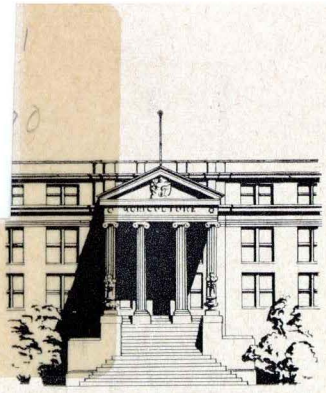

Identification and Measurement Of Inefficiencies In Leasing Systems

(An Application of Linear Programming)

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Identification and Measurement of Inefficiencies in Leasing Systems[1]

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BY MICHELE DE BENEDICTIS AND JOHN F. TIMMONS[2]

This study is directed toward developing procedures for identifying, measuring and appraising intratemporal dissociations between benefits and costs on rented farms. Development of these procedures is expected to provide further insight into the resource structure and operation of a firm in which multiple interests are present.

Recent studies appear to have achieved a satisfactory agreement in defining the functions of a lease, thus providing a common starting point for economic analysis.[3] Chryst and Timmons have summarizd the purposes of farm rent:

1. It helps allocate resources among particular kinds and amounts of uses in the productive process.

2. It distributes returns between landlord and tenant from the joint use of their combined resources.

3. It helps to keep landlords and tenants working together as teams, which is necessary in the continued joint use of their combined resources.[4]

This interpretation of a farm lease provides a useful frame of reference for analyzing leasing problems. It is possible to measure deviations, whether induced by institutions or other causes, from optimum attainment of the functions of the lease.

Surveys made to detect criteria motivating behavior of landlords and tenants have suggested an acceptance of these functions of the lease.[5]

PROBLEMS GENERATED BY INTRAFIRM MULTIPLE INTERESTS

In traditional economic theory, the firm is conceived of as the effective decision-making unit in whatever production activity is considered. To this definition of a firm, economic analysis has traditionally added a set of collateral characteristics in terms of which the theory of the firm has been formulated. Particularly relevant to this study is the assumed perfect association between input contributor and return receiver within the firm, to the effect that, under certain conditions, the resource owner receives the marginal value product of the resource he contributes.[6] This association is attained by assuming the existence of an entrepreneur in whose hands are centralized the power, responsibility and consequences of decision-making. He owns or hires factors of production, and he acts to attain a position of profit maximization for the firm as a whole.[7]

The assumption of the traditional theory, by which benefits and costs are perfectly associated in the hands of the entrepreneur, would be justified in farms operated by their owners.[8] This, of course makes allowances for interspatial and intertemporal dissociations of costs and benefits.[9] The owner-operator, under those conditions could attain an optimum allocation of resources to maximize his profits.[10] For a rented farm, however, the situation is very different. Since resources are furnished separately by landowner and tenant and since the decision-making process

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[2] Formerly research assistant, Iowa State University, now professor of economics, University of Naples; and professor of economics, Iowa State University; respectively.

[3] Heady, E. O. Economics of agricultural production and resource use. Prentice-Hall, New York. 1952. Chryst, W. E. and Timmons, J. F. Adjusting farm rents to changes in prices, costs and production. Iowa Agr. Exp. Sta. Special Report No. 9. 1955.

[4] Chryst and Timmons, **ibid.** p. 7.

[5] Timmons, J. F. Improving farm rental arrangements in Iowa. Iowa Agr. Exp. Sta. Res. Bul. 393. 1953.

[6] The residual imputational procedures for resource valuation assume (1) the market value of each resource is equal to its marginal value product, and (2) the firm is operating under constant returns to scale.

[7] This is the concept developed by J. R. Hicks. Value and capital. Oxford University Press, Oxford. 1941. p. 86.

[8] **Ibid.,** Ch. 6. Hicks states the necessary conditions to maximize profits as follows:

a. The price-ratio between two products must equal the marginal rate of substitution between the two products.

b. The price-ratio between any two factors must equal their marginal rate of substitution.

c. The price-ratio between any factor and any product must equal the marginal rate of transformation between the factor and the product.

Besides these necessary conditions, Hicks adds two stability conditions which are: a diminishing marginal rate of transformation for the factor-product and the factor-factor relationships and an increasing marginal rate of substitution for the product-product relationship. Supposing that the farmer's capital availability is limited, which is the ordinary case, then if the first two necessary conditions hold—conditions a and b—the marginal unit of each factor or service applied to different uses obtains the same rate of returns within the multiple-product agricultural firm.

[9] For further elaboration, see: Timmons, J. F. Economic framework for watershed development. Jour. Farm Econ. 46:1178. 1954.

[10] Assuming single-valued expectations.

is not united in a single entrepreneur but is variably split between the resource contributors, the theoretical conditions for profit maximization may not be attained. In effect, at the time when an agreement on the initial contributions of resources is made, the division of returns also is stipulated. This agreement may vary from almost complete abstention of the landlord regarding decision-making (cash lease), to an intermediate combination of mutual decision-making (crop-share lease), to a form of cooperative decision-making by both parties (certain livestock shares).[11] The division of decision-making within the firm engenders conflicts of interests between the two parties involved and may produce resource misallocations which are directly attributable to leasing arrangements.

Even though this study places major emphasis upon potential inefficiencies inherent in the existence of multiple interests within the firm, it is necessary to point out that several economic advantages may be attained by individuals through leasing. For instance, severe capital limitations of an endogenous nature can be relaxed through leasing. Capital limitations might induce the entrepreneur to plan over short periods, because survival of the firm becomes basic for continued farm operation. A landlord with a fixed amount of land and scarce operating capital may achieve an optimum amount of resource quantity through combination with a tenant, labor and capital. Conversely, the capital which would be used by a tenant for purchase of land is used for acquiring other productive resources.

In the area of endogenous capital limitation, the presence of the "principle of increasing risk" suggests that the size of production unit might be larger under renting than under proprietorship. In fact, the risks associated with a larger outlay may be spread under certain types of leases, particularly share leases.

Finally, sharing of uncertainties connected with yields and prices may be an incentive to expand the size of the firm. The existence of larger farms in acres under share leases may be partly explained by the increased propensity for sharing uncertainties.

The Problem Delimited for This Study

After the initial interest by early economists in the problems raised by rental contracts, research became oriented toward investigations largely descriptive in nature. Extensive surveys on the proportions of the various forms of leases and shares of contributions and products, mainly in the attempt to identify leasing customs, were carried out. More recently, however, emphasis has turned toward studies and investigations of a more analytical nature.

The trend of recent research seems to have followed two main routes: (1) exploration of the theory of the firm under situations with split ownership of resources and (2) empirical analysis of the existing leasing arrangements to identify lack of fulfillment of optimum conditions in certain areas[12] at specific points of time and to compare productivities of resources between alternative tenure arrangements.[13] Less stress has been laid upon the empirical isolation for individual farms of eventual deviations from postulated incentive conditions. The techniques most often employed are descriptive analysis, productivity analysis using single equation models and, more recently, linear programming.

Within the context of earlier research, this study is specifically concerned with (1) the impact of the intratemporal dissociation between benefits and costs on resource allocation and income distribution in a typical crop-share-cash lease, (2) an analysis of the impact of alternative leasing arrangements on the initial collection of resources and (3) an analysis of the effect of relaxing some resource restrictions on optimum farm plans. Linear programming is the analytical tool used, and the analysis of the initial situation is carried out for the period 1951-55.[14]

Objectives of Study

This study has the general objective of developing methods for empirically testing hypotheses which have been presented theoretically in the literature. Further hypotheses, advanced in the following chapter, are also tested.

In the light of this general objective, the specific objectives of this study are as follows:

1. To isolate and identify leasing-engendered imperfections through intrafirm analysis of resource allocation. The emphasis is essentially methodological, since the primary goal is to devise an analytical procedure or to adapt available analytical tools to detect and measure tenure impacts on resource allocation within the firm.

Within this general area, and on the basis of the methodology developed, the following specific objectives are pursued: (a) to point out basic bargaining conflicts between landlord and tenant under typical resource restrictions; (b) to evaluate the impact on resource allocation generated by alternative leasing arrangements and alternative resource restrictions.

2. To draw preliminary conclusions on the types of adjustments needed in farm leases and rented farms, both with respect to types of leases, given certain resource restrictions, and levels of resource combination, given certain leasing arrangements.

The Plan of This Report

This study has four major parts: (1) develop-

[11] This division is based on types of leases most common in the Midwest; however, they reflect general categories of leases present elsewhere. For a further discussion of lease characteristics, see: Hurlburt, V. L. Farm rental practices and problems in the Midwest. Iowa Agr. Exp. Sta. Res. Bul. 416. 1954.

[12] See Iowa Agr. Exp. Sta. Res. Buls. 386, 393, 416, 425, 426, 445 and Special Report No. 9.

