2	1	-	3	3	2	1	1	1	1
-6- -3	3	2	1	-	1	2	1	-	2	-	-	-	1	2	1	-	2	-	-	-
-9- -6	-	-	-	-	3	-	-	-	1	-	-	-	1	-	1	-	-	-	-	-
-12- -9	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
-15- -12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-20- -15	-	-	-	-	-	-	-	-	-	-	-	-	1[d]	-	-	-	-	-	-	-
Mean($100)	19	10	8	2	70	59	49	34	114	93	92	80	98	55	70	49	110	85	87	83
S.D.[e]($100)	48	29	32	17	101	80	67	29	108	70	71	50	165	78	99	42	92	56	61	55

[a]Data from Appendix F, Tables II, III, and IV.

[b]$34,251.

[c]$47,540.

[d]-$19,282.

[e]S.D. = Standard Deviation.

Table XI

Expected Frequency Distribution of Returns to Annual Operating Capital and Management, Four Planning Situations, Five Land Resource Units, Tenant-Operator Tenure Class, 16 Production Periods[a]

Return Interval ($1,000)	Land Resource Planning Situations: Small Balanced Unit Plans				Small Range Unit Plans				Large Balanced Unit Plans				Large Range Unit Plans				Large Cropland Unit Plans			
	6A	18A	6C	6D	6A	18A	6C	6D	6A	18A	6C	6D	6A	18A	6C	6D	6A	18A	6C	6D
30-43	-	-	-	-	-	-	-	-	-	-	-	-	1[b]	-	-	-	-	-	-	-
27-30	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
24-27	-	-	-	-	1	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-
21-24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
18-21	-	-	-	-	-	1	-	-	-	-	-	-	1	1	-	-	-	-	-	-
15-18	-	-	-	-	1	-	1	-	-	1	1	-	-	-	1	-	-	-	-	-
12-15	-	-	-	-	1	1	-	-	1	-	-	-	2	-	-	-	2	-	-	-
9-12	1	-	-	-	1	1	1	-	-	4	3	-	-	1	1	-	1	-	2	-
6-9	-	-	-	-	1	2	1	-	3	-	1	3	1	1	2	2	4	5	3	2
3-6	3	1	1	-	3	-	3	2	3	4	1	3	4	3	1	-	3	2	1	4
0-3	3	4	4	-	3	6	3	6	1	3	6	5	1	1	2	7	2	5	6	6
-3-0	5	7	6	12	1	1	2	5	-	1	1	3	1	4	3	2	-	3	2	3
-6- -3	2	4	5	4	1	2	3	3	1	3	3	2	-	3	3	4	-	1	2	1
-9- -6	2	-	-	-	1	1	2	-	2	-	-	-	1	-	-	1	2	-	-	-
-12- -9	-	-	-	-	1	1	-	-	2	-	-	-	1	2	2	-	1	-	-	-
-15- -12	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
-18- -15	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-
-25- -18	-	-	-	-	-	-	-	-	-	-	-	-	1[c]	-	-	-	-	-	-	-
Mean($100)	-1	-10	-12	-18	34	23	13	-2	55	34	33	21	49	6	21	0	52	29	27	25
S.D.[d]($100)	46	26	30	13	100	78	65	26	101	60	61	37	164	77	98	41	82	39	45	37

[a]Data from Appendix F, Tables XI, XII, and XIII.

[b]$42,497.

[c]-$24,619.

[d]S.D. = Standard Deviation.

Table XII

Changes in Equity Derived From Returns to Land Equity, Annual, Operating Capital, and Management; Credit Requirements and Deferral of Annual Operating Expenses; Owner-Operator Tenure Class, Four Selected Plans, Small Balanced Unit, 16 Production Periods

Item	Planning Situation			
	6A	18A	6C	6D
	- Dollars -			
Total Returns to Land Equity, Annual Operating Capital, and Management	30,255	15,965	12,913	2,825
Allocation of Returns				
Interest on borrowed capital	5,662	1,290	2,667	434
Federal income tax	9,351	6,378	5,802	3,764
Social security tax	3,859	3,844	3,559	3,699
Oklahoma income tax	433	201	202	89
Withdrawal for a higher level of family living[a]	6,500	4,500	1,500	0
Number of years at $5,000	2	3	1	-
Number of years at $7,000	1	0	0	-
Equity Relationships				
Annual operating capital	16,796	10,121	12,641	8,222
Beginning capital equity	13,000	13,000	13,000	13,000
Change in capital equity	4,450	-248	-817	-5,161
Average capital equity	11,469	8,778	9,865	7,771
Debt free equity in land	39,434	39,434	39,434	39,434
Percent return on equities[b]	2.2	1.9	1.3	0.3
Credit Requirements				
Number of years required	14	10	14	10
Average credit required	6,088	2,149	3,175	722
Maximum credit required	10,627	4,480	6,886	2,135
Percent of annual capital	63	44	54	26
Deferral of Annual Expenditures				
Number of years requiring partially deferred expenses	8	4	7	7
Total expenses deferred	7,892	3,386	5,820	6,320
Family living	4,000	2,000	3,500	3,500
Other	3,892	1,385	2,320	2,820

[a]Withdrawal of funds to attain a family living level of either $5,000 or $7,000 rather than the assumed minimum level of $3,500.

[b]Average return on equity in land and owned annual operating capital after deducting $3,500 for family labor and paying interest on borrowed capital.

Table XIII

Changes in Equity Derived From Returns to Land Equity, Annual Operating Capital, and Management; Credit Requirements and Deferral of Annual Operating Expenses; Part Owner Tenure Class, Four Selected Plans, Large Balanced Unit, 16 Production Periods

Item	Planning Situation			
	6A	18A	6C	6D
	- Dollars -			
Total Returns to Land Equity, Annual Operating Capital, and Management	135,127	101,532	99,925	81,420
Allocation of Returns				
Interest on borrowed capital	18,348	4,905	7,108	3,926
Federal income tax	33,743	24,709	24,138	18,354
Social security tax	4,348	4,444	4,507	4,637
Oklahoma income tax	2,710	1,307	1,278	864
Withdrawal for a higher level of family living[a]	22,000	31,000	29,500	29,500
Number of years at $5,000	3	2	1	1
Number of years at $7,000	5	8	8	8
Equity Relationships				
Annual operating capital	40,261	22,677	26,285	20,696
Beginning capital equity	13,000	13,000	13,000	13,000
Change in capital equity	54,607	35,167	33,394	24,139
Average capital equity	21,749	17,668	19,019	16,605
Debt free equity in land	59,150	59,150	59,150	59,150
Percent return on equities[b]	9.0	7.9	7.4	6.4
Credit Requirements				
Number of years required	12	9	9	8
Average credit requirec	24,683	8,904	12,927	8,181
Maximum credit required	39,472	11,252	15,136	10,254
Percent of annual capital	98	50	58	50
Deferral of Annual Expenditures				
Number of years requiring partially deferred expenses	5	3	3	2
Total expenses deferred	10,753	5,859	6,390	2,727
Family living	2,500	1,500	1,500	1,000
Other	8,253	4,359	4,890	1,727

[a]Withdrawal of funds to attain a family living level of either $5,00 or $7,00 rather than the assumed minimum level of $3,500.

[b]Average return on equity in land and owned annual operating capital after deducting $3,500 for family labor and paying interest on borrowed capital.

Table XIV

Changes in Equity Derived From Returns to Land Equity, Annual Operating Capital, and Management; Credit Requirements and Deferral of Annual Operating Expenses; Part Owner Tenure Class, Four Selected Plans, Small Range Unit, 16 Production Periods

Item	Planning Situation			
	6A	18A	6C	6D
	- Dollars -			
Total Returns to Land Equity, Annual Operating Capital, and Management	82,600	66,266	49,575	25,367
Allocation of Returns				
Interest on borrowed capital	20,533	12,374	13,791	8,323
Federal income tax	18,801	16,732	12,889	5,288
Social security tax	4,009	4,040	3,665	3,724
Oklahoma income tax	1,368	1,018	701	166
Withdrawal for a higher level of family living[a]	12,000	15,000	6,500	1,500
Number of years at $5,000	1	3	2	1
Number of years at $7,000	3	3	1	0
Equity Relationships				
Annual operating capital	35,852	27,236	26,688	19,932
Beginning capital equity	13,000	13,000	13,000	13,000
Change in capital equity	25,889	17,102	12,029	6,366
Average capital equity	14,913	14,759	13,051	11,748
Debt free equity in land	36,517	36,517	36,517	36,517
Percent return on equities[b]	7.5	6.6	4.5	2.2
Credit Requirements				
Number of years required	14	14	15	16
Average credit required	23,930	14,260	14,804	8.184
Maximum credit required	35,935	22,550	31,113	11,828
Percent of annual capital	100.2	83	79	59
Deferral of Annual Expenditures				
Number of years requiring partially deferred expenses	8	8	9	10
Total expenses deferred	8,430	8,120	8,485	8,950
Family living	4,000	4,000	4,500	5,000
Other	4,430	4,120	3,985	3,950

[a]Withdrawal of funds to attain a family living level of either $5,000 or $7,000 rather than the assumed minimum level of $3,500.

[b]Average return on equity in land and owned annual operating capital after deducting $3,500 for family labor and paying interest on borrowed capital.

Table XV

Changes in Equity Derived From Returns to Land Equity, Annual Operating Capital, and Management; Credit Requirements and Deferral of Annual Operating Expenses; Part Owner Tenure Class, Four Selected Plans, Large Range Unit, 16 Production Periods

Item	Planning Situation			
	6A	18A	6C	6D
	- Dollars -			
Total Returns to Land Equity, Annual Operating Capital, and Management	117,413	49,230	72,616	39,016
Allocation of Returns				
Interest on borrowed capital	43,324	15,650	24,845	27,760
Federal income tax	28,282	13,150	17,202	4,063
Social security tax	3,948	3,542	3,662	3,420
Oklahoma income tax	2,301	818	1,169	196
Withdrawal for a higher level of family living[a]	6,500	6,500	6,500	0
Number of years at $5,000	2	2	2	-
Number of years at $7,000	1	1	1	-
Equity Relationships				
Annual operating capital	57,276	28,371	39,095	35,436
Beginning capital equity	13,000	13,000	13,000	13,000
Changes in capital equity	33,085	9,570	18,732	3,577
Average capital equity	12,790	12,751	13,214	7,537
Debt free equity in land	50,458	50,458	50,458	50,458
Percent return on equities[b]	7.3	3.3	4.6	1.2
Credit Requirements				
Number of years required	15	15	15	16
Average credit required	47,452	16,661	27,606	27,899
Maximum credit required	65,710	24,020	36,704	34,744
Percent of annual capital	115	85	94	98
Deferral of Annual Expenditures				
Number of years requiring partially deferred expenses	8	9	9	13
Total expenses deferred	10,132	9,682	9,942	12,032
Family living	4,000	4,500	4,500	6,500
Other	6,132	5,182	5,442	5,532

[a]Withdrawal of funds to attain a family living level of either $5,000 or $7,000 rather than the assumed minimum of $3,500.

[b]Average return on equity in land and owned annual operating capital after deducting $3,500 for family labor and paying interest on borrowed capital.

Table XVI

Changes in Equity Derived From Returns to Land Equity, Annual Operating Capital, and Management; Credit Requirements and Deferral of Annual Operating Expenses; Part Owner Tenure Class, Four Selected Plans, Large Cropland Unit, 16 Production Periods

Item	Planning Situation			
	6A	18A	6C	6D
	- Dollars -			
Total Returns to Land Equity, Annual Operating Capital, and Management	129,188	89,977	93,111	86,667
Allocation of Returns				
Interest on borrowed capital	12,232	101	3,159	770
Federal income tax	31,111	21,098	22,045	19,296
Social security tax	4,444	4,702	4,534	4,619
Oklahoma income tax	1,886	1,030	1,109	914
Withdrawal for a higher level of family living[a]	26,000	38,500	33,000	36,500
Number of years at $5,000	1	0	1	1
Number of years at $7,000	7	11	9	10
Equity Relationships				
Annual operating capital	33,086	13,002	17,856	15,139
Beginning capital equity	13,000	13,000	13,000	13,000
Changes in capital equity	53,515	24,546	30,263	24,568
Average capital equity	20,840	12,966	15,708	14,406
Debt free equity in land	57,502	57,502	57,502	57,502
Percent return on equities[b]	9.3	8.0	7.8	7.5
Credit Requirements				
Number of years required	10	2	8	7
Average credit required	19,594	291	4,296	1,674
Maximum credit required	28,705	362	5,410	2,255
Percent of annual capital	87	3	30	15
Deferral of Annual Expenditures				
Number of years requiring partially deferred expenses	5	2	3	3
Total expenses deferred	11,310	3,432	6,131	3,942
Family living	2,500	1,000	1,500	1,500
Other	8,810	2,432	4,631	2,442

[a]Withdrawal of funds to attain a family living level of either $5,000 or $7,000 rather than the assumed minimum of $3,500.

[b]Average return on equity in land and owned annual operating capital after deducting $3,500 for family labor and paying interest on borrowed capital.

Appendix A, Table I

Two Levels of Assumed Annual Overhead Cost For Farms, Rolling Plains, Northwest Oklahoma

Item	Size of Operation	
	Small	Large
	- Dollars -	
Truck		
Interest on average investment	60	116
Annual Depreciation	132	253
Repairs (4 pct. of original cost)	72	138
Taxes (1 pct. of original cost)	18	34
Insurance (liability only)	22	25
Fuel, Oil, Lubrication	177	276
Telephone	75	105
Bookkeeping and Tax Service	40	60
Building and Machinery Insurance	100	150
Total	696	1,157
Truck Acquisition Price	1,800[a]	3,450[b]
Truck Salvage Value	216	416
Years to Depreciate	12	12

[a]A 1/2-ton truck with an average of 7,000 miles per year was assumed.

[b]A 1/2-ton truck with an average of 9,000 miles per year was assumed.

Appendix A, Table II

Capital Requirements For Selected Optimum Plans
For Five Specified Resource Situations

Plan Symbol[a]	Annual Operating Capital				
	Small Balanced	Small Range	Large Balanced	Large Range	Large Cropland
			- Dollars -		
6A	16,796	35,852	40,261	57,276	33,086
6B	16,796	34,800	35,630	56,709	31,176
6C	12,643	26,668	26,285	39,095	17,856
6D	8,222	19,932	20,696	35,436	15,139
18A	10,121	27,236	22,677	28,371	13,002
18B	9,061	26,265	22,473	28,212	12,095
18C	7,001	20,993	20,893	28,212	10,951
18D	5,528	14,955	16,384	26,065	10,320
			Estimated Value of Land		
All Plans	39,434	73,034	118,301	100,917	115,005

[a]A - All activities in the full programming model included as alternatives.

B - Temporary graze steer activities ($P67_a$ and $P67_b$) excluded as alternatives.

C - Heavy graze steers (P62) plus temporary graze steer activities excluded as alternatives.

D - All steer activities excluded as alternatives.

The number preceding the letter indicates the rate that was assumed as the required capital marginal value product for all annual operating capital used by the plan. For cost analysis, interest on annual capital was adjusted to an annual rate of 6 percent. Returns to land capital were charged at the rate of 5 percent.

Appendix B, Table I

Estimated Variability of Pounds of Beef Production Per Acre, Steers and Cow-Calf For Selected Types of Grazing, 1942-57

Base Period	Native Grass: Heavy Graze Steers[a]	Native Grass: Moderate Graze Steers[b]	Native Grass: Moderate Graze Cow-Calf[b]	Johnson Grass[c] Steers	Johnson Grass[c] Cow-Calf	Sudan Steers	Sudan Cow-Calf	Oct.-Feb. Wheat Steers[e]	Oct.-Feb. Wheat Cow-Calf	Mar.-May Wheat Steers[f]	Mar.-May Wheat Cow-Calf
(Year)				- Pounds -							
1942	45.94	32.56	24.20	123.49	61.71	140.76	51.38	21.59	7.79	145.99	83.03
1943	43.80	32.18	23.16	83.50	56.95	75.17	56.10	13.71	6.93	152.52	85.32
1944	64.50	48.70	24.91	111.35	60.27	120.83	53.89	12.62	6.81	199.70	88.87
1945	54.81	43.88	24.40	97.26	58.59	97.73	50.46	16.14	7.19	167.07	83.74
1946	60.67	47.79	24.81	92.16	57.98	89.39	48.90	11.28	6.67	211.61	90.16
1947	38.36	34.41	23.39	80.04	56.54	69.49	48.27	23.58	8.00	137.97	81.46
1948	31.04	27.38	22.65	103.01	59.87	115.37	53.31	10.21	6.55	131.56	82.15
1949	44.72	35.77	23.54	94.68	58.28	93.56	50.91	12.06	6.75	142.64	79.09
1950	58.97	46.94	24.72	109.59	60.06	117.95	53.60	9.81	6.51	109.77	82.66
1951	58.43	45.26	24.54	67.97	55.10	49.71	46.10	6.57	6.15	129.17	81.77
1952	48.93	41.66	24.16	81.38	56.70	71.71	48.52	10.68	6.60	134.38	81.20
1953	59.28	56.91	25.90	86.44	57.30	80.79	49.52	7.05	6.20	101.87	78.22
1954	38.68	41.66	23.43	68.32	55.14	46.06	45.70	7.07	6.20	112.64	78.36
1955	28.38	30.24	23.92	76.53	56.12	62.42	47.50	5.44	6.03	103.00	79.40
1956	33.86	37.54	23.94	65.71	54.83	49.69	46.10	6.78	6.17	111.03	79.23
1957	34.17	23.40	21.68	74.21	55.84	60.97	47.34	5.25	6.01	112.76	79.42
$\bar{X}$[g]	46.53	39.14	23.95	88.48	57.58	83.85	49.85	11.24	6.66	137.73	82.13
S.D.[h]	9.43	8.98	0.99	17.41	2.07	28.59	3.14	5.43	0.59	32.49	3.55
C.V.[h]	20.27	22.94	4.15	19.68	3.60	34.10	6.30	48.31	8.86	23.59	4.33

Appendix B, Table I (Continued)

[a]Data for heavy graze steers were compiled from annual summaries of experimental work at the United States Southern Great Plains Field Station, ARS, USDA, Woodward, Oklahoma.

[b]Robert W. Greve, James S. Plaxico, and William F. Lagrone, Production and Income Variability of Alternative Farm Enterprises in Northwest Oklahoma, Oklahoma Agricultural Experiment Station in Bulletin B-563 (Stillwater, 1960). p. 10

Unpublished Southern Great Plains Experiment Station data of pounds of harvested forage sorghum per acre for 1926-59. Johnson grass was assumed to have the same variability of production as this data had for the period 1942-57. Variability of pounds of beef produced was based on the relationship that existed between native range, steers, and cow-calf units at the experiment station.

[d]Sudan grass data for 1953-57 was regressed with forage sorghum data. The estimating equation derived was

$$\hat{Y} = 1.484 + \underset{(.26)}{1.996\ X} \qquad r^2 = .95$$

Data for Sudan grass was tabulated from "Annual Reports of Progress in Forage Crop Research" conducted by the Oklahoma Agricultural Experiment Station in cooperation with the Forage and Range Section, ARS, USDA. Variability of pounds of beef was based on the relationship between native range, steers, and cow-calf units.

[e]Based on an estimating equation derived by Odell Walker and James S. Plaxico, in A Survey of Production Levels and Variability of Small Grain Pastures in Oklahoma, Processed Series P-366 (Oklahoma, 1959), p. 21. Estimating equation used was

$$\hat{Y} = .93 + \underset{(.40)}{1.81\ X} \qquad r^2 = .61$$

Information for X (Sept.-Feb. rainfall) was from Climatic Survey - Oklahoma, United States Department of Commerce Weather Bureau. Variability of pounds of beef was based on relationship between native range, steers, and cow-calf units.

[f]Based on data for five years of steer gains from W. C. Elder, Grazing Characteristics and Clipping Responses of Small Grains, Bulletin B-567 (Stillwater, 1960), p. 6. Regression equation used with Oct.-Feb. gains for deriving Mar.-May steer estimates was

$$\hat{Y} = 77.67 + \underset{(2.81)}{4.96\ X} \qquad r^2 = .69$$

Variability of pounds of beef from cow-calf units was based on the relationship between steers and cow-calf units on native range.

[g]Average pounds of beef shown are the gains expected on the quality of land most commonly used for each enterprise in the programmed plans.

[h]S. D. = Standard Deviation, C. V. = Coefficient of Variation.

Appendix B Table II

Estimated Physical Product Produced, Bushels of Grain Per Acre and Pounds of Beef Per Steer Or Per Cow-Calf Unit, 1942-57

Base Period	Wheat	Grain Sorghum	P61[a] Steers Moderate Graze Native	P62[a] Steers Heavy Graze Native	P67$_a$[b] Steers Johnson Grass Native	P67$_b$[b] Steers Wheat Sudan Native	P69[a] Cow-Calf Native	P73$_a$[c] Cow-Calf Johnson Grass Native	P73$_b$[c] Cow-Calf Wheat Sudan Native
(Year)	- Bushel -					- Pounds -			
1942	11.0	16.4	300.6	330.8	487.9	491.7	492.7	488.0	488.9
1943	12.4	9.0	299.8	311.0	343.4	506.0	493.6	453.7	489.3
1944	19.3	9.7	363.0	361.2	465.6	492.0	439.6	481.5	487.1
1945	14.5	13.0	330.8	323.4	408.5	444.8	437.8	468.8	475.5
1946	14.3	2.5	340.0	333.7	395.3	389.1	422.4	466.5	465.3
1947	10.1	11.2	311.9	268.5	333.9	453.1	485.5	451.9	476.5
1948	9.7	8.7	357.2	347.7	425.3	408.4	640.4	470.1	467.1
1949	13.8	4.3	293.9	286.2	388.4	396.3	453.1	463.4	462.9
1950	12.6	21.9	349.9	342.0	456.9	429.0	436.0	479.4	475.9
1951	13.3	27.9	325.9	327.2	304.6	263.7	423.3	446.9	438.4
1952	21.6	10.0	282.3	200.6	348.4	344.1	401.7	456.0	454.7
1953	6.9	21.8	371.2	314.2	386.8	338.2	390.9	466.3	456.0
1954	9.5	10.1	264.7	193.4	301.4	251.1	351.3	442.9	431.5
1955	7.0	10.1	322.7	295.1	315.7	250.6	442.3	451.1	438.0
1956	7.4	19.5	276.7	216.7	286.4	249.6	436.9	442.6	435.0
1957	16.8	15.2	285.4	307.5	298.3	239.9	488.2	440.9	428.6
Mean	12.5	13.2	317.2	297.5	371.7	371.7	452.2	460.7	460.7
S.D.[d]	4.1	6.8	32.9	52.2	64.7	96.4	63.4	14.7	21.1
C.V.[d]	33.1	51.6	10.4	17.5	17.4	25.9	14.0	3.2	4.6

[a]Data from Appendix B, Table II.

[b]Data from Appendix B, Table III.

[c]Data from Appendix B, Table IV.

[d]S.D. = Standard Deviation, C.V. = Coefficient of Variation.