[13] See Iowa Agr. Exp. Sta. Res. Buls. 433 and 461.

[14] Only the eventual deviations induced by intratemporal dissociations are taken into consideration. Intertemporal dissociations, problems of long-term combinations of landlord and tenant resources and effects of prices, cost and yield variations on stability of leases are recognized but are outside the objectives of this study.

ment of a theoretical framework for appraisal of resource use in rental arrangements, (2) adaptation of linear programming procedure to the analysis of tenancy problematic situations, (3) application of this analytical model to selected resource and lease situations with results and their interpretation and (4) suggestions for further research in the extension and use of the methods presented.

The theoretical framework is a synthesis and reorganization of relevant concepts advanced in current literature on leasing theory. It provides the elements necessary for the formulation of hypotheses to be tested in following sections in which linear programming is employed as an analytical tool to identify and measure lease-engendered imperfections.

The approach differs from previous studies in the general area of land tenure and production economics in two main respects. First, this study endeavors to determine, in addition to the optimum positions for the two parties, the feasible intermediary positions between the two optima, pointing out the possibility of alternative farm plans within a given lease. Second, instead of considering discrete changes in landlord and tenant capital restrictions, the modification of the linear programming simplex solution is used, which allows for continuous variation in the operating capital. The methods developed are applied to a typical lease and rented farm in north-central Iowa. Varying lease and resource situations are also analyzed.

THEORETICAL FRAMEWORK FOR IDENTIFICATION AND ANALYSIS OF LEASING PROBLEMS

In the traditional approach, the firm is assumed to be operating in perfectly competitive markets for both products and factors. The entrepreneur makes decisions, bears the costs and receives the returns. Traditionally, this type of firm has become the operational norm from which deviations are measured.

The economic setting within which any lease is assumed to function is characterized by the following conditions: (1) competition (abstracting from the imperfections inherent in the lease) and private ownership of resources prevail and (2) the existing price system provides the measure for efficiency in resource allocation.

The amount of variability between rental agreements is considerable. Each farm situation is unique. To draw conclusions and recommendations of general validity, it becomes helpful to use the theoretically perfect lease as a point of departure for an analysis. A perfect lease, as a leasing goal, should bring about the most efficient allocation of resources. The test of a leasing arrangement with respect to its efficiency is whether it allows fulfillment of the conditions necessary for the maximization of profits by the individual firm. The leasing system thus becomes inefficient if it hinders allocation of resources in the achievement of these conditions: (1) a combination of enterprises which will equate the marginal returns of resources employed in each enterprise, (2) substitution of factors such that the ratio of their marginal productivities is equal to the ratio of their prices, (3) combination of variable with fixed resources such that marginal returns and costs for the former are equated and (4) an overall scale of operations which equates marginal costs and returns at a level consistent with the cost-price relationships and normal uncertainties of the market.[15]

These conditions may be stated in an alternative way. To have an efficient lease which maximizes the plan for the farm as a whole as well as the plans of both the landlord and the tenant, four incentive conditions have been proposed.[16] These conditions within the lease are: (1) the share of the factor of variable input must be the same as the share of output obtained from it, (2) the share of all the products must be the same, (3) each resource owner must receive the full share of the product earned by each unit of resource he contributes and (4) each resource owner must have an opportunity to receive a return on investment made in one production period but not forthcoming until a subsequent period. These conditions can be considered as necessary but not sufficient. The sufficient condition for the perfect lease is the availability of capital.

The application of these criteria is hypothetically illustrated in fig. 1. The production possibility curve on which the rented firm operates is represented by PP; the reduction in revenue with respect to the analogous curve P′ P′ is assumed to be induced by imperfections inherent in the lease arrangement. An adjustment in the

[15] The third condition is only valid for allocating resources within the firm in the short-run period of production. Also, it should be pointed out that these conditions are not all fulfilled on many owner-operated farms.

[16] Hurlburt, **op. cit.**, p. 86.

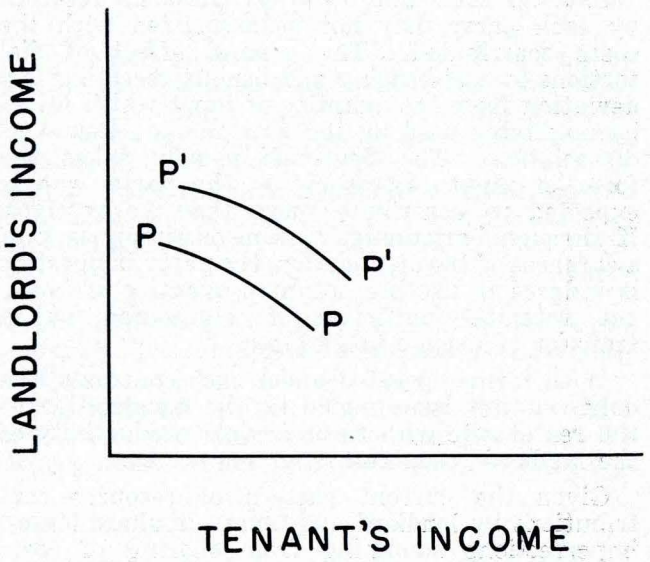

Fig. 1. Hypothetical illustration of the relationship between efficiency and lease arrangement.

leasing arrangement, guaranteeing fulfillment of the previously mentioned conditions, would make possible the shift to curve P′ P′. The curve is assumed to be characteristic of a firm owning the same collection of factors of production but having no schism in the decision-making and in the sharing of costs and returns.

Because of rigidity injected by customs and traditions, the possibility of continuous substitution between the income of landlord and tenant, as suggested by curves such as PP or P′ P′, is replaced in practice by a few discrete positions corresponding to shares determined by current rental contracts.

Nature of Inefficiencies Induced by Leases

Deviations from the efficiency conditions engendered by current leasing arrangements may be divided into those stemming from the determination of the initial amounts of resources contributed and from short-term decisions.

Problems connected with the determination of the initial amount of resources used are not treated in this study. Here, only problematic areas connected with allocation of resources after establishment of the rental contract—that is, only short-term decisions—are investigated.

Short-Term Decisions in Leases

Conflicts and imperfections stemming from short-term decisions may be divided, for clarity of presentation, into *intratemporal* conflicts and *intertemporal* conflicts.

INTRATEMPORAL CONFLICTS

Intratemporal conflicts may be discussed as (1) sharing costs and returns, (2) sharing enterprises and (3) intrafirm cost transfers.

Sharing costs and returns: Returns received by each party may not be associated with the costs contributed. The general effect of distortions in cost-bearing and benefit-receiving is a deviation from the quantity of input which would be profitably used by the firm in the absence of dissociation. The deviation usually takes the form of input restriction by the party who is expected to contribute more than he receives. If through bargaining, custom or simply lack of awareness of the dissociation, the party in question is induced to use the optimum quantity of input, the potential inefficiency is eliminated, but a transfer of income takes place.

With farms operated under cash contracts, the only relevant issue would be the equalization of the rental rate with the marginal productivity of the landlord resources.

Given the current pattern of resource contributions by landlord and tenant in share leases, imperfections stemming from sharing of costs and benefits are particularly significant for one type of resource—operating capital. Relationships between landlord and tenant contributions of operating capital to each enterprise and the restriction in the total amount of capital imposed by each party are particularly relevant for understanding the nature and implications of current cost- and benefit-sharing. It is hypothesized that, given the limitation in the amount of operating capital traditionally contributed by the landlord, a sharing of costs equal to the sharing of benefits would severely limit the level of production. Particular attention is then devoted in empirical studies to the analysis of the role of operating capital and the impact of its restriction on farm organization under alternative leasing arrangements.

Sharing enterprises: The complexity of the effect of tenancy on resource use within the firm is increased when shares of enterprises are considered. When two or more enterprises are shared differently, both parties are induced to allocate resources in favor of the enterprise from which the largest return is received. If market prices represent the index of consumer satisfaction and the choice criterion for allocation of resources among alternative enterprises, differential sharing would bring about a value of production less than the maximum attainable with the resources used.

Differential sharing of products is sometimes interpreted as an accounting device to adjust for differences in the contributions (of landlords and tenants) to total costs. If differences in cost-sharing were exactly balanced off by differences in product-sharing, leasing would not need to result in deviation from equilibrium of production. It is unlikely, however, that highly uniform sharing practices would suit situations differing in resource quality and quantity.

Intrafirm cost transfers: A common form of rent in the Midwest combines share and cash characteristics. This arrangement calls for shares of grain crops, while cash is paid for hay and pasture.[17]

As shown by Chryst and Timmons, shares of grain crops are highly rigid because of custom and tradition and do not respond, within a broad range, to changes in price-cost relationships and methods of production.[18] The landlord is likely to seek adjustment in the level of rent through modification of the cash rent paid on hay and pasture. In fact, while shares of grain crops are basically the same over wide areas and for divergent resource situations, cash rent on hay and pasture varies from $6 to $25 or more per acre.