Appendix B, Table III

Estimated Acres of Native Range Required For the Specified Grazing Intensity and Pounds of Beef Produced Per Beef Unit, 1942-57[a]

Base Period	Moderate Graze P61 Steers		Heavy Graze P62 Steers		Moderate Graze P69 Cow-Calf	
(Year)	(Acres)	(Pounds)	(Acres)	(Pounds)	(Acres)	(Pounds)
1942	10.9	300.6	7.2	330.8	22.0	492.7
1943	11.0	299.8	7.1	311.0	22.1	493.6
1944	8.8	363.0	5.6	361.2	17.6	439.6
1945	8.9	330.8	5.9	323.4	17.9	437.8
1946	8.4	340.0	5.5	333.7	16.8	422.4
1947	10.7	311.9	7.0	268.5	21.4	485.5
1948	15.4	357.2	11.2	347.7	31.1	640.4
1949	9.7	293.9	6.4	286.2	19.5	453.1
1950	8.8	349.9	5.8	342.0	17.6	436.0
1951	8.5	325.9	5.6	327.2	17.0	423.3
1952	8.0	282.3	4.1	200.6	16.2	401.7
1953	7.7	371.2	5.3	314.2	15.7	390.9
1954	7.5	264.7	5.0	193.4	17.1	351.3
1955	12.6	322.7	10.4	295.1	20.3	442.3
1956	8.7	276.7	6.4	216.7	22.0	436.9
1957	14.4	285.4	9.0	307.5	27.1	488.2
$\bar{X}$	10.0	317.25	6.72	297.45	20.09	452.17
S.D.[b]		32.93		52.17		63.43
C.V.[b]		10.38		17.54		14.03

[a]Annual Progress Reports, United States Great Plains Field Station, Agricultural Research Service, USDA, Woodward, Oklahoma. Four of these reports from which data was compiled for use in this study are listed in the selected bibliography.

[b]S.D. = Standard Deviation, C.V. = Coefficient of Variation.

Appendix B, Table IV

Estimated Pounds of Beef Produced Per Steer, Temporary Grazing, 1942-57

Base Period	$P67_a$ Steers (Temporary Graze)			$P67_b$ Steers (Temporary Graze)				
	Johnson Grass	Native	Total	Wheat Oct. Feb.	Wheat Mar. May	Sudan June Sept.	Native	Total
(year)				- Pounds -				
1942	444.56	43.33	487.89	204.24	45.69	198.42	43.33	491.68
1943	300.60	42.80	343.40	129.70	47.74	285.79	42.80	506.03
1944	400.86	64.75	465.61	119.39	62.51	245.32	64.73	491.95
1945	350.14	58.36	408.50	152.69	52.29	181.49	58.35	444.82
1946	331.78	63.54	395.32	106.71	66.23	152.62	63.54	389.10
1947	288.14	45.73	333.87	223.07	43.18	141.09	45.73	453.07
1948	388.84	36.42	425.26	96.59	41.18	234.24	36.42	408.43
1949	340.85	47.59	388.44	114.09	44.65	189.95	47.58	396.27
1950	394.52	62.34	456.86	92.80	34.36	239.47	62.33	428.96
1951	244.69	60.21	304.90	62.15	40.43	100.93	60.21	263.72
1952	292.97	55.43	348.40	101.03	42.06	145.59	55.42	344.10
1953	311.18	75.64	386.82	66.69	31.89	164.02	75.63	338.23
1954	245.95	55.43	301.38	66.88	35.26	93.51	55.42	251.07
1955	275.51	40.15	315.66	51.46	32.24	126.73	40.15	250.58
1956	236.56	49.85	286.41	64.14	34.75	100.89	49.84	249.62
1957	267.16	31.10	298.26	49.67	35.29	123.79	31.11	239.86
$\bar{X}$	319.65	52.04	371.69	106.33	43.11	170.24	52.04	371.72
S.D.[a]			64.73					96.42
C.V.[a]	19.6	22.9	17.42	48.3	23.6	34.1	22.9	25.94

[a]S.D. = Standard Deviation, C.V. = Coefficient of Variation.

Appendix B, Table V

Estimated Pounds of Beef Produced, Temporary Grazing, 1942-57

Base Period (Year)	$P73_a$ Cow-Calf (Temporary Graze) Johnson Grass	Native	Total	$P73_b$ Cow-Calf (Temporary Graze) Wheat Oct. Feb.	Wheat Mar. May	Sudan June Sept.	Native	Total
				- Pounds -				
1942	394.94	93.09	488.03	142.98	50.59	202.26	93.08	488.91
1943	364.48	89.25	453.73	127.20	51.99	220.84	89.24	489.27
1944	385.73	95.78	481.51	125.00	54.15	212.14	95.77	487.06
1945	374.98	93.85	468.83	131.97	51.02	198.64	93.85	475.48
1946	371.07	95.39	466.46	122.43	54.93	192.50	95.39	465.25
1947	361.86	90.02	451.88	146.84	49.63	190.02	90.01	476.50
1948	383.17	86.94	470.11	120.22	50.05	209.86	86.94	467.07
1949	372.99	90.40	463.39	123.89	48.19	200.41	90.39	462.88
1950	384.38	95.01	479.39	119.49	50.36	211.00	95.01	475.86
1951	352.64	94.24	446.88	112.88	49.82	181.48	94.24	438.42
1952	362.88	93.09	455.97	121.14	49.48	191.00	93.08	454.70
1953	366.72	99.62	466.34	113.80	47.66	194.94	99.62	456.02
1954	352.90	90.02	442.92	113.80	47.74	179.90	90.01	431.45
1955	359.17	91.94	451.11	110.68	48.38	186.99	91.93	437.98
1956	350.91	91.94	442.85	113.25	48.27	181.48	91.93	434.93
1957	357.38	83.49	440.87	110.31	48.39	186.36	83.48	428.54
$\bar{X}$	368.51	92.13	460.64	122.24	50.04	196.23	92.13	460.64
S.D.[a]			14.65					21.13
C.V.[a]	3.6	4.2	3.18	8.9	4.3	6.3	4.2	4.59

[a]S.D. = Standard Deviation, C.V. = Coefficient of Variation.

Appendix C

Calculation of Whole Farm Income Variability

When two enterprises are combined by bringing together the resources required by each, the variance for the total income is defined by the following equation:

$$(1) \qquad S_t^2 = S_1^2 + S_2^2 + 2r_{12}S_1S_2$$

For "n" enterprises, the general equation for the variance of total income becomes:

$$(2) \qquad S_t^2 = \sum_{i=1}^{n} S_i^2 + 2\sum_{i<j}^{n} r_{ij}S_iS_j \qquad 2 \leq j \leq n$$

where S_i^2 is the variance of the income from the i^{th} enterprise, r is the simple correlation coefficient between the i^{th} and j^{th} enterprises, and S_i and S_j are the standard deviations of the income from the i^{th} and j^{th} enterprises.

The income from enterprise "i" may be defined as a linear combination of "a" units of the deflated returns per acre for the i^{th} enterprise.[1] If the variance of deflated returns per acre is defined as s_i^2, then the variance of the income from enterprise "i" is given by the relationship:

$$(3) \qquad S_i^2 = a_i^2 s_i^2$$

where a_i is given by the equation:

$$(4) \qquad a_i = \frac{\text{Income from enterprise "i"}}{\text{Deflated income per acre from enterprise "i"}}$$

and s_i^2 is the unbiased estimate of the variance of the deflated income per acre for enterprise "i". An evaluation of these values in equation 2 for a farm plan gives the total variance of the income from that farm plan.

[1] Paul G. Hoel, Introduction to Mathematical Statistics, 2nd ed. (New York, 1954), pp. 196-200.

Appendix D, Table I

Example of the Derived Sequence of Gross Farm Income
For a Specific Plan

Base Period	Enterprise (i)				Gross Income
	Wheat	Milo	P69	$P73_a$	
(k)	(Y_{ik})	(Y_{ik})	(Y_{ik})	(Y_{ik})	(I_{ik})
1942	8,831	4,928	4,404	827	18,990
1943	11,813	3,658	4,213	737	20,421
1944	18,386	2,955	4,859	809	27,009
1945	14,072	5,008	5,027	832	24,939
1946	15,140	1,050	5,625	906	22,721
1947	10,517	4,932	5,027	861	21,337
1948	8,470	2,210	5,098	990	16,768
1949	12,052	1,054	5,290	911	19,307
1950	11,452	4,915	7,133	1,195	24,695
1951	11,734	6,968	7,420	1,150	27,272
1952	18,863	3,175	4,883	782	27,703
1953	6,149	5,351	3,399	556	15,455
1954	8,637	2,481	3,112	594	14,824
1955	5,991	1,880	3,399	606	11,876
1956	6,008	4,623	2,633	506	13,770
1957	12,749	2,637	3,423	716	19,525
$\overline{Y}_i$	11,304	3,614	4,684	811	$20,413\overline{(I)}$
S.D.[a]	3,979	1,700	1,344	197	5,026
C.V.[a]	35.2	47.0	28.7	24.2	24.6

[a]S.D. = Standard Deviation, C.V. = Coefficient of Variation.

Method of Deriving Data for Income Sequences

The sequences of whole farm income for the programmed plans were derived from the sequences of gross deflated returns per acre (Table IX) and the returns for the enterprises in each of the programmed plans (Appendix D). The example shown is for the high capital level cow-calf plan on the large balanced farm unit. From Plan 6D, the following enterprise gross incomes were obtained:

Enterprise (i)	$\bar{Y}$
Wheat	$11,304
Milo	3,614
Cow-calf(P69)	4,684
Cow-calf($P73_a$)	811

The computational form used to derive the sequences of enterprise returns was:

$$\frac{\bar{Y}_i}{\bar{X}_i} X_{ik} = Y_{ik}$$

where

$\bar{Y}_i$ is defined as the programmed returns from the i^{th} enterprise

$\bar{X}_i$ is the deflated average per acre return from the i^{th} enterprise, and

X_{ik} is the deflated return per acre from the i^{th} enterprise in the k^{th} period.

The computed value Y_{ik} is the expected gross income for the farm plan from the i^{th} enterprise in the k^{th} period.

The computed gross farm income, which is the sum of the enterprise returns in the k^{th} period, is given by:

$$\sum_{i=1}^{n} Y_{ik} = I_k \qquad 1 \leq k \leq p$$

If the computations are mathematically correct, the following equation should check except for rounding error.

$$\frac{1}{p} \sum_{k=1}^{p} \sum_{i=1}^{n} Y_{ik} = \sum_{i=1}^{n} \bar{Y}_i = \bar{I}$$

where

n is the number of enterprises

p is the number of income periods, and

I_k is the computed gross farm income for the k^{th} period.

The derived sequence of gross farm income can also be used to check the accuracy of equation 2, Appendix C. If the unbiased estimate of the variance of the sequence of estimated gross income is computed, the value obtained should be the same as the value calculated using equation 2, except for rounding error.

Tables II through XIII in this appendix were derived from the total gross farm income sequences by subtracting operating expenditures including average family living. The residual represents the sequence of expected returns to annual operating capital, land equity, and management.

Appendix D, Table II

Owner-Operator, Full Equity, Returns to Annual Capital, Land, and Management, By Income Periods

Base Period (Year)	I Small Balanced Unit				III Large Balanced Unit			
	6A	6C	6D	18A	6A	6C	6D	18A
	- Dollars -							
1942	864	-968	-386	680	11,486	5,895	6,625	8,217
1943	-110	-1,137	143	-46	8,134	5,878	8,056	7,420
1944	6,269	3,943	2,426	4,227	22,277	17,416	14,644	17,913
1945	5,120	2,958	1,578	3,445	19,002	15,345	12,574	15,930
1946	7,076	4,434	1,206	3,530	21,736	15,551	10,356	14,654
1947	705	146	416	608	10,522	8,644	8,972	8,895
1948	635	-184	-796	88	13,243	5,158	4,403	5,364
1949	1,550	380	82	391	11,858	6,823	6,942	7,011
1950	12,125	7,702	1,730	6,856	34,251	22,904	12,330	21,929
1951	8,238	4,790	2,373	4,784	19,992	19,201	14,907	19,363
1952	-4,006	-942	2,614	-706	3,130	8,802	15,338	7,845
1953	-5,213	-4,163	-1,788	-3,277	-6,890	-773	3,090	-161
1954	1,594	1,294	-1,725	-17	8,229	8,146	2,459	5,855
1955	-2,983	-2,619	-2,656	-3,106	-3,407	-591	-489	-1,474
1956	-3,721	-2,969	-2,307	-2,663	-3,305	818	1,405	607
1957	2,112	246	-85	1,171	12,208	8,047	7,160	9,515
$\bar{X}$	1,891	807	177	998	11,404	9,204	8,048	9,305
S.D.[a]	4,832	3,203	1,690	2,904	10,780	7,051	5,026	6,968

[a]S. D. = Standard Deviation.