This arrangement, which is actually an accounting device, may induce deviation from optimum resource allocation, since the tenant, in considering marginal costs and returns of each individual enterprise, is induced to consider the cost structure resulting from this intrafirm cost

[17] In some cases cash rent is paid as a distinct rent on buildings.
[18] See Chryst and Timmons, **op. cit.**

transfer, rather than the cost structure for the firm as a whole. Again, the resulting allocation of resources will differ from that which would hold under an unrestricted system of prices.

Hypotheses Directing Study

The hypotheses guiding the empirical phase of this study are formulated on the basis of the preceding analysis within the frame of objectives specified. Tests of these hypotheses are intended to provide further insight into the structure of a farm where multiple interests are present and where the interests are regulated by custom and tradition.

This inquiry proceeds according to the following steps: (1) to delineate and measure the inefficiencies created by intratemporal misallocations of resources within the lease, (2) to identify factors relevant in creating the gap and to investigate their behavior and (3) to advance remedial propositions.

The specific hypotheses directing the study are:

1. Provisions for sharing costs and returns in customary share leases are the cause of intratemporal misallocation of resources. Inefficiency is revealed through (a) a level of profit lower than the one attainable under unified entrepreneurship and (b) divergency between landlord's and tenant's optimum farm plans. The relationship between restriction in the amount of landlord's and tenant's capital and the sharing of costs and returns plays an important role in determining the divergency between the two optimum farm plans.

2. In a lease characterized by customary sharing of benefits and costs, agreement between parties on resource allocation and increase in efficiency may be obtained through appropriate modifications in the quantity of capital to be contributed by the landlord and the tenant.

3. The application to a typical lease of the optimum conditions of sharing benefits and costs should be accompanied by a sizable adjustment in the quantity of resources contributed by the two parties.

DEVELOPMENT OF MODEL FOR ANALYZING LEASING PROBLEMS

Application of Linear Programming to Farm Planning

Linear programming is an important analytical tool available to research workers concerned with efficient use of resources at the firm level.[19] From an analytical standpoint, programming is an amplification of budgeting, since it allows simultaneous consideration of the many alternatives available. It allows selection of the plan which maximizes profit, given the resource restrictions of the individual situation. The basic advantage of linear programming, as compared with the production-function approach, lies in a more accurate description of the technology of the firm. Three concepts form the basis of linear programming: resources, products and production processes. While the first two are familiar, the third is somewhat new. A process is a particular method of producing a given product; it specifies the kind of input, the kind of output and the ratio of each input to the output.

The main object of linear programming is selection of the most profitable processes for the products to be produced. The procedure leading to the determination of the optimum program rests on a set of assumptions which surround the conditions to which this analytical technique is applicable. The assumptions are: (1) each process is characterized by constant proportions between inputs and outputs, regardless of the extent to which the process is used; (2) indivisibilities of resources and products are ignored; (3) the output of two activities produced simultaneously is always the sum of the output of the separate activities; (4) the number of processes available is finite; and (5) at least one resource is limiting. Within the framework of these assumptions, linear programming appears particularly adapted to the analysis of resource use in the farm unit.

The simplex method has been used extensively to select the profit-maximizing combination of activities.[20] In this study, the simplex method has been modified for determining the optimum combination of activities when resources are allocated under the additional restrictions imposed by rental contracts.

Modification of Simplex Solution to A Rented Farm

The basic modification consists of setting up the initial tableau so that it will reflect the terms of the lease under analysis.[21] The input-output coefficients and the net prices are divided on the basis of the stipulated sharing of costs and returns. Each resource available to the firm also is divided on the basis of the contributions by landlord and tenant. The net price row is divided into two rows, the first composed of the share of the net price of each activity going to the tenant, and the second composed of the landlord's shares.[22] The matrix so composed is solved according to the simplex method.

The tenant's net price is chosen as the vector to be maximized first, and the enterprise with the largest negative net price becomes the incoming

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[19] For a more elaborate description of the nature of linear programming see: Charnes, A., Cooper, W. W. and Henderson, A. An introduction to linear programming. John Wiley and Sons, New York; Dorfman, R. Application of linear programming to the theory of the firm. The University of California Press; Greenwald, D. U. Linear programming. The Ronald Press Co., New York; and Heady, E. O. and Candler, Wilfred. Linear programming methods. Iowa State University Press. 1958.

[20] An explantation of the simplex method is given in Heady and Candler, **ibid.**

[21] For an explanation of the initial tableau see Heady and Candler, **ibid.**

[22] The net price is obtained by subtracting the cash expense from the gross revenue. **Ibid.**, pp. 112-116.

activity in the following iteration. The solution proceeds until all the tenant's net prices become positive or zero, indicating that the selection of enterprises and their intensity which guarantees maximization of tenant's net returns has been attained. If at this point all the landlord net prices are also positive or zero, the farm plan which maximizes the tenant's net returns also maximizes the net returns for the landlord. If, on the other hand, some of the landlord's net prices are still negative, a reorganization of the enterprises or a modification of their level of intensity would increase landlord's net returns. The movement from the tenant's to the landlord's optimum combination of enterprises may proceed along different paths, depending upon the selection of the profitable enterprises to be introduced in the following iterations. We are particularly interested in those intermediary positions between the two optima which form the upper boundary of the feasible combinations of enterprises in the landlord-tenant income plane, however.

An initial approximation of the boundary may be obtained by introducing in every step toward the landlord's optimum that enterprise which involves the largest increase in landlord's income for each unit of tenant's income given up. The collection of points so obtained, however, does not necessarily encompass all of the feasible points between the two optima. The correctness of the boundary may be checked through the introduction of alternative profitable enterprises in moving from the tenant's optimum position and in the following intermediary points. This trial and error procedure explores the possible paths between the two optima and thus tests the correctness of the boundary traced previously.[23]

A graphical illustration of the results of a hypothetical solution is given in fig. 2. At point A, all the tenant's net prices have become positive, and the total net income attached to the plan ($7,500) is shared between landlord and tenant in the proportion of $5,500 and $2,000, respectively. Points B, C and D represent incomes flowing from the plans specified by each intermediate position between A and E on the boundary AE. When point E has been attained, the combination of enterprises which yields the largest possible return going to the landlord has been selected.

The wider the divergency between A and E, the more likely is the lease to become a source of conflict between landlord and tenant. It should be pointed out, however, that even if the solution of the matrix leads to a unique point, C for example, this is not a necessary guarantee of efficiency. Point F, for instance, could represent the level of total income attainable if the same collection of resources were employed under a different decision-making structure, such as unified ownership and control or a perfect lease.

The methodological modification suggested here presents two main advantages to arriving at landlord's and tenant's optimum through the solution of two simplex tableaus.[24] First, the optima of the two parties are determined with one tableau; second, feasible intermediary points composing the upper boundary in the landlord-tenant income plane are also determined.

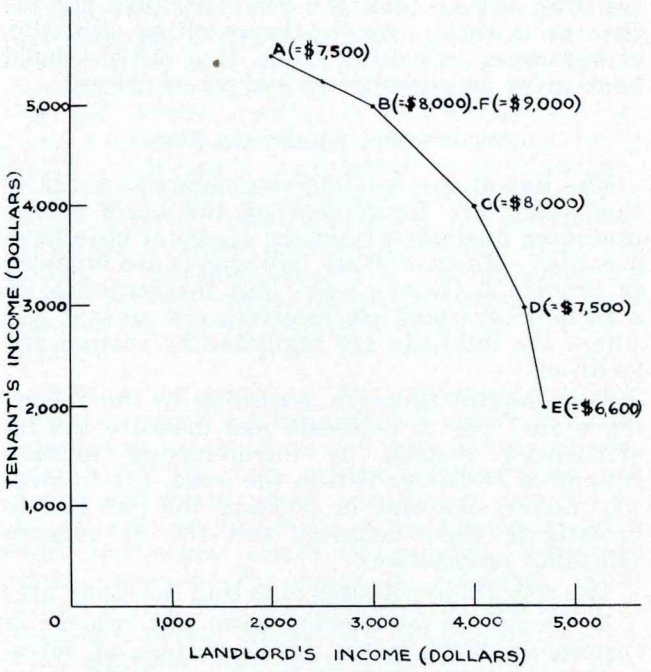

Fig. 2. Hypothetical illustration of conflicts between landlord and tenant in selecting the farm plan and the division of income.

The simplex solution of linear programming with variable capital restrictions may also be applied to obtain some knowledge about the modification in the degree of inefficiency and conflict when the quantity of capital contributed by the two parties is varied.[25] To determine the tenant's capital optima, the criterion for the selection of incoming activities is given by the ratio between tenant's net price and tenant's capital coefficient ($d_j = \frac{z_j - c_{jT}}{a_{jT}}$, where $z_j - c_{jT} < 0$, and a_{jT}, the coefficient in the tenant capital row, is positive). Analogously, the ratio between landlord's net price and landlord's capital coefficient becomes the criterion when landlord's capital optima are sought.

An empirical example of the proposed modification to the simplex solution is given in Appendix A.

ISOLATION AND MEASUREMENT OF LEASE-ENGENDERED INEFFICIENCIES INHERENT IN A "TYPICAL LEASE"

The measurement of inefficiency is performed through an *ex post* analysis of resource allocation

[23] In the empirical cases to which this procedure has been applied only a few enterprises could be introduced profitably for the landlord when tenant's optimum was attained. This considerably simplified the trial and error check.

[24] Heady, E. O., Dean, G. W. and Egbert, A. C. Analysis of alternative farm-leasing arrangements. Iowa Agr. Exp. Sta. Res. Bul. 445. 1956.

[25] See: Candler, Wilfred. A modified simplex solution for linear programming with variable capital restrictions. Jour. Farm Econ. 88:940-955. 1956.

in a typical farm situation in north-central Iowa.[26]

Isolation of inefficiency caused by *intratemporal* resource misallocation stemming from conflicts between landlords and tenants within the typical crop-share-cash lease is obtained by programming the available quantities of resources for two different types of tenure arrangements. First, linear programming is applied to a unified ownership and control (owner-operator) situation; this situation is characterized by having complete association between bearing of costs and receipt of returns and perfect unity in the decision-making.[27] The farm plan and the return associated with this situation become the norm from which deviations engendered by *intratemporal* misallocation of resources in leasing are measured. Second, a situation characterized by differences between contribution of resources and receipt of returns customary in the typical crop-share-cash lease is similarly programmed. The eventual difference in net income and farm plan between the first and second situation is due to the arrangements for intratemporal allocation of resources in the lease, since all the other variables have remained unchanged.

The *ex post* analysis based on this procedure is performed for a period of 5 years, 1951 through 1955. A graphical illustration of the *analytical procedure* is given in fig. 3. The points connected by the line "A" represent levels of returns attained by programming the resources in the case of an owner-operated firm. Line B represents the optimum positions attainable when resources are allocated according to the conditions established by the typical lease. As illustrated previously (fig. 2), however, a wide divergency may exist between the landlord's and the tenant's optimum plans, thus creating alternative net incomes attainable each year from the lease.

This analytical procedure enables the isolation in individual farms of the reduction in efficiency caused by intratemporal allocation of resources in rental contracts. The difference in net income between line "A" and line "B" is attributable to the impact of the lease on intratemporal allocation of resources. Coincidence of the points of lines "A" and "B" would indicate that a perfect leasing arrangement, as far as intratemporal efficiency is concerned, has been adopted.

Within this analytical scheme, a set of efficiency conditions may be set up. A necessary condition is that the optimum plans for landlord and tenant must be the same. Besides this necessary condition, a sufficient condition also has to be fulfilled; namely, the optimum plan for each leasing party must be the same as the one for the owner-operator. With reference to fig. 3, the necessary and sufficient conditions are both attained when a common net income and farm plan are established, regardless of the form of tenure and the decision-making structure.[28]

The *ex post* analysis composing the first stage of the empirical investigation is exclusively concerned with inefficiencies stemming from intratemporal conflicts within the lease. Abstraction from intertemporal analysis of resource allocation permits more accurate delineation of inefficiencies connected with the conditions regulating the intratemporal use of resources. Furthermore, it becomes possible to identify the relevant factors in determining the area of inefficiency and thereby to develop remedial measures. Therefore, the programming of resource use over the period under examination has been performed separately and independently for each year.

INEFFICIENCY TESTS OF ALTERNATIVE LEASING ARRANGEMENTS WITH VARIATIONS IN OPERATING CAPITAL

According to the contributions of resources within customary leasing arrangements, operating capital can be varied relatively more easily than other factors of production. Therefore, the modified simplex solution for linear programming with variable capital restrictions is applied to a set of alternative tenure arrangements. The situations considered are owner-operatorship, two types of crop-share leases and a livestock-share lease. This segment of the analysis has the purpose of determining: (1) the relationship

[26] Details on the selection of the farm, input-output coefficients, enterprises and leases are given in the section following.

[27] Owner-operatorship as a class of tenure is not necessarily assumed here as a tenure norm. It is the relationship between benefits and costs and the decision-making structure connected with owner-operatorship which are relevant to this study

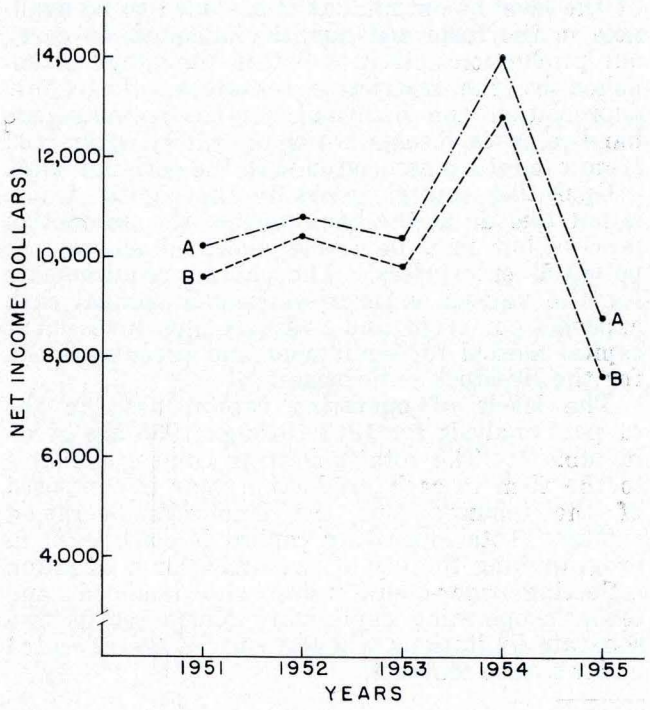

Fig. 3. Hypothetical illustration of income reduction engendered by imperfections in a lease in intratemporal allocation of resources.

[28] This analysis is carried out in terms of "absolute" efficiency in the sense that one optimum position is selected as the normative goal. It must be pointed out, however, that problems of "relative" efficiency or suboptima, in the sense of selection of the position with minimum deviation from the norm, are relevant. Within any given lease if the norm is unattainable, the identification and adoption of the suboptimum position becomes the relevant goal.

between the capital optima when landlord's and tenant's net incomes are alternatively maximized for a given lease and (2) the relative efficiency of leases compared with a normative arrangement when capital is allowed to vary.

FARM SITUATION AND LEASES USED FOR STUDY

The Farm and Its Setting

The farm selected for analysis is located in the Clarion-Webster soil association in north-central Iowa in Hamilton County. It was selected from those farms belonging to the Farm Business Association for which a detailed account of production history during the past years is available. The criterion for the selection of the farm was the fact that it is typical with respect to both quantity and quality of resources and type of rental contract.[29] The analysis is carried out for the years 1951 through 1955. Table 1 summarizes the quantities of restricting resources present in the selected farm during the period considered.

Land. The farm size is 200 acres, of which 190 are tillable. Noncultivated acres consist of farmstead, road, lots and space occupied by fences.

Buildings. The service buildings on the farm include livestock housing and grain storage facilities. Grain and hay storage facilities are adequate to handle the production from the cropland. The cattle barn consists of 1,176 square feet of building space and has the floor adapted to swine production. In addition to this possible area for hogs, there are 504 square feet of hog house available. Therefore, the total building space available for hogs is 1,680 square feet.

Labor and management. The labor supply is composed of operator labor of 260 man-hours per month from November through February and 275 man-hours per month from March through October, plus family labor equivalent to 15 man-hours per month from November through February, 60 man-hours in March, 75 man-hours per month from April through August and 25 man-hours per month in September and October. Labor supplies are grouped, as indicated in table 1, in units of 2 or 3 months each, depending on labor requirements and the time available to complete farming operations. Hence, the labor restrictions are for a certain part of the season, rather than for the individual months. This method of aggregating labor supplies supposes that the labor requirements within different time groups are relatively flexible.[30]

A constant level of management is assumed under the different tenure arrangements. In other words, to isolate the impact on resource use exclusively attributable to changes in the organization of the firm, it is assumed that the level of management does not vary when alternative tenure arrangements are compared.