Appendix D, Table III

Owner-Operator, Full Equity, Returns to Annual Capital, Land, and Management, By Income Periods

Base Period (Year)	II Small Range Unit				IV Large Range Unit			
	6A	6C	6D	18A	6A	6C	6D	18A
	- Dollars -							
1942	6,235	1,834	2,600	5,327	8,985	3,276	3,909	2,614
1943	2,290	194	2,879	2,341	2,089	-320	3,663	-154
1944	13,827	9,195	5,785	11,706	18,702	11,200	6,489	9,054
1945	13,025	8,723	5,265	11,192	18,910	12,095	6,545	9,726
1946	16,664	11,692	5,202	13,199	24,766	15,830	7,840	12,384
1947	4,835	3,705	4,064	4,448	6,563	5,585	5,947	4,496
1948	6,367	3,798	2,636	4,577	8,859	6,077	5,438	4,724
1949	6,100	3,605	3,698	4,644	7,946	4,505	6,386	3,470
1950	29,948	20,798	7,478	23,898	47,540	31,311	12,088	24,667
1951	20,003	13,943	8,638	17,148	31,995	21,013	13,232	16,663
1952	-8,667	-2,308	6,041	-5,631	-19,282	-6,443	6,662	-4,701
1953	-7,127	-4,437	326	-4,806	-11,418	-5,365	641	-4,238
1954	7,048	7,148	-179	5,595	11,138	11,155	-162	8,550
1955	-2,320	-798	-845	-1,929	-3,230	-164	118	-442
1956	-3,671	-1,616	-1,066	-2,373	-5,707	-1,108	-1,652	-965
1957	6,957	3,003	1,727	5,834	9,132	3,544	1,448	2,869
$\bar{X}$	6,969	4,905	3,391	5,948	9,812	7,012	4,912	5,545
S.D.[a]	10,102	6,695	2,927	8,005	16,506	9,884	4,210	7,762

[a] S.D. = Standard Deviation.

Appendix D, Table IV

Owner-Operator, Full Equity, Returns To Annual Capital, Land, And Management By Income Periods

Base Period (Year)	V Large Cropland Unit			
	6A	6C	6D	18A
	- Dollars -			
1942	10,404	5,936	6,456	7,439
1943	9,709	7,586	8,765	8,502
1944	22,699	18,015	16,837	17,280
1945	18,213	14,768	13,335	14,446
1946	19,981	13,288	11,104	10,974
1947	10,943	8,625	8,759	8,997
1948	11,724	3,606	3,891	3,879
1949	11,816	6,615	7,126	6,185
1950	27,657	16,151	11,104	13,400
1951	16,244	15,898	13,321	14,365
1952	9,601	14,454	17,574	15,841
1953	-5,484	835	2,465	2,402
1954	6,565	5,330	3,012	3,564
1955	-3,621	-1,361	-963	-1,807
1956	-2,896	1,023	1,398	1,763
1957	12,041	8,750	8,907	9,171
$\bar{X}$	10,975	8,720	8,318	8,525
S.D.[a]	9,234	6,097	5,450	5,613

[a]S.D. = Standard Deviation.

Appendix D, Table V

Part Owner (50 Percent Owned and 50 Percent Rented), Returns To Annual Operating Capital, Land Equity, and Management, By Income Periods

Base Period (Year)	I Small Balanced Unit				III Large Balanced Unit			
	6A	6C	6D	18A	6A	6C	6D	18A
	- Dollars -							
1942	-73	-1,905	1,323	-257	8,676	3,085	3,814	5,406
1943	-1,127	-2,154	-874	-1,063	5,084	2,828	5,005	4,369
1944	4,934	2,608	1,091	2,892	18,272	13,411	10,638	13,907
1945	3,886	1,724	344	2,211	15,300	11,643	8,871	12,227
1946	6,049	3,407	179	2,503	18,657	12,472	7,277	11,575
1947	-326	-885	-615	-423	7,429	5,551	5,878	5,801
1948	-100	-919	-1,531	-647	11,038	2,953	2,197	3,158
1949	695	-475	-773	-464	9,293	4,258	4,376	4,445
1950	11,042	6,619	647	5,773	31,004	19,657	9,082	18,681
1951	7,002	3,554	1,137	3,548	16,285	15,494	11,199	15,655
1952	-5,383	-2,319	1,237	-2,083	-1,000	4,672	11,208	3,715
1953	-6,030	-4,980	-2,605	-4,094	-9,340	-3,223	639	-2,612
1954	831	531	-2,488	-780	5,942	5,859	172	3,568
1955	-3,558	-3,194	-3,231	-3,681	-5,132	-2,316	-2,215	-3,200
1956	-4,482	-3,730	-3,068	-3,424	-5,587	-1,464	-878	-1,675
1957	1,111	-755	-1,086	170	9,206	5,045	4,157	6,512
$\bar{X}$	904	-180	-810	11	8,445	6,245	5,089	6,346
S.D.[a]	4,731	3,083	1,504	2,762	10,430	6,573	4,363	6,466

[a] S.D. = Standard Deviation.

Appendix D, Table VI

Part Owner (50 Percent Owned and 50 Percent Rented), Returns To Annual Operating Capital, Land Equity, and Management, By Income Periods

Base Period (Year)	II Small Range Unit				IV Large Range Unit			
	6A	6C	6D	18A	6A	6C	6D	18A
	- Dollars -							
1942	4,476	77	844	3,570	6,536	827	1,460	264
1943	453	-1,643	1,043	504	-399	-2,808	1,175	-2,643
1944	11,671	7,040	3,631	9,551	16,054	8,553	3,841	6,405
1945	10,970	6,668	3,211	9,137	16,312	9,497	3,947	7,127
1946	14,817	9,845	3,356	11,352	22,272	13,336	5,346	9,889
1947	2,984	1,854	2,214	2,597	4,068	3,090	3,452	2,000
1948	4,812	2,243	1,082	3,022	6,511	3,729	3,090	2,375
1949	4,425	1,930	2,024	2,969	5,538	2,097	3,978	1,061
1950	28,041	18,896	5,577	21,996	45,018	28,789	9,566	22,144
1951	17,947	11,887	6,583	15,092	29,397	18,415	10,634	14,064
1952	-10,864	-4,505	3,845	-7,828	-21,950	-9,111	3,994	-7,370
1953	-8,764	-6,074	-1,310	-6,443	-13,807	-7,754	-1,748	-6,623
1954	5,465	5,565	-1,759	4,012	8,778	8,794	-2,523	6,188
1955	-3,715	-2,193	-2,237	-3,324	-5,498	-2,432	-2,150	-2,711
1956	-5,252	-3,197	-2,644	-3,954	-8,068	-3,469	-4,013	-3,327
1957	5,134	1,182	-93	4,013	6,651	1,063	-1,033	387
$\bar{X}$	5,163	3,099	1,585	4,142	7,338	4,538	2,438	3,077
S.D.[a]	10,074	6,609	2,739	7,917	16,473	9,850	4,134	7,743

[a]S.D. = Standard Deviation.

Appendix D, Table VII

Part Owner (50 Percent Owned and 50 Percent Rented), Returns to Annual Operating Capital, Land Equity, And Management By Income Periods

Base Period (Year)	V Large Cropland Unit			
	6A	6C	6D	18A
	- Dollars -			
1942	7,695	3,227	3,746	4,729
1943	6,690	4,567	5,745	5,482
1944	18,447	13,763	12,584	13,027
1945	14,352	10,907	9,473	10,584
1946	16,926	10,233	8,048	7,918
1947	7,869	5,551	5,684	5,922
1948	9,797	1,679	1,963	1,951
1949	9,424	4,223	4,733	3,792
1950	24,384	12,878	7,830	10,126
1951	12,377	12,031	9,453	10,497
1952	5,188	10,041	13,160	11,427
1953	-7,727	-1,408	221	158
1954	4,533	3,298	979	1,531
1955	-4,928	-2,668	-2,271	-3,115
1956	-4,923	-1,004	-630	-265
1957	9,084	5,793	5,949	6,213
$\bar{X}$	8,074	5,819	5,417	5,624
S.D.[a]	8,665	5,291	4,581	4,748

[a]S.D. = Standard Deviation.

Appendix D, Table VIII

Encumbered Owner, Returns To Annual Operating Capital, Average Land Equity, and Management After Annual Land Payment, By Income Periods

Base Period	I Small Balanced Unit				III Large Balanced Unit			
	6A	6C	6D	18A	6A	6C	6D	18A
(Year)	- Dollars -							
1942	-368	-2,200	-1,618	-552	7,790	2,199	2,929	4,521
1943	-1,342	-2,369	-1,089	-1,278	4,438	2,182	4,360	3,724
1944	5,037	2,711	1,194	2,995	18,581	13,720	10,948	14,217
1945	3,888	1,726	346	2,213	15,306	11,649	8,878	12,234
1946	5,844	3,202	-26	2,298	18,040	11,855	6,660	10,958
1947	-527	-1,086	-816	-624	6,826	4,948	5,276	5,199
1948	-597	-1,416	-2,028	-1,144	9,547	1,462	707	1,668
1949	318	-852	-1,150	-841	8,162	3,127	3,246	3,315
1950	10,893	6,470	498	5,624	30,555	19,208	8,634	18,233
1951	7,006	3,558	1,141	3,552	16,296	15,505	11,211	15,667
1952	-5,238	-2,174	1,382	-1,938	-566	5,106	11,642	4,149
1953	-6,445	-5,395	-3,020	-4,509	-10,586	-4,469	-606	-3,857
1954	362	62	-2,957	-1,249	4,533	4,450	-1,237	2,159
1955	-4,215	-3,851	-3,888	-4,338	-7,103	-4,287	-4,185	-5,170
1956	-4,953	-4,201	-3,539	-3,895	-7,001	-2,878	-2,291	-3,089
1957	880	-986	-1,317	-61	8,512	4,351	3,464	5,819
$\bar{X}$	659	-425	-1,055	-234	7,708	5,508	4,352	5,609
S.D.[a]	4,832	3,203	1,690	2,904	10,780	7,051	5,026	6,968

[a]S. D. = Standard Deviation.

Appendix D, Table IX

Encumbered Owner, Returns To Annual Operating Capital, Average Land Equity, and Management After Annual Land Payment, By Income Periods

Base Period (Year)	II Small Range Unit				IV Large Range Unit			
	6A	6C	6D	18A	6A	6C	6D	18A
	- Dollars -							
1942	3,953	-448	318	3,045	5,832	123	756	-443
1943	8	-2,088	597	59	-1,064	-3,473	510	-3,311
1944	11,545	6,913	3,503	9,424	15,549	8,048	3,336	5,897
1945	10,743	6,441	2,983	8,910	15,757	8,942	3,392	6,569
1946	14,382	9,410	2,920	10,917	21,613	12,677	4,687	9,227
1947	2,553	1,423	1,782	2,166	3,410	2,432	2,794	1,339
1948	4,085	1,516	354	2,295	5,706	2,924	2,285	1,567
1949	3,818	1,323	1,416	2,362	4,793	1,352	3,233	313
1950	27,666	18,516	5,196	21,616	44,388	28,158	8,935	21,510
1951	17,721	11,661	6,356	14,866	28,842	17,860	10,079	13,506
1952	-10,949	-4,590	3,759	-7,913	-22,435	-9,596	3,509	-7,858
1953	-9,409	-6,719	-1,956	-7,088	-14,571	-8,518	-2,512	-7,395
1954	4,766	4,866	-2,461	3,313	7,986	8,002	-3,315	5,393
1955	-4,602	-3,080	-3,127	-4,211	-6,383	-3,317	-3,035	-3,599
1956	-5,953	-3,898	-3,348	-4,655	-8,860	-4,261	-4,805	-4,122
1957	4,675	721	-555	3,552	5,979	391	-1,705	-288
$\bar{X}$	4,687	2,623	1,109	3,666	6,659	3,859	1,759	2,394
S.D.[a]	10,102	6,695	2,927	8,005	16,506	9,884	4,210	7,762

[a] S.D. = Standard Deviation.

Appendix D, Table X

Encumbered Owner, Returns to Annual Operating Capital, Average Land Equity, And Management After Annual Land Payment, By Income Periods

Base Period (Year)	V Large Cropland Unit			
	6A	6C	6D	18A
	- Dollars -			
1942	6,811	2,343	2,863	3,846
1943	6,116	3,993	5,172	4,909
1944	19,106	14,422	13,244	13,687
1945	14,620	11,175	9,742	10,853
1946	16,388	9,695	7,511	7,381
1947	7,350	5,032	5,166	5,404
1948	8,131	13	298	286
1949	8,223	3,022	3,533	2,592
1950	24,064	12,558	7,511	9,807
1951	12,651	12,305	9,728	10,772
1952	6,008	10,861	13,981	12,248
1953	-9,077	-2,759	-1,128	-1,191
1954	2,972	1,737	-581	-29
1955	-7,214	-4,954	-4,556	-5,400
1956	-6,489	-2,570	-2,195	-1,830
1957	8,448	5,157	5,314	5,578
$\bar{X}$	7,382	5,127	4,725	4,932
S.D.[a]	9,234	6,097	5,450	5,613

[a]S.D. = Standard Deviation.

Appendix D, Table XI

Tenant-Operator, Returns To Annual Operating Capital and Management, By Income Periods

Base Period (Year)	I Small Balanced Unit				!!! Large Balanced Unit			
	6A	6C	6D	18A	6A	6C	6D	18A
	- Dollars -							
1942	-1,010	-2,842	-2,260	-1,194	5,865	274	1,004	2,596
1943	-2,144	-3,170	-1,891	-2,080	2,033	-223	1,955	1,319
1944	3,599	1,273	-244	1,557	14,266	9,405	6,633	9,903
1945	2,651	489	-891	976	11,596	7,939	5,168	8,524
1946	5,022	2,380	-848	1,476	15,578	9,393	4,198	8,496
1947	-1,357	-1,916	-1,646	-1,454	4,335	2,457	2,785	2,709
1948	-835	-1,654	-2,266	-1,382	8,832	747	-8	953
1949	-160	-1,330	-1,628	-1,319	6,727	1,692	1,811	1,880
1950	9,960	5,527	-435	4,691	27,757	16,410	5,836	15,435
1951	5,766	2,318	-99	2,312	12,576	11,785	7,491	11,948
1952	-6,760	-3,696	-140	-3,460	-5,131	541	7,077	-415
1953	-6,847	-5,795	-3,422	-4,911	-11,791	-5,674	-1,811	-5,062
1954	68	-232	-3,251	-1,543	3,655	3,572	-2,115	1,282
1955	-4,133	-3,768	-3,806	-4,256	-6,858	-4,042	-3,940	-4,925
1956	-5,243	-4,491	-3,829	-4,185	-7,870	-3,747	-3,160	-3,958
1957	110	-1,756	-2,087	-831	6,203	2,042	1,155	3,510
$\bar{X}$	-82	-1,166	-1,796	-975	5,486	3,286	2,130	3,387
S.D.[a]	4,640	2,975	1,294	2,633	10,114	6,135	3,710	6,002

[a] S.D. = Standard Deviation.

Appendix D, Table XII

Tenant-Operator, Returns To Annual Operating Capital and Management, By Income Periods

Base Period (Year)	II Small Range Unit				IV Large Range Unit			
	6A	6C	6D	18A	6A	6C	6D	18A
	- Dollars -							
1942	2,731	-1,686	-913	1,814	4,087	-1,622	-989	-2,184
1943	-1,384	-3,479	-794	-1,332	-2,888	-5,297	-1,314	-5,131
1944	9,516	4,886	1,476	7,397	13,407	5,906	1,194	3,759
1945	8,916	4,615	1,157	7,084	13,715	6,900	1,350	4,531
1946	12,970	7,999	1,509	9,506	19,779	10,843	2,853	7,397
1947	1,133	4	363	747	1,572	594	956	-495
1948	3,257	689	-473	1,468	4,163	1,381	742	28
1949	2,750	256	349	1,295	3,130	-311	1,570	-1,346
1950	26,143	16,994	3,674	20,094	42,497	26,268	7,045	19,624
1951	15,891	9,832	4,527	13,037	26,799	15,817	8,036	11,467
1952	-13,061	-6,701	1,648	-10,024	-24,619	-11,780	1,325	-10,038
1953	-10,401	-7,710	-2,947	-8,079	-16,196	-10,143	-4,137	-9,016
1954	3,882	3,983	-3,344	2,430	6,416	6,432	-4,885	3,827
1955	-5,110	-3,587	-3,634	-4,718	-7,766	-4,700	-4,418	-4,978
1956	-6,833	-4,777	-4,227	-5,534	-10,429	-5,830	-6,374	-5,687
1957	3,315	-638	-1,914	2,193	4,170	-1,418	-3,514	-2,093
$\bar{X}$	3,357	1,293	-221	2,336	4,865	2,065	-35	604
S.D.[a]	10,001	6,530	2,559	7,834	16,443	9,819	4,062	7,709

[a] S.D. = Standard Deviation.

Appendix D, Table XIII

Tenant-Operator, Returns To Annual Operating Capital And Management By Income Periods

Base Period (Year)	V Large Cropland Unit			
	6A	6C	6D	18A
	- Dollars -			
1942	4,987	519	1,039	2,022
1943	3,672	1,549	2,728	2,465
1944	14,195	9,511	8,333	8,776
1945	10,490	7,045	5,612	6,723
1946	13,870	7,177	4,993	4,863
1947	4,795	2,477	2,611	2,849
1948	7,870	-248	37	25
1949	7,032	1,831	2,342	1,401
1950	21,112	9,606	4,559	6,855
1951	8,509	8,163	5,586	6,630
1952	774	5,627	8,747	7,014
1953	-9,971	-3,652	-2,022	-2,085
1954	2,501	1,266	-1,052	-500
1955	-6,235	-3,975	-3,577	-4,421
1956	-6,949	-3,030	-2,655	-2,290
1957	6,128	2,837	2,994	3,258
$\bar{X}$	5,174	2,919	2,517	2,724
S.D.[a]	8,155	4,517	3,722	3,895

[a]S.D. - Standard Deviation.

Appendix E, Table I

Probability of Covering Cumulated Expenditures, Eight Selected Plans, Small Balanced Unit

Expenditure Items	Plan Number							
	6A	6B	6C	6D	18A	18B	18C	18D
Family Living	.916	.916	.942	.981	.953	.951	.966	.965
Nondeferable								
Enterprise	.745	.745	.742	.806	.784	.772	.774	.758
General	.695	.695	.668	.683	.707	.688	.659	.606
Real Estate Taxes	.671	.671	.626	.599	.663	.641	.592	.518
Annual Depreciation	.652	.652	.599	.544	.634	.610	.553	.472
6 Pct. Annual Capital	.572	.572	.508	.428	.552	.532	.472	.397
5 Pct. Land Capital	.412	.412	.275	.089	.294	.261	.150	.076

Appendix E, Table II

Probability of Covering Cumulated Expenditures, Eight Selected Plans, Small Range Unit

Expenditure Items	Plan Number							
	6A	6B	6C	6D	18A	18B	18C	18D
Family Living	.944	.932	.958	.998	.943	.942	.972	.997
Nondeferable								
Enterprise	.805	.800	.834	.956	.828	.827	.867	.952
General	.785	.781	.807	.929	.805	.803	.837	.918
Real Estate Taxes	.767	.763	.782	.897	.784	.781	.808	.877
Annual Depreciation	.755	.750	.768	.876	.771	.768	.788	.854
6 Pct. Annual Capital	.682	.681	.688	.801	.704	.702	.719	.759
5 Pct. Land Capital	.545	.543	.480	.309	.533	.524	.463	.238

Appendix E, Table III

Probability of Covering Cumulated Expenditures, Eight Selected Plans, Large Balanced Unit

Expenditure Items	Plan Number							
	6A	6B	6C	6D	18A	18B	18C	18D
Family Living	.986	.988	.997	.999	.997	.995	.998	.999
Nondeferable								
Enterprise	.909	.913	.957	.985	.966	.952	.971	.984
General	.890	.893	.939	.974	.945	.933	.956	.971
Real Estate Taxes	.870	.871	.918	.955	.922	.912	.938	.954
Annual Depreciation	.842	.856	.903	.945	.908	.898	.925	.940
6 Pct. Annual Capital	.797	.803	.860	.912	.873	.860	.891	.912
5 Pct. Land Capital	.612	.603	.595	.570	.614	.606	.603	.548

Appendix E, Table IV

Probability of Covering Cumulated Expenditures, Eight Selected Plans, Large Range Unit

Expenditure Items	Plan Number							
	6A	6B	6C	6D	18A	18B	18C	18D
Family Living	.918	.916	.950	.998	.948	.947	.947	.997
Nondeferable								
Enterprise	.770	.767	.825	.955	.840	.839	.839	.958
General	.747	.746	.792	.923	.801	.800	.800	.918
Real Estate Taxes	.733	.731	.770	.894	.774	.772	.772	.882
Annual Depreciation	.723	.720	.760	.878	.762	.760	.760	.863
6 Pct. Annual Capital	.649	.648	.681	.746	.689	.688	.688	.739
5 Pct. Land Capital	.532	.529	.486	.297	.439	.437	.437	.208

Appendix E, Table V

Probability of Covering Cumulated Expenditures, Eight Selected Plans, Large Cropland Unit

Expenditure Items	Plan Number							
	6A	6B	6C	6D	18A	18B	18C	18D
Family Living	.994	.993	.999	.999	.999	.999	.999	.999
Nondeferable								
Enterprise	.936	.928	.973	.981	.980	.978	.978	.977
General	.919	.909	.958	.969	.967	.964	.965	.964
Real Estate Taxes	.900	.887	.939	.951	.950	.945	.945	.943
Annual Depreciation	.883	.871	.924	.936	.935	.931	.929	.926
6 Pct. Annual Capital	.834	.824	.895	.913	.916	.911	.912	.910
5 Pct. Land Capital	.637	.622	.622	.618	.638	.626	.615	.604

Appendix F

Income-Standard Deviation Function

The income for each farm plan can be plotted against the standard deviation of that plan. Removing the enterprise with the highest variability from the programming matrix will result in a farm plan with another income-variance combination. Each time this operation is repeated, another point can be plotted. An income-variability curve such as in Diagram 1 can be derived by plotting the average income and standard deviation for each of a series of programmed farm plans.

If a unique equilibrium planning position is to be attained, the shape of the indifference curve must be such that it is tangent to the income opportunity curve at only one point. Further, the curves must not intersect at any other point. If the indifference curve should coincide with the income curve, then all plans would appear to be equally desirable. The various forms that the indifference curve might theoretically take on may serve as a partial explanation of why, in situations that appear similar, individual farm operators make different decisions as to the plan to follow.

Theoretically, the optimum farm plan would be the plan indicated by a point such as P. At this point, the farm operator's indifference curve, with respect to income and variability of income, is tangent to the income variability curve. With a low risk aversion, the shape and location of the farm operator's indifference curve will be such that the point of tangency lies to the right hand portion of the income curve, which allows more variable and higher income enterprises to enter the farm plan. If the farm operator has a high risk aversion, the point of tangency will be towards the left hand portion of the income curve, which allows less variable and lower income enterprises to be included in the farm plan.

The income-variability curve suggested here is similar to the risk opportunity curve derived by Freund and Rein.[1] Their model was developed by the use of an expected utility function that brought risk aversion into a quadratic programming model. By the use of a variance-covariance matrix and a technology matrix for seven crops single valued points on the curve were computed. With a low risk aversion factor in the utility function, the plan derived was essentially the same as the plan when risk was not considered. Increasing the magnitude of the risk aversion factor resulted in programmed plans that included crops with a lower degree of risk and a lower and less variable farm income. Thus, with different risk aversion factors, points on the curve representing different combinations of income and variance were derived by quadratic programming.