Capital supply. The capital used by the firm in the production process is divided into two categories—fixed capital and operating capital. Fixed capital is composed of the investment in machinery and buildings, which is present regardless of the level of output. It is assumed to be available in the form and quantity adequate to carry out production activities within the range established by the restrictive resources. Therefore, depreciation and insurance on fixed capital are handled as fixed costs, which have to be subtracted from the return associated with the optimum plan.

Operating capital refers to the capital which is not tied up at the beginning of the production process but may be freely allocated among the potential enterprises. The capital requirements for the various enterprises include annual cash expenses for crops and livestock plus investment capital needed for equipment and breeding stock for the livestock enterprises.

The levels of operating capital used in the *ex post* analysis for 1951 through 1955 are given in table 1. The total operating capital available to the firm in each production year is composed of the tenant's plus the landlord's operating capital. Total operating capital is considered in programming the use of resources for a situation reflecting owner-operatorship, while landlord's and tenant's operating capital are considered as two separate limitations when resources are allocated under a lease contract.

[29] The quantity of resources present in the typical farm was determined from the farm data available at the Iowa Cooperative Crop and Livestock Reporting Service, Des Moines, Iowa. The characteristics of the typical lease are described in a study by Timmons, Improving farm rental arrangements in Iowa, op. cit.

TABLE 1. QUANTITIES OF SELECTED RESOURCES AVAILABLE IN THE TYPICAL FARM, HAMILTON COUNTY, 1951-55.

Item	Units	1951	1952	1953	1954	1955
Land						
Farm size	acres	200	200	200	200	200
Tillable acres	acres	190	190	190	190	190
Harvested crop	acres	168	166	160	185	168
Rotated pasture	acres	22	24	30	5	22
Operating capital						
Total	dollars	7,574	7,630	7,103	10,947	10,847
Landlord	dollars	467	462	625	534	501
Tenant	dollars	7,107	7,168	6,478	10,413	10,346
Livestock buildings						
Hog farrowing space	sq. ft.	1,680	1,680	1,680	1,680	1,680
Labor						
Monthly group A	man-hours	825	825	825	825	825
Dec.	man-hours	275	275	275	275	275
Jan.	man-hours	275	275	275	275	275
Feb.	man-hours	275	275	275	275	275
Monthly group B	man-hours	685	685	685	685	685
March	man-hours	335	335	335	335	335
April	man-hours	350	350	350	350	350
Monthly group C	man-hours	700	700	700	700	700
May	man-hours	350	350	350	350	350
June	man-hours	350	350	350	350	350
Monthly group D	man-hours	700	700	700	700	700
July	man-hours	350	350	350	350	350
Aug.	man-hours	350	350	350	350	350
Monthly group E	man-hours	875	875	875	875	875
Sept.	man-hours	300	300	300	300	300
Oct.	man-hours	300	300	300	300	300
Nov.	man-hours	275	275	275	275	275
Machinery available		— adequate —				
Storage facilities		— adequate —				

[30] Extension personnel consider this procedure to be a realistic method for handling labor restrictions in their effect on farm plans.

In the second phase of the empirical analysis, operating capital is considered to be a continuous variable, adopting the modification to the linear programming technique developed recently.[31]

Enterprises Used in Programming

A previous study has determined the optimum combinations and sizes of crop and livestock enterprises for a typical farm in the soil area considered.[32] Hence, since the purpose of the present study is to evaluate the effect of leasing arrangements on optimum farm planning, only the range of crop and livestock enterprises indicated in the previous study to be profitable and present in the farm during the period considered are included.

CROP ENTERPRISES

The previous study indicates that only three crop rotations ordinarily enter into the most profitable farm plans in this soil area.[33] Thus, the rotations included as possibilities for this study are corn-corn-soybeans (CCSb), corn-soybeans-corn-oats-meadow (CSbCOM) and corn-corn-oats-meadow (CCOM). The meadow in the last two rotations is an alfalfa-red clover-timothy mixture. Four fertilization levels are considered for each rotation (table 2). Hereafter, fertilization levels for a given rotation are noted by a subscript following the abbreviated form of the rotation (for example, $CCSb_1$, $CCOM_3$, $CSbCOM_4$). Hence, there are 12 crop alternatives. Crop yields for the three rotations at each fertilization level are shown in table 3.

The various levels of fertilization are included to determine eventual conflicts in selecting rotations and fertilization levels between (1) alternative tenure arrangements given certain capital restrictions and (2) landlord and tenant within a given lease and for variable quantities of operating capital.

The customary assumption of single-valued expectation with respect to the input-output relationship within each process or enterprise is also adopted in this study. Besides, the expectation is assumed to remain unchanged in all the situations considered, regardless of the tenure arrangement.

Since the emphasis of this study is on leasing imperfections leading to inefficiencies in intratemporal allocation of resources, the input-output relationship in a given rotation is assumed to be unaffected by intertemporal relationships within the lease.

Finally, out of the various possible ways of producing a given rotation, especially in what concerns substitutability between machinery and labor, only one appropriate set of techniques is chosen. Descriptions of cost items of each rotation and its labor requirements are given in Appendix B.

TABLE 2. POUNDS PER ACRE OF AVAILABLE NUTRIENTS SUPPLIED BY COMMERCIAL FERTILIZER FOR DIFFERENT ROTATIONS AND FERTILIZATION LEVEES FOR CLARION-WEBSTER SOILS.[a]

	First			Second			Third			Fourth		
	N	P	K	N	P	K	N	P	K	N	P	K
Corn	0	0	0	15	20	10	45	50	20	75	60	20
Corn	0	0	0	30	80	10	50	25	20	70	30	20
Soybeans	0	0	0	0	0	0	0	0	0	0	20	0
Corn	0	0	0	5	20	10	10	50	20	40	60	20
Soybeans	0	0	0	0	0	0	0	0	0	0	10	0
Corn	0	0	0	15	20	10	45	50	20	75	60	20
Oats	0	0	0	10	20	0	15	20	0	20	10	40
Meadow	0	0	0	0	0	0	0	0	0	0	0	0
Corn	0	0	0	5	10	10	10	50	20	40	60	20
Corn	0	0	0	30	20	10	60	25	20	80	30	20
Oats	0	0	0	10	20	0	15	20	0	20	35	30
Meadow	0	0	0	0	0	0	0	0	0	0	0	0

[a] The fertilization rates in this table were furnished by the Department of Agronomy, Iowa State University, Ames, Iowa.

TABLE 3. ESTIMATED CROP YIELDS PER ACRE FOR VARIOUS LEVELS OF FERTILIZATION FOR CLARION-WEBSTER SOILS.[a]

Rotations	Unit	Fertilizer level 1	2	3	4
Corn	bushels	40	50	57	59
Corn	bushels	32	42	49	51
Soybeans	bushels	19	21	23	24
Corn	bushels	58	65	67	68
Soybeans	bushels	20	22	24	25
Corn	bushels	50	56	59	61
Oats	bushels	32	38	41	43
Meadow	tons	1.9	2.2	2.4	2.5
Corn	bushels	58	68	67	68
Corn	bushels	48	54	57	59
Oats	bushels	32	38	41	43
Meadow	tons	1.9	2.2	2.4	2.5

[a] The estimated yields were furnished by the Department of Agronomy, Iowa State University, Ames. They are based on the fertilization levels given in table 2 and on the following assumptions: (1) Rotations and treatments have been in effect since at least 1925-30. (2) Yields are a 10-year average yield estimate for the period 1951-60, assuming normal weather conditions. (3) Soil tests typically low in phosphorus, medium in potassium and medium in nitrogen.

LIVESTOCK ENTERPRISES

Two livestock enterprises are considered in planning—the most profitable hog system and

[31] See: Candler, **op. cit.**

[32] See: Mackie, A. B., Heady, E. O. and Howell, H. B. Optimum farm plans for beginning tenant farmers on the Clarion-Webster soils (An application of linear programming). Iowa Agr. Exp. Sta. Res. Bul. 449. 1957.

[33] **Ibid.**

cattle feeding program for average conditions.[34] Dairy and poultry enterprises are not included since they were found to enter the optimum program infrequently and with only minor changes in income.

Spring pigs: This hog system includes pigs farrowed in March, fed out on pasture and marketed in November at 270 pounds. Litters average 7.8 pigs weaned per sow, but one gilt per litter is saved for farrowing the following year. Pork sold per litter, including a 400-pound sow, averages 2,136 pounds. The death loss is estimated at 5 percent after weaning.

Pasture-fed steer calves: The calves are purchased in October and sold the following September. They are wintered in drylot on roughage and a limited amount of grain. Feed is increased after the calves are put on pasture, from May to July, and full feeding is continued in drylot until the calves are finished. Initial weight is 430 pounds, and market weight is 1,000 pounds. Input-output data for these two livestock enterprises are given in Appendix C.

Prices Used in Programming

An expectation model based on the average prices of the previous years has been assumed to have been adopted by the entrepreneur for each year of the period considered. Expectations about crop prices have been obtained by considering the average of the prices occurring in the previous 10 years, while a 5-year average is assumed for livestock enterprises.

Returns Associated With Optimum Farm Plans

Net returns are maximized in the optimum farm plans obtained through linear programming. The net return coming from each activity, or "net price," is obtained by subtracting from the gross revenue the variable cost needed to produce one unit of the activity. The total net return, that is the sum of net revenues associated with the enterprises composing the plan is, therefore, gross of fixed costs. Since fixed costs do not vary in the situations considered, the returns given for farm plans are comparable and may be used to show the difference in income between plans.

Net taxable return for each farm plan is obtainable by subtracting fixed cost from net return. Tenant's profit could thus be computed by subtracting his fixed costs (mainly depreciation and insurance on machinery) from his net return. Similarly landlord's profit is equal to his return minus his quota of fixed costs (depreciation and insurance on buildings and property taxes).

Types of Leases

Even though the central part of the empirical analysis concerns the typical crop-share-cash lease and its impact on efficiency, alternative leasing arrangements also are analyzed.

The leases considered in this study are outlined in table 4. The first lease is the typical arrangement in north-central Iowa, as pointed out in a study by Timmons.[35] The feature which varies most frequently in this lease is the amount of cash rent paid for hay land. In practice, the cash rent varies from a minimum of $6 to a maximum of about $25 per acre. To study the effect on efficiency of the change in magnitude of this type of intrafirm cost transfer, leases 2, 3 and 4 are considered. They are identical to lease 1, except that the cash rent is varied from $10 to $16 and to $29 per acre. In the last lease, the cash rent of $29 per acre is equivalent to the marginal return to land as derived from the optimum farm plan for the owner-operator. In a fifth lease alternative, the incentive conditions which encourage achievement of efficient intratemporal allocation of resources have been introduced in the crop-share lease.[36] Finally, a typical livestock-share lease is analyzed.

TABLE 4. SHARING OF RECEIPTS AND EXPENDITURES IN LEASING ARRANGEMENTS CONSIDERED IN THE STUDY.

Items	Receipts and expenses	
	Tenant's percentage	Landlord's percentage
Lease 1. Typical crop-share lease		
Corn	50	50
Soybeans	60	40
Oats	60	40
Fertilizer and seed expense[a]	50	50
Operating expenses	100	0
Real estate expenses	0	100
Labor	100	0
Cattle and hogs (receipts and expenses)	100	0
Cash rent of $6 per acre of hay land		
Lease 2. Same as Lease 1 except $10 per acre cash rent for hay land		
Lease 3. Same as Lease 1 except $16 per acre cash rent for hay land		
Lease 4. Same as Lease 1 except $29 per acre cash rent for hay land		
Lease 5. Modified crop-share lease		
All grain crops	50	50
Value of hay and pasture[b]	50	50
Fertilizer and seed expense	50	50
Operating expense	50	50
Real estate expense	0	100
Labor	100	0
Cattle and hogs (receipts and expense)	100	0
Lease 6. Livestock-share lease		
Livestock receipts	50	50
Investment in livestock and livestock equipment	50	50
Livestock expenses	50	50
Crop receipts	50	50
Fertilizer and seed	50	50
Operating expenses	50	50
Real estate expenses	0	100
Labor	100	0

[a] Landlord furnishes all the grass and legume seed, while tenant furnishes all of the seed oats.
[b] It is assumed that the tenant purchases the landlord's share of the hay and pasture at the market price for hay.

The analysis of these leases permits the investigation of the comparative effect on efficiency given a common resource situation and price expectations and the eventual changes in the level of efficiency and conflict between parties within a lease when operating capital is introduced as a continuous variable.

THE RESULTS AND THEIR INTERPRETATION

Farm Program Under Unified and Divided Resource Control

It is necessary to define and measure the

[34] Ibid.

[35] See: Timmons, Improving farm rental arrangements in Iowa, p. 416.

[36] See: Hurlburt, op. cit., pp. 86-90.

problem before formulating conclusions and possible remedies. A preliminary delimitation of the impact of customary leasing provisions on resource efficiency is attained through an *ex post* analysis comparing the farm programs attainable under owner-operatorship with those associated with a typical crop-share-cash lease.

For each individual year—1951 through 1955—linear programming has been applied to the bundle of resources available for production to determine the optimum farm programs under two tenure situations—unified resource control and ownership and typical crop-share-cash lease. The first situation is characterized by a complete association between benefits and costs and by unity in the decision-making process. The second situation usually represents the dissociation between benefits and costs and the schism in decision-making. The linear programming technique applied to the second situation, with the modification described in Appendix A, leads eventually to two alternative programs—landlord's and tenant's.

The programs and net income associated with these situations are presented in table 5. The levels of net income are shown in fig. 4.

The interpretation of the results of this analysis leads to a series of considerations about the relationships between leasing provisions and resource efficiency:

1. A typical crop-share lease is a source of inefficiency in the intratemporal allocation of resources at the firm level. This is indicated by the discrepancy in total returns between the optimum program under unified ownership and those of the tenant and landlord. The discrepancy between levels of returns exists in every year of the period considered. The data in table 5 thus give empirical support to the hypothesis that inefficiency is engendered by the typical rental contract. It is relevant to note that the magnitude of the income reduction is not constant, but varies from year to year. The income associated with the lease, expressed as a percentage of the owner-operator income, varies from a maximum of 92.5 percent in 1953 to a minimum of 77 percent in 1955. In the analytical model used, the factors which have been allowed to vary during the period analyzed are: (a) price expectations, (b) amounts of landlord's and tenant's operating capital and (c) capital coefficients of the activities. The variation throughout the period of income reduction caused by the crop-share-cash lease indicates that conflicts created by imper-

TABLE 5. OPTIMUM FARM PLANS AND ASSOCIATED RETURNS UNDER OWNER-OPERATORSHIP AND A TYPICAL CROP-SHARE-CASH LEASE, 1951-55.

Year	Tenure situation	Total returns (dollars)	Landlord's returns (dollars)	Tenant's returns (dollars)	Rotation (acres)	Hogs (litters)	Beef calves (head)	Limiting resources
1951	Owner-operator's optimum plan	6,965	.....	.....	168 $CCSb_3$	19	0	Land Capital
	Landlord's optimum plan	5,978	3,006	2,972	92 $CCOM_1$ 76 $CCSb_2$	21	0	Land Landlord's capital Corn
	Tenant's optimum plan	5,871	2,868	3,003	52 $CCOM_1$ 115 $CSbCOM_2$	20	0	Land Landlord's capital Corn
1952	Owner-operator's optimum plan	7,611	.....	.....	165 $CCSb_3$	19	0	Land Capital
	Landlord's optimum plan	6,307	3,304	3,003	22 $CCOM_1$ 78 $CCSb_2$	21	0	Land Landlord's capital Corn
	Tenant's optimum plan	6,307	3,304	3,003	22 $CCOM_1$ 78 $CCSb_2$	21	0	Land Landlord's capital Corn
1953	Owner-operator's optimum plan	7,578	.....	.....	160 $CCSb_3$	17	0	Land Capital
	Landlord's optimum plan	7,013	3,681	3,302	12 $CCOM_1$ 147 $CCSb_2$	19	0	Land Landlord's capital Tenant's capital
	Tenant's optimum plan	6,959	3,583	3,376	55 $CSbCOM_2$ 105 $CCSb_2$	20	0	Land Landlord's capital Tenant's capital Corn
1954	Owner-operator's optimum plan	9,762	.....	.....	93 $CSbCOM_3$ 92 $CCSb_3$	23	22	Land Capital Hog housing Hay
	Landlord's optimum plan	7,543	4,072	3,477	88 $CCOM_1$	0	33	Land Landlord's capital Hay
	Tenant's optimum plan	8,665	3,857	4,808	85 $CSbCOM_2$ 40 $CCOM_2$ 52 $CCOM_1$ 6 $CCSb_2$	0	52	Land Landlord's capital Cattle housing Hay Corn
1955	Owner-operator's optimum plan	10,452	.....	.....	10 $CSbCOM_3$ 159 $CCSb_3$	24	16	Land Capital Hog housing Hay
	Landlord's optimum plan	8,013	3,787	4,226	81 $CCSb_2$ 88 $CCOM_1$	1	49	Land Landlord's capital Hay Corn
	Tenant's optimum plan	8,009	3,761	4,248	80 $CCOM_1$ 16 $CCOM_2$ 72 $CCSb_2$	0	54	Land Landlord's capital Hay Corn