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[1]Rudolph J. Freund and M. E. Rein, !Aspects of Risk Programming," (unpub. 20 page paper based on Freund's unpub. Ph.D. thesis, North Carolina State College, 1955; and Rein's unpub. M.S. thesis, Virginia Polytechnic Institute, 1958).

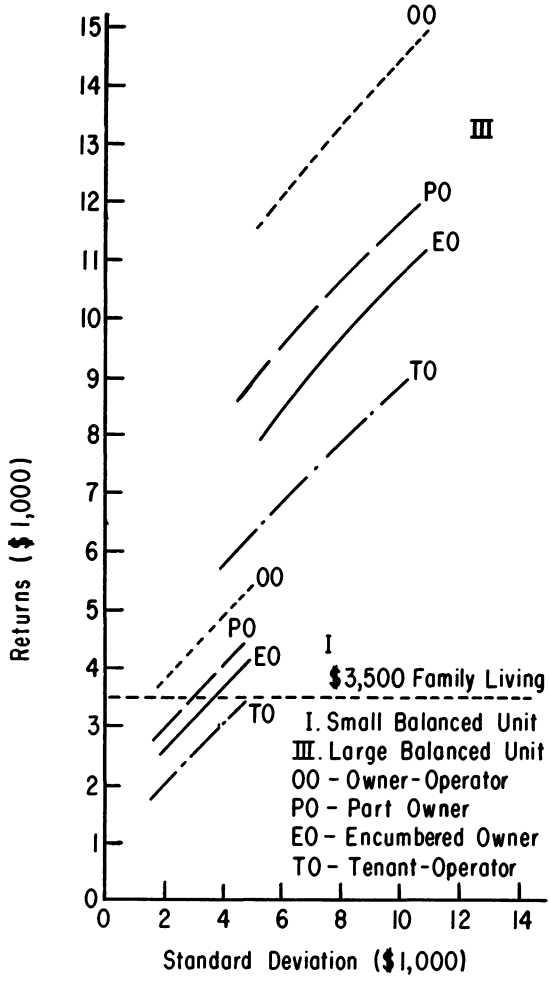

Figure 3. Disposable income opportunity curves, four tenure classes with full equity in annual operating capital, two balanced farm resource situations.

owner, the shift in the disposable income curve is down, due to the land payment. Since the land payment is a constant amortized amount, the variability of disposable income is the same for the encumbered owner as for the owner-operator with full land equity.

In relation to the curves, plans 6A and 6D are at the extreme ends. Plan 18A is located either on or above the curves with plan 6C located below the curves, except for resource situation IV. For resource situation

IV, the constructed curves pass through the point representing plan 6C with plan 18A below the curves.[9]

Figure 4 is a comparison of the small range unit and the large range unit when tenure is considered. When only the four planning situations (6A, 18A, 6C, and 6D) were considered, the derived curves for the range units are slightly convex down to the right. This shape was due to a relatively sharp decline in variability as a change was made from the moderate graze steer plan to the cow-calf plan. With this change, variability decreased at a faster rate than income. On the range units, income curves shifted down when less than full equity in land was assumed. However, due to the fact that the greater part of the income was from livestock, the reduction in variability was low, compared with the balanced units when all or part of the land was rented.

Differences in variability are apparent between the range units as a result of the higher proportion of cropland on the small range unit compared with the large range unit. Cropland comprises 20 percent of the land resources on the smaller unit, compared with six percent on the larger unit. For example, the income from plan 6A on the small range unit has a coefficient of variation of 96, compared with a coefficient of variation of 124 for the same planning situation on the large range unit. Plan 6C showed a coefficient of variation of 94 on the large range unit. Plan 6C on the large range unit corresponds to the point where the 00 curve for II nearly touches the 00 curve for IV in Figure 6. On the small range unit, the coefficient or variation for plan 6C was 80 at an income level of $8,400.

The effects of tenure on the disposable income for the large cropland unit are shown in Figure 5. Because of the higher proportion of income from cash grain crops on a cropland unit and the high correlation between rent (crop share) and cash grain income, the reduction in variability for a rental unit was greatest on the cropland unit. For example, if the tenant employed optimum plan 6A, the standard deviation of disposable returns would be 12 percent lower than for the full owner of a cropland unit. With this reduction in variability through the payment of crop share rent, disposable income was reduced by 40 percent. The same analysis for a large range unit indicated only about 0.5 percent reduction in variability with a 38-percent reduction in disposable income. The data also indicated a six percent reduction in variability for the tenant on the large balanced unit with a 40-percent lower disposable income than the owner-operator with the same plan on this balanced unit.

[9] For resource situation IV under planning situation 18A, moderate graze steers enter the optimum plan rather than heavy graze steers as in the other resource situations. This change in optimum plan is due to the high proportion of hired labor required for this unit and the increased cost of this labor when the 18 percent marginal value product of capital was required.

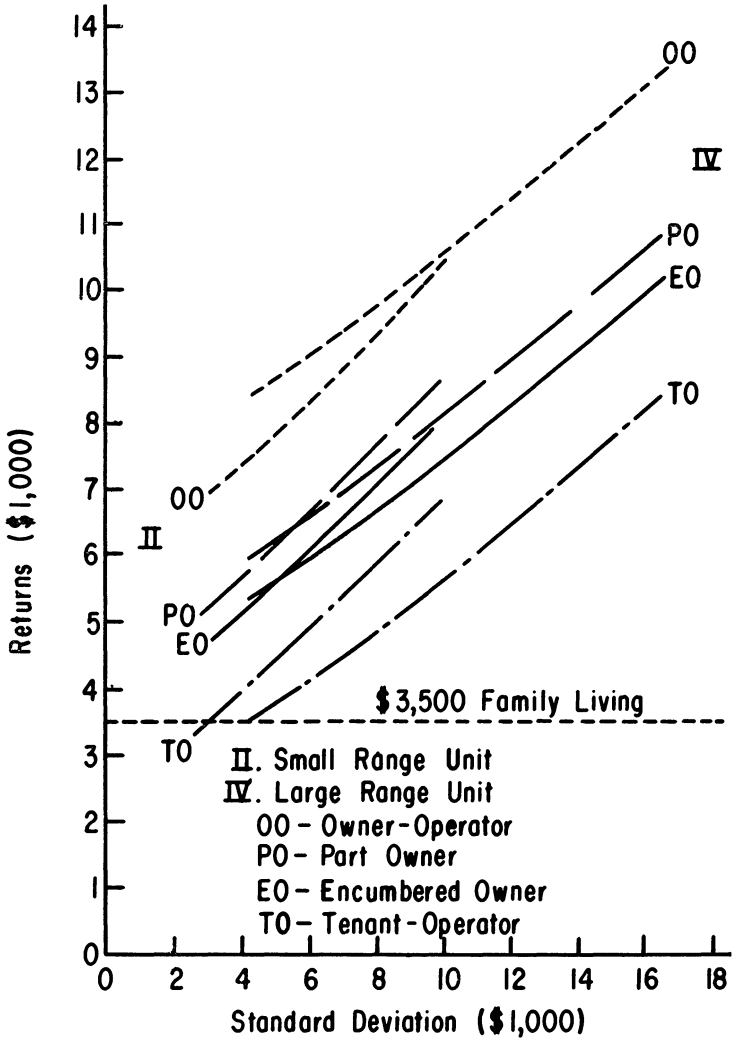

Figure 4. Disposable income opportunity curves, four tenure classes with full equity in annual operating capital, two range resource situations.

Probability of Specified Income Levels

The farm operator with high land equity and adequate operating capital may be most interested in the probability of a specified level of income. To analyze the probability of specified income levels, the probabilities of gross incomes equal to or greater than cumulated expenditures

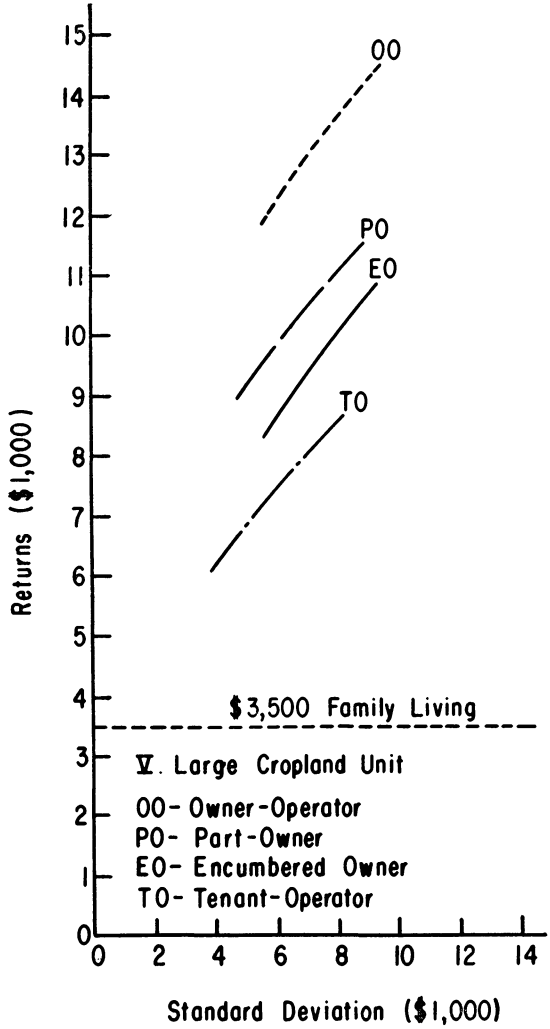

Figure 5. Disposable income opportunity curves, four tenure classes with full equity in annual operating capital, large cropland resource situation.

were tabulated (Appendix E).[10] These probabilities were tabulated for the owner-operator for the eight plans on each of the different types of farm units.

When a level of gross income high enough to cover only family living was considered, the cow-calf plans (6D and 18D) had the highest

[10]The probabilities in Appendix E were based on normal distribution theory, and standard deviation data from Table IX.

probability of yielding that level of income for all resource situations. This probability ranged from 0.96 for the small balanced unit to 0.99 for the large crop unit. However, when all specified expenditure items were considered, the cow-calf plan derived by restricting capital with an 18-percent opportunity cost had the lowest probability of attaining a gross income equal to the cumulated expenditure total. This probability varies from 0.08 for the small balanced unit to 0.60 for the large crop unit.

The two plans, 6A and 6B, which have the highest average gross income but the most variability, showed the lowest probability of covering only family living. However, the level of probability is relatively high being between 0.92 for the small balanced unit and 0.99 for the large crop unit. The higher proportion of low incomes for these plans are balanced by a higher proportion of high incomes, especially for plan 6A, relative to the other plans so that plan 6A shows the highest probability of covering all expenditures for resource situations I, II, and IV. For resource situations III and V, plan 18A had the same probability of covering all expenditures as plan 6A. For plan 6A, the probability of covering all expenditures on the small balanced unit was only 0.41.

Examining the level of cumulated expenditures, which includes all expenses except the returns to capital, showed that there was not as much consistency in the plans that exhibit the most or least probability of covering expenditures when the different resource situations are considered. For resource situation I, the cow-calf plans showed the lowest probability of covering this level of cost, while for the other four resource situations, plans 6B and 6A showed the lowest probability of returning all costs except interest on investment.

Resource situation I differs from the other four resource situations in this case, because the unit is so small that the gross income from plans 18D and 6D is so low that the annual general overhead expenses and real estate taxes which are considered constant for the planning situation forces the two cow-calf plans to be least likely to return all costs except interest. The predetermined fixed costs more than offset the reduced variability for these two plans. In a similar manner for situation I, the highest income and most variable plan (6A) is most likely to cover all specified costs except interest on annual operating capital and interest on land capital.

For the other four resource situations, the cow-calf plan derived using the 6-percent capital opportunity cost showed the highest probability of covering all specified costs except interest on annual operating land capital. For resource situations II and IV, although the coefficients of

variation for plan 18D were slightly lower; the lower average gross income prevented them from having a higher probability of covering this level of expenditure. In the case of resource situation III, plan 18D had both a higher coefficient of variation and a lower income than plan 6D. For resource situation V, plan 18A was about equivalent to plan 6D having both a higher income and higher coefficient of variation.