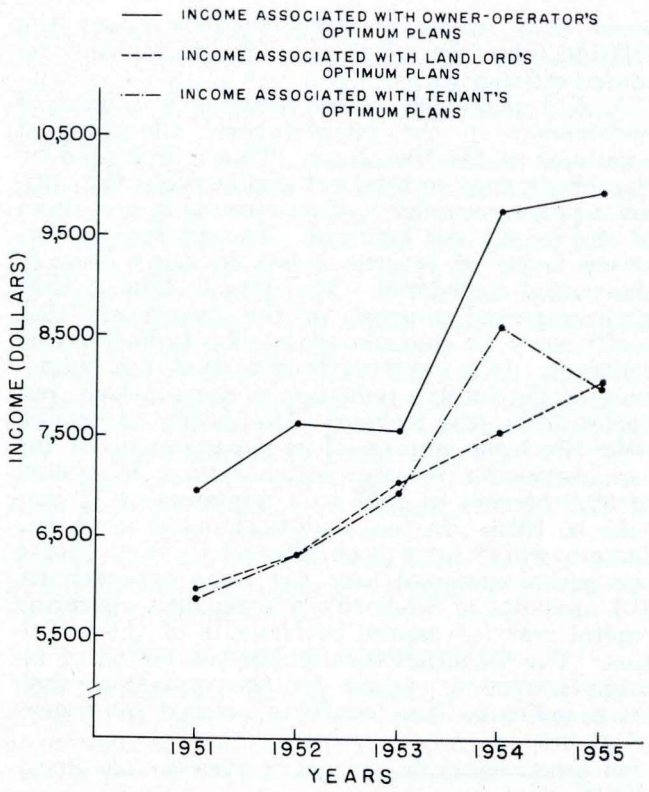

Fig. 4. Income associated with owner-operator's, landlord's and tenant's optimum plans and actual farm plans, 1951-55.

fections in the rental contract are not independent of these factors. This phase of the analysis thus points out the necessity of investigating the relationship between each of these factors and the presence of leasing-engendered inefficiency.

2. The results summarized in table 5 indicate the presence of important conflict between the landlord and the tenant. The necessary conditions for efficiency which call for identity between landlord's and tenant's farm plans are fulfilled only in 1952. The divergency between the two plans, which can be measured in terms of the change of the income of each party in going from one optimum plan to the other, varies from year to year. This indicates that the conflict between the two parties of the lease is significantly affected by changes in the amounts of operating capital, changes in costs of enterprises expressed as changes in the capital coefficients and changes in the prices of the products expressed as changes in the shares of the net price of each activity.[37] The impact of these factors on the conflict between landlord's and tenant's production plans needs to be investigated if a greater insight into the mechanics of conflicts engendered by leasing is desired.

Additional understanding of resource allocation as influenced by customary rental provisions is obtained by comparing the farm programs of the owner-operator, the landlord and the tenant as given in table 5. The optimum programs under unified ownership remain relatively unchanged during the period. Through 1953, with the low price expectation for beef cattle, hogs are the only livestock entering the plan, and operating capital receives greater return when used in fertilizing the CCSb rotation. In 1954 and 1955, with a higher expected price for beef cattle, it becomes convenient to include a rotation which increases the hay supply, such as CSbCOM. The increase in the amount of operating capital during the same years encourages a medium level of fertilization in both rotations entering the plan. Land and capital are the limiting resources throughout the period, and, obviously, the change in the production plan is a function of the combination of enterprises which would maximize the returns to the limiting factors. Hog housing and hay become limitational when the expected price of cattle increases and there is an increment in the availability of operating capital.

The comparison between landlord's and tenant's optimum plans demonstrates how the intratemporal dissociation of costs and benefits resolves into conflict about the types and the intensities of enterprises to introduce into the plan. With limited capital (around $500 in each of the years considered) the landlord is unable, even under his limited share of cost, to contribute the amount of operating capital to achieve the level of fertilization which appears to be profitable for the owner-operator. Therefore, he finds it most profitable to select the rotation and the fertilizer level which would give him the highest return per dollar invested. Accordingly, the landlord's optimum programs include a portion of the tillable area devoted to a CCOM rotation without fertilization and the remaining area to CCSb with light fertilization. Land and landlord's capital are the resources limiting the intensity of production in the landlord's optimum program. It is interesting to note that landlord's capital is restrictive to the extent of letting a portion of tenant's capital lay idle. This, of course, results from the rigidity of relationship between coefficients and amounts of available resources implied in the linear programming solution. In practice, it is likely that the tenant would use his unused capital to intensify the level of production to the point at which the proportion that he receives of the marginal return to capital would equal the cost.

The tenant's optimum program, instead of the CCSb rotation selected by the landlord, includes a meadow rotation, CSbCOM. This is explained by the low cash rent ($6 per acre) charged on meadow and by the fact that landlord's capital used in producing crops adds a disproportionate share to the tenant's return in relation to tenant's contribution. Also, in the tenant's optimum program, landlord's capital is a severely restricting factor which makes tenant's capital remain idle. Proportional relationships between landlord's and tenant's capital seem to be an important factor in creating intratemporal conflicts

[37] Logically, landlord-tenant conflict might be influenced by other factors, such as contribution of factors other than operating capital and divergent expectation of input-output coefficients. In the analytical model employed in this study, however, these factors have been kept constant.

between the two parties of the lease and between tenure arrangements.

MARGINAL RETURNS TO RESTRICTIVE RESOURCES

The price of resources is the allocative criterion not only in formal economic theory but also in linear programming. The principle of "opportunity cost" lies at the root of linear programming, which is essentially based on an enumeration of the opportunities available for the use of a given set of resources. Even though linear programming seems to arrive at an optimum allocation without recourse to the concept of price, a problem of pricing or valuation is implicit in the linear programming solution.

This problem of ascribing values to the services of several resources separately is of particular significance for the traditional firm whenever a great enough time horizon of decision permits adjustments in the holdings of durable capital equipment. The question of which types of resources should be acquired and which should be disposed of can be answered only by comparing the value of the contribution to net revenue of each resource with its acquisition cost or disposal price. In the firm in which multiple interests are present and the bundle of resources available for production is obtained through the contribution of two parties, the problem of valuation of resources is particularly important. In fact, besides the determination of the quantity of each resource, the quota contributed by each party is of crucial significance. The assignment of value to the quantities of resources contributed by each party is a necessary step in the determination of maladjustments in resource contributions which necessarily result in a decrease of efficiency.

A linear programming solution imputes prices to the restrictive resources. In the simplex solution, the optimum program has been determined when all the elements of the "marginal revenue" row have become positive or zero. The entries in the "marginal revenue" row which are associated with resource disposal activities are the imputed prices per unit of the potential restricting resources. The factors which are restrictive in the final plan possess a marginal return greater than zero, while the idle sectors of factors are free goods, and their price equals zero. These values, when multiplied by the quantities of factors employed, account for the total return resulting from the optimum plan.

In the modified simplex solution used in this study, the net price row is divided into two rows, the landlord's and the tenant's.[38] When the optimum plan is reached for either the landlord or the tenant, the solution imputes the contribution of each resource to the net income of the two parties. It is thus possible to determine, in comparing landlord's and tenant's optimum plan with that of the owner-operator, the changes in marginal returns to restricting resources induced by leasing. In addition, comparison between landlord's and tenant's optimum programs and related marginal returns from factors to each party provides a useful insight into the structural distribution of returns to landlord and tenant as a function of the lease and of the proportion of resource contribution.

Table 6 presents the marginal returns to restrictive resources associated with optimum programs with unified ownership during the period under analysis. The marginal returns to restrictive factors from both landlord's and tenant's optimum plans during the same years are presented in table 7.

TABLE 6. MARGINAL RETURNS TO RESTRICTIVE RESOURCES IN THE OWNER-OPERATOR'S OPTIMUM PLANS, 1951-55, DOLLARS.[a]

Items	1951	1952	1953	1954	1955
Marginal return to land	13.36	20.83	24.51	29.88	28.66
Marginal return to capital	0.62	0.54	0.51	0.37	0.36
Marginal return to hog housing	0.00	0.00	0.00	0.04	0.77
Marginal return to hay	0.00	0.00	0.00	11.43	11.08

[a] The quantities of disposal resources are given in table 8. They have not been included in the table since in the programming solution a marginal return equal to zero is imputed to them.

A comparison between the returns to factors in the two tenure situations shows a more efficient utilization of the limiting resources in the owner-operator plan. The complete association between benefits and costs allows a full utilization of the supply of operating capital. Land and capital are the restricting resources throughout the period. In 1954 and 1955, the larger amount of capital available (see table 1) reduces the marginal returns to capital with respect to the previous years, but the return to land, which can be viewed as the fixed factor to which capital is applied, is correspondingly increased.