None of the plans programmed for the small balanced farm unit produced an income large enough to cover all costs 50 percent of the time. As indicated by Figure 6, the income levels above and below which 50 percent of incomes will occur are approximately $10,200, $8,600, $8,400, and $7,000, respectively, for plans 6A, 6C, 18A, and 6D. The use of expenditure information that 50 percent of the time returns to land capital will be less than $885 for plan 6A, less than $90 for plan 6C, and

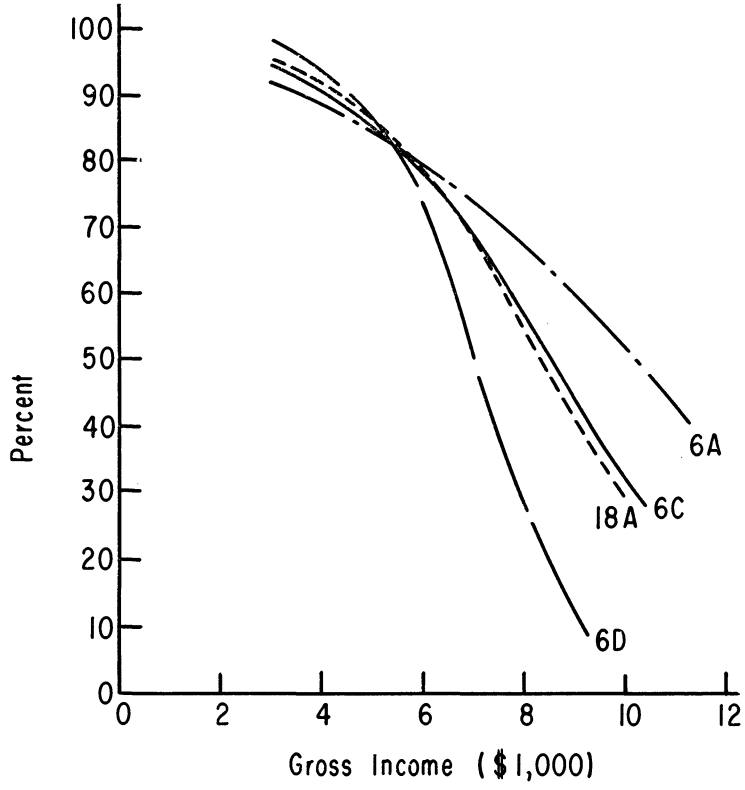

Figure 6. Percent of time gross income may be expected to be equal to or greater than cumulated annual expenditure items, four selected plans, small balanced unit.

less than $420 for plan 18A. An average of $1,972 is required if land is to return 5 percent on its calculated value. Plan 6D returns less than $160 for returns to annual operating capital 50 percent of the time and no returns to land capital 57 percent of the time. A 6-percent return to annual operating capital would be $493 for plan 6D.

In contrast, resource situation III, which is a balanced unit three times as large as situation I, yields returns to management more than 50 percent of the time for all plans. An analysis of Figure 7 indicates that the income levels 84 percent of the time will be equal to or greater than $16,570, $16,050, $15,550, and $15,450 for plans 6A, 6C, 18A, and 6D, respectively. At a probability of 0.84 for plan 6A, the returns to annual capital are greater than $620. Appendix G was used with Figure 7 to calculate the returns to land capital at the 0.84 probability level for the four plans. With this information, plan 6C shows returns to land capital of $565 or greater 84 percent of the time. At the same probability level, plan 6D shows $1,780 returns to land, while plan 18A shows $970 returns to land. For resource situation III, a 5-percent return to land requires $5,915. For plan 6A, a 6-percent return to annual operating capital requires $2,416. These comparisons for the two balanced farm units point

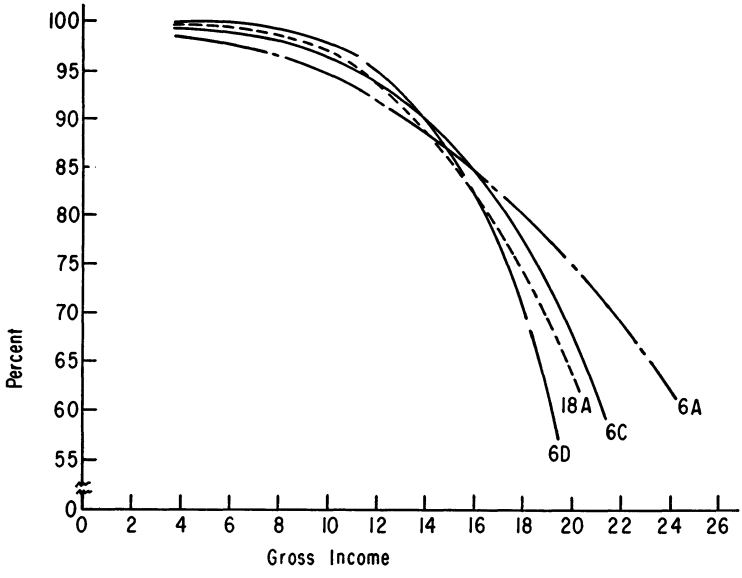

Figure 7. Percent of time gross income may be expected to be equal to or greater than cumulated annual expenditure items, four selected plans, large balanced unit.

out the higher probability of receiving returns to capital with the larger unit (III) compared with the smaller unit (I).

The range resource situations are both analyzed at the 0.50 probability level, since some of the plans for each of them will not yield returns to management over 50 percent of the time. Returns to management are $1,166 or more 50 percent of the time for plan 6A and with this same probability, they are $662 for plan 18A on the small range unit. Figure 8 indicates that the income level above and below which 50 percent of the incomes would occur for plan 6C is approximately $15,100, while for plan 6D this income level is about $11,900. Based on these incomes, plan 6C yields more than $3,330 returns to land capital while plan 6D yields more than $2,575 returns to land capital 50 percent of the time, with no returns to management 52 percent of the time (6C) and 69 percent of the time (6D).

For the large range unit (IV) of the four plans graphed, only plan 6A yields returns to management more than 50 percent of the time (Figure 9). Returns to management are $1,329 with a probability of 0.50 of attaining at least this level. After paying all other specified expenditures for this resource situation, plan 6C produces $4,666 or greater returns to land 50 percent of the time. If the alternative plan 6D is followed, the returns to land are $2,786 while for plan 18A the returns to land are $3,849 on the same basis. For the last three plans, no returns to management are indicated 51, 70, and 56 percent of the time, respectively, for plans 6C, 6D, and 18A.

All the plans studied for the large cropland unit indicate returns to management over 50 percent of the time. Based on the incomes indicated on Figure 10 at the 0.84 probability level and expenditures shown in Appendix E, Table V, plan 6A shows a return of at least $1,740 to annual capital 84 percent of the time with no returns to land capital only 43 percent of the time. Plans 6C, 6D, and 18A show returns to land capital 84 percent of the time. The returns for these three plans are at least $1,550, $1,960, and $2,130 in that order at the 0.84 probability level.

Firm Survival and Capital Accumulation

For short-run survival the time periods and sequence in which given levels of income occur are critical. The tendency of bunchiness of income levels increases the danger of financial failure of the farm firm if several relatively low income years should occur before the farm operator has acquired sufficient equity.

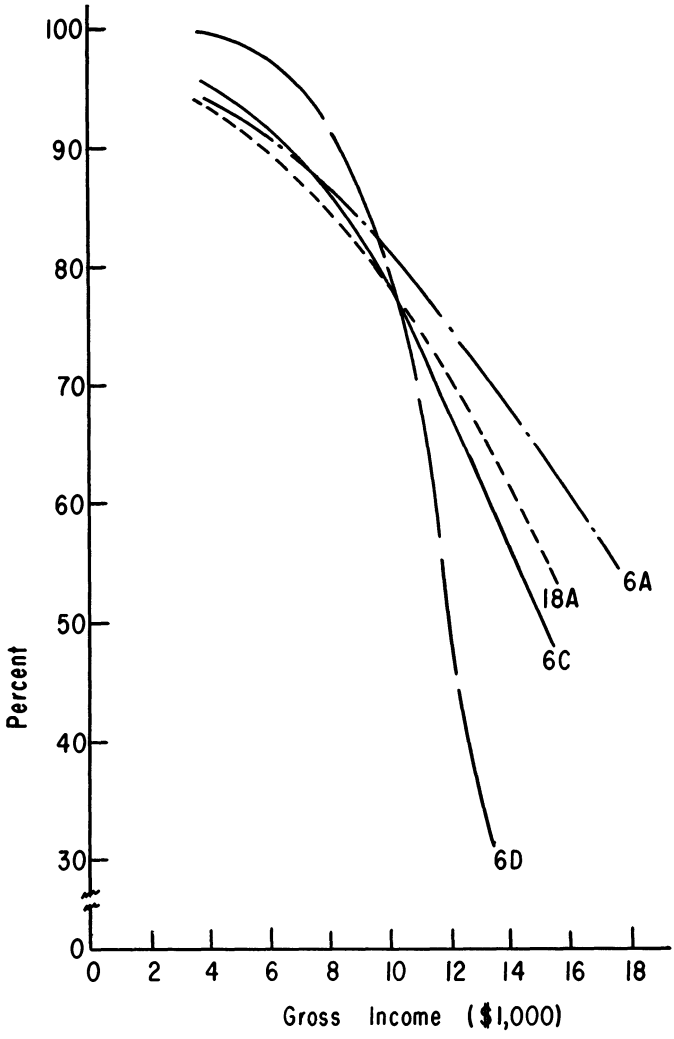

Figure 8. Percent of time gross income may be expected to be equal to or greater than cumulated annual expenditure items, four selected plans, small range unit.

The computed disposable operator returns[11] based on the variability for the 1942 to 1957 period are shown in Appendix F. The returns shown for the operator in these tables are the returns that would occur for

[11]These values are the returns to operating capital, land equity, and management. These are the sequences used as a base for calculating credit required and capital accumulation, assuming a specified starting equity. The amount of $3,500 was deducted from disposable returns used in the preceding section as an allowance for minimum family living and was assumed to be returns to family labor. The average of these values are the potential investment funds discussed for the static plans.

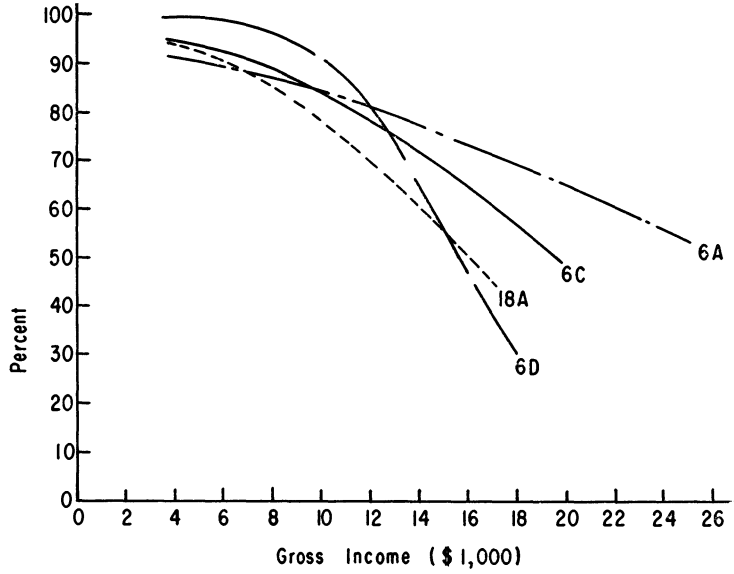

Figure 9. Percent of time gross income may be expected to be equal to or greater than cumulated annual expenditure items, four selected plans, large range unit.

the specified plans if the gross income varied as in 1942-57 with the programmed income level as an average annual income.

The frequency distributions of estimated annual farm income levels for selected plans were tabulated for each farm by income intervals. Generally, the more income intervals over which the annual returns are dispersed, the greater the income variability for that plan. The stronger the tendency for annual farm income levels to bunch in income intervals about the mean, the greater the income stability for that plan.

Frequency Distribution of Reserve Funds

The frequency distributions of the maximum funds available for reserves are shown in Table X for the owner-operator tenure class. Four farm plans for each of the five resource situations were analyzed. Under each land resource situation the plans were ordered in terms of the level of returns on the large balanced unit.

For all resource situations the plan that includes heavy and temporary graze steers (6A) showed the widest range of income intervals. The distribution of incomes was also more concentrated in the income intervals

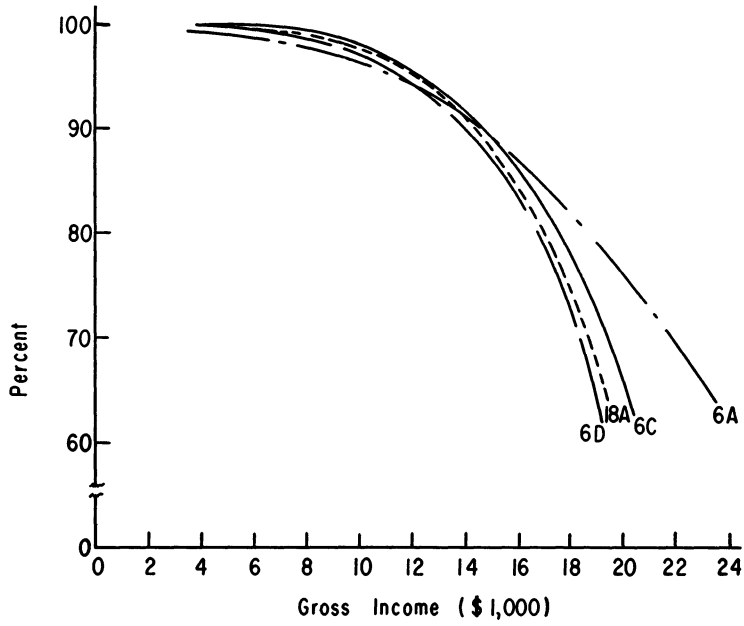

Figure 10. Percent of time gross income may be expected to be equal to or greater than cumulated annual expenditure items, four selected plans, large cropland unit.

near the mean for plan 6D than for plan 6A. As measured by coefficient of variation and standard deviation plan 6D was also the least variable of the four plans analyzed.

The dispersion of the frequency distribution of the returns in Table X decreased with the income level for the large units and for the small range unit. However, for the small balanced unit with plan 18A, which showed a slightly higher return to capital, land, and management than plan 6C, the dispersion of income was less than for plan 6C on the same unit. The difference in dispersion was due to the fact that a higher proportion of the income was derived from cash grain grops with plan 18A than with plan 6C.

The effects of renting land on the frequency distribution of returns that could be available for reserves can be observed by comparing Table XI with Table X. Table XI shows the expected frequency distribution of returns when all land was considered as being rented.

As shown in Table XI, the level of the distribution of returns to equity and management would be lower for the tenant-operator than for

the owner-operator. This lower level of returns reflects the returns to equity in land at a zero level of the operator who rents all of his land. It was also observed that the returns tended to be more concentrated about the mean for the tenant group. The most concentrated frequency distribution of these returns was exhibited by the cow-calf plan (6D) on the small balanced unit. This distribution was about a mean of —$1,800 in two return intervals. Twelve observations were in the interval —3,000 to zero, with four observations in the interval —6,000 to —3,000. This distribution indicates that on the average either family living would have to be reduced by at least $1,800 or else equity would decline for the tenant-operator on the 640 acre balanced unit using plan 6D.

The frequency distribution for the operator who rented half of his land was between that for the full owner and the tenant-operator, both in terms of income levels and observed frequencies. The frequency distribution of returns for the encumbered owner was at a slightly lower level than for the part owner, while the variability exhibited by this frequency distribution was nearly the same as for the full owner.

Conditions for Survival and Expansion

The net change in capital that could take place for specified resource, tenure, and planning situations can be analyzed only after making allowances for interest on borrowed capital and taxes. The sequence of incomes analyzed was the sequence that was most unfavorable for the high capital level cow-calf plans (6D) on all resource units. For this computation of capital accumulation, the assumption was made that the base period years 1953 through 1957 preceded the years 1942 through 1952. For the cow-calf plans other sequences of years would be more favorable. However, if the base period 1952 was also moved to the beginning of the sequence, a more unfavorable sequence of incomes would result for the steer grazing plans.

For all plans the assumption was made that the operator had cash and/or equity in machinery and livestock equivalent to $13,000. In the first period the required annual operating capital in excess of $13,000 was borrowed. In subsequent periods the amount of borrowed capital required was determined by the change in annual operating capital equity. The equity for the succeeding periods is the current equity plus the returns to land equity, annual operating capital, and management minus interest on borrowed capital, Federal income tax, social security tax, and Oklahoma income tax.[12]

[12]For income tax computation it was assumed that the number of dependent exemptions claimed was four.

The assumption was made that when equity falls below $13,000, part of the annual specified costs could be deferred to reduce the amount of borrowed capital.[13] It was assumed that when equity exceeded $13,000 previously deferred expenditures could be recovered. It was further assumed that $1,500 could be withdrawn to raise the level of family living to $5,000 when equity was above a quantity equal to $13,000, plus the difference between $13,000 and the lowest equity attained. If equity exceeded 100 percent of annual operating capital, the withdrawal for additional family living was increased to $3,500.

In analyzing the encumbered owner tenure class, the assumption was made that the 16-year base period represented the 10th through the 25th year of a 33-year amortization period. This assumption was made to simulate an average change in land equity for encumbered owners. At a given point in time, individual operators would be at different stages in the amortization period.

Levels of accumulated equity, credit, family living, and expenditure deferrals were calculated based on these assumptions. These relationships are discussed below in relation to the five previously specified resource situations.

Balanced Farm Units

The small balanced farm unit could not provide a family living of $3,500 and yield a positive increment to annual operating capital equity for the part owner, encumbered owner, and tenant-operator. The cow-calf plan if used by an owner-operator would also result in a decrease in annual capital equity (Table XII). However, this owner-operator would have the possibility with this plan of renting additional land so that the total land farmed could result in net returns with which to increase operating equity. For example computations for the tenant-operator on the large balanced unit, indicated that such a farm three times as large as the small unit is capable of producing a $9,000 increase in equity, plus $5,000 toward a higher level of family living.

With the assumed unfavorable sequence of income, the owner-operator could have increased his capital equity by employing any of the three steer grazing plans if family living did not exceed the $3,500 specified. If the withdrawal for a higher level of family living indicated in Table XII was made, a negative change in capital equity would have resulted for two of these plans (18A and 6C). The level of credit required

[13]Expenses to be deferred when necessary were $500 family living, annual depreciation, part of the general overhead costs, and real estate taxes, in that order. It was assumed that taxes could be deferred for 4 years, and that annual depreciation and overhead costs could be deferred for a maximum of 5 years.

for the owner-operator appeared to be low enough so that he should not have experienced difficulty in securing the needed credit from established credit agencies.

All four tenure classes could increase their equity in annual operating capital with each of the four plans on the large balanced farm unit. As indicated by Table XIII, the part owner on this type of unit could accumulate equity in excess of average annual operating capital. These funds would be available for savings or investment. At the same time family living would be at a level considerably above $3,500. The low level capital heavy graze steer plan (18A) showed the possibility of the highest level of family living with the assumed system of withdrawal of additional family living funds. In terms of combined change in equity and family living, the high capital level heavy graze steer plan (6A) showed the greatest change.

Plan 6A also required the most borrowed capital. The maximum credit required reached over $39,000 for this plan. Although this figure represents 98 percent of the average annual operating capital, with a good credit record the operator should be able to secure the needed credit. This seems likely since the major portion of the capital needed is for the purchase of steers to graze and also because the operator was assumed to have a debt free equity in 50 percent of the land farmed.

Ranch Units

The encumbered owner on the small range unit using the cow-calf plan (6D) could not maintain his operating capital equity and family living while making payments on the land. Computations indicated that the encumbered owner using the moderate graze steer plan (6C) could increase his operating capital equity by $6,500, providing that he could secure annual operating credit equal to 104 percent of the average annual operating capital level of $26,668. For the low capital heavy graze steer plan (18A), the maximum level of financing required was about the same as annual operating capital. Equity increased by $13,325 with an additional $6,500 available for family living from this plan. Similarly, plan (6A) yielded a $17,269 increase in annual operating capital equity with $6,500 additional family living. The maximum credit required by this plan was 110 percent of the annual operating capital. Land equity increeased $16,740 in the same period for the encumbered owner on the small range unit.

The tenant-operator on this unit would have negative returns after considering interest on borrowed capital and taxes for plans 6C and 6D.

With plans 6A and 18A, equity levels would increase if he could survive the short run. However, plan 6A requires that capital be borrowed equal to a maximum of 120 percent of annual operating capital, while plan 18A requires maximum credit equal to 113 percent of annual operating capital. Some type of emergency credit program would likely have to be available in order for the tenant-operator to survive on this unit.

Calculations for the part owner on the small range unit were as shown in Table XIV. All four plans indicated the possibility of capital accumulation. Levels of credit required were low enough so that survival appeared to be possible for all four plans on this unit.

The most credit was required by the highest income and most variable plan (6A). The least credit was required by the lowest income and least variable of the plans (6D). Plan 18A allowed the highest withdrawal of funds for family living, whereas plan 6A showed the highest total change in annual operating capital equity plus family living. Both plans 6A and 18A provided funds in excess of annual operating capital that could be used for savings or investment.

On the large range unit only plan 6A over the 16 production periods could produce positive cumulated returns for the tenant-operator. However, the net increase after taxes and interest on borrowed capital was only $407 with family living maintained at $3,500. Even with this plan survival appeared unlikely, since maximum borrowed capital would reach 145 percent of annual capital. Furthermore, the average borrowed capital would exceed annual operating capital.

On both of the range units with the assumed rental rate, survival appeared unlikely for a tenant-operator. To attain survival, a lower rental rate and/or a larger land resource base than were assumed, would be required for survival of tenant-operated ranch units.

On the large range unit, the encumbered owner could not maintain equity and family living by the use of plan 18A or plan 6D.[14] When the high capital level moderate graze steer plan (6C) was assumed, annual operating capital equity increased by $7,864 with family living maintained at $3,500. By the use of the heavy graze steer plan (6A) annual operating capital equity could increase $17,457 with $4,500 withdrawn for additional family living. Although both of these plans require a maximum level of borrowed capital in excess of 110 percent of annual operating capital, survival of the ranch firm should have been possible

[14]For planning situation 18A on the large range unit the optimum plan had moderate graze steers rather than heavy graze steers. Plan 6D is a moderate graze cow-calf plan.

with current lending practices and the increase in land equity that was occurring. Over the 16-year period, land equity increased $23,129.

For the part owner tenure class, although all four plans would accumulate equity, none of them accumulated sufficient funds to provide a savings or investment other than in annual operating capital (Table XV). The cow-calf plan provided only the minimum $3,500 family living while the three steer grazing plans allowed for the withdrawal of $6,500 for a higher level of family living.

As indicated by the low rate of return (1.2 percent) on owned capital and land equity, this unit is close to the minimum size for the cow-calf plan. To provide more than the minimum family living, this unit would have to expand. If additional cropland were added, this would not only increase net income but would also decrease the coefficient of variation.

Borrowed capital requirements were relatively high. However, with a beginning debt-free land equity of over $50,000, the part owner should be able to secure sufficient credit to survive with the assumed sequence of incomes.

Cropland Unit

All four of the plans analyzed for the cropland unit would provide a family living level above $3,500 and increase annual operating capital equity for all tenure situations. These relationships are shown in Table XVI for the part owner tenure class.

A cropland unit of the size programmed permitted a higher withdrawal for family living than the other four programmed resource situations. The highest level of living was possible under the low capital level heavy graze steer plan (18A). With this plan for 11 of the 16 years, a $7,000 level of family living was possible for the part owner.

In addition, all four plans provided a sufficient increase in capital equity so that funds would be available for savings and investment. For a given planning situation, the rate of return on owned capital and land equity was higher for the cropland unit than for the other four land resource units.

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