A comparison of marginal returns to factors under landlord's and tenant's optimum plans illustrates the distortion induced by the pattern of resource contribution and sharing of returns by the two parties in a typical crop-share-cash lease. Landlord's capital is highly restrictive, its marginal return being as high as $2.44 (in 1952). Because of the limitation in landlord's capital, which is a necessary complement in all the crop enterprises, tenant's capital lies idle and has a marginal return equal to zero. The conflicts in resource use between landlord and tenant thus chiefly concern the allocation of landlord's capital as suggested by the change in marginal return to this resource when reallocated from landlord's to tenant's optimum program.

The conflicts over the allocation of landlord's capital affect the return to land, which in every year is lower than the return received by land under owner-operatorship. The allocation of land, also a restricting resource during the whole period,

[38] For an illustration of the modified simplex solution see Appendix A.

TABLE 7. MARGINAL RETURNS TO RESTRICTIVE RESOURCES IN LANDLORD'S AND TENANT'S OPTIMUM PLANS IN A TYPICAL CROP-SHARE-CASH LEASE, 1951-55, DOLLARS.[a]

Items	1951	1952	1953	1954	1955
Landlord's optimum plan					
Marginal return to landlord from land	14.81	15.32	16.11	16.83	16.71
Marginal return to tenant from land	12.21	11.28	-4.10	23.36	19.21
Marginal return to landlord from landlord's capital	1.11	1 64	1.76	1.79	1.95
Marginal return to tenant from landlord's capital	1.97	2.44	1.50	-3.93	1.47
Marginal return to landlord from tenant's capital	0.00	0.00	0.00	0.00	0.00
Marginal return to tenant from tenant's capital	0.00	0.00	0.49	0.00	0.00
Marginal return to landlord from hay	0.00	0 00	0.00	0.00	0.00
Marginal return to tenant from hay	0.00	0.00	0.00	34.85	6.44
Marginal return to landlord from corn	0.00	0 00	0.00	0.00	0.00
Marginal return to tenant from corn	0.77	0.67	0.00	0.00	0.89
Tenant's optimum plan					
Marginal return to landlord from land	15.80	15.82	-1.18	16.90	16.35
Marginal return to tenant from land	11.99	11.28	1.56	14.76	17.85
Marginal return to landlord from landlord's capital	0.45	1.64	-1.11	0.80	0.94
Marginal return to tenant from landlord's capital	2.11	2.44	0.43	2.03	2.31
Marginal return to landlord from tenant's capital	0.00	0.00	0.72	0.00	0.00
Marginal return to tenant from tenant's capital	0.00	0.00	0.46	0.00	0.00
Marginal return to landlord from corn	0.00	0.00	-0.93	-0.24	-0.16
Marginal return to tenant from corn	0.77	0.87	0.04	0.67	1.02
Marginal return to landlord from hay	0.00	0.00	0.00	5.00	5.13
Marginal return to tenant from hay	0.00	0.00	0.00	3.46	2.21

[a] The quantities of disposal resources are given in table 8. They have not been included in the table since in the programming solution a marginal return equal to zero is imputed to them.

is analogously an element of conflict between the two parties. The degree of conflict over the allocation of land among potential enterprises might become so great that one party would be better off to have less land if it were to be allocated to maximize the profit of the other. In 1953, for example, the allocation of land to maximize landlord's profit is so suboptimum for the tenant that planting the last 8 acres actually reduces the total income of the tenant. The inverse occurs if the tenant's optimum program is established. Between the two plans there may be intermediate plans in which returns from land to both landlord and tenant are positive and in which the total return is greater than that associated with the optimum program for either party (see table 9).

The quantities of resources which have remained partially or totally unutilized in the alternative optimum programs are presented in table 8.[39] This table is, in a sense, a counterpart of the table containing the marginal returns. From an analysis of both tables, useful suggestions can be derived in connection with the size of the categories of resources. Given the technique of producing the enterprises which has been assumed in this study—that is, given the assumed substitution between labor and machinery —the amount of labor available appears to be out of proportion with the other resources, particularly land and operating capital. In fact, in the plans corresponding to the two alternative tenure situations, all the labor groups in every year present disposal quantities. This indicates that the level of output at which land and capital become limiting is too low to allow full utilization of the labor supply within the firm. An interfirm reallocation of resources thus could lead to greater efficiency. Therefore, the landlord would not become worse off in associating with a tenant owning the same amount of capital and a smaller amount of labor.[40] The present tenant, on the other hand, would gain by associating with a land-

[39] Disposal resources refer only to the amount of resources left unutilized by the enterprises considered in programming. This does not exclude the possibility of increasing these resources in activities not considered here. For example, labor is likely to be employed in activities such as fence repairing, land improvements, maintenance of buildings and machinery.

[40] The amount of labor needed for the optimum plans may be obtained by subtracting the disposal quantity of labor in each group (table 9) from the quantity initially available (table 1).

TABLE 8. COMPARISON BETWEEN QUANTITIES OF DISPOSAL RESOURCES ASSOCIATED WITH OWNER-OPERATOR'S, LANDLORD'S AND TENANT'S OPTIMUM PROGRAMS, 1951-55.

Year	Optimum program	Disposal resources: Tenant capital (dollars)	Hog housing (sq. ft.)	Labor (man-hours) A	B	C	D	E	Hay (tons)	Corn (bus.)
1951	Owner-operator	0	369	697	410	202	507	188	24	4,040
	Landlord	897	180	690	391	217	355	286	65	0
	Tenant	1,403	267	648	398	330	365	449	100	0
1952	Owner-operator	0	325	695	407	205	506	191	26	3,886
	Landlord	1,137	197	692	394	222	362	291	67	0
	Tenant	1,137	197	692	394	222	362	291	67	0
1953	Owner-operator	0	514	709	433	230	521	229	44	3,994
	Landlord	0	308	696	410	224	488	228	48	0
	Tenant	0	262	671	403	273	482	300	64	0
1954	Owner-operator	0	0	621	330	118	399	121	0	2,316
	Landlord	3,152	1,680	680	465	81	269	259	0	0
	Tenant	143	1,680	562	394	39	98	327	0	0
1955	Owner-operator	0	0	619	328	120	408	121	0	2,546
	Landlord	563	1,567	621	421	37	199	247	0	0
	Tenant	250	1,680	614	421	21	166	255	0	0

TABLE 9. LANDLORD'S, TENANT'S AND TOTAL INCOME ASSOCIATED WITH ALTERNATIVE FARM PROGRAMS BETWEEN TENANT'S AND LANDLORD'S OPTIMUM PROGRAM, 1951-55, IN DOLLARS.

	Tenant's optimum program	First intermediate program	Second intermediate program	Third intermediate program	Fourth intermediate program	Landlord's optimum program	Change from tenant's to landlord's program
1951							
Landlord's income	2,869	.....	.....	.....	.....	3,007	138
Tenant's income	3,003	.....	.....	.....	.....	2,972	-31
Total	5,872	.....	.....	.....	.....	5,979	107
1952							
Landlord's income	3,305	.....	.....	.....	.....	3,305	0
Tenant's income	3,304	.....	.....	.....	.....	3,304	0
Total	6,609	.....	.....	.....	.....	6,609	0
1953							
Landlord's income	3,583	3,599	3,657	.....	.....	3,681	98
Tenant's income	3,376	3,375	3,362	.....	.....	3,332	-44
Total	6,959	6,974	7,019	.....	.....	7,013	54
1954							
Landlord's income	3,857	3,876	3,892	3,971	4,071	4,072	215
Tenant's income	4,808	4,794	4,759	4,487	4,018	3,477	-1,331
Total	8,665	8,670	8,651	8,458	8,087	7,549	-1,116
1955							
Landlord's income	3,761	.....	.....	.....	.....	3,767	26
Tenant's income	4,248	.....	.....	.....	.....	4,226	-22
Total	8,009	.....	.....	.....	.....	8,013	4

lord provided with a larger amount of land and capital.[41]

CONFLICTS BETWEEN OPTIMUM PROGRAMS OF LANDLORD AND TENANT

Necessary and sufficient conditions for optimum resource allocation within a rented farm have been expressed previously. It has been shown that in the typical crop-share lease applied to the selected quantities of resources and input-output relationships, the sufficient condition (identity of rented farm plan with owner-operated farm plan) was not fulfilled during the period under analysis. To complete the *ex post* analysis of resource allocation in a typical rented farm, it is relevant to investigate the deviations from the necessary condition for efficiency (identity between landlord's and tenant's programs).

The net incomes associated with landlord's, tenant's and intermediate farm plans are summarized in table 9. Intermediate farm plans are those corresponding to iterations in the simplex solution between the two optima and which constitute the upper boundary of the feasible combinations of enterprises in the landlord-tenant income plan.[42]

The data are graphed in fig. 5. As shown in the graphical presentation of the data, landlord-tenant conflicts on intratemporal allocation of resources may actually fit into three general cases: (1) identity of plans of the two parties (as in 1952), (2) two alternative positions only,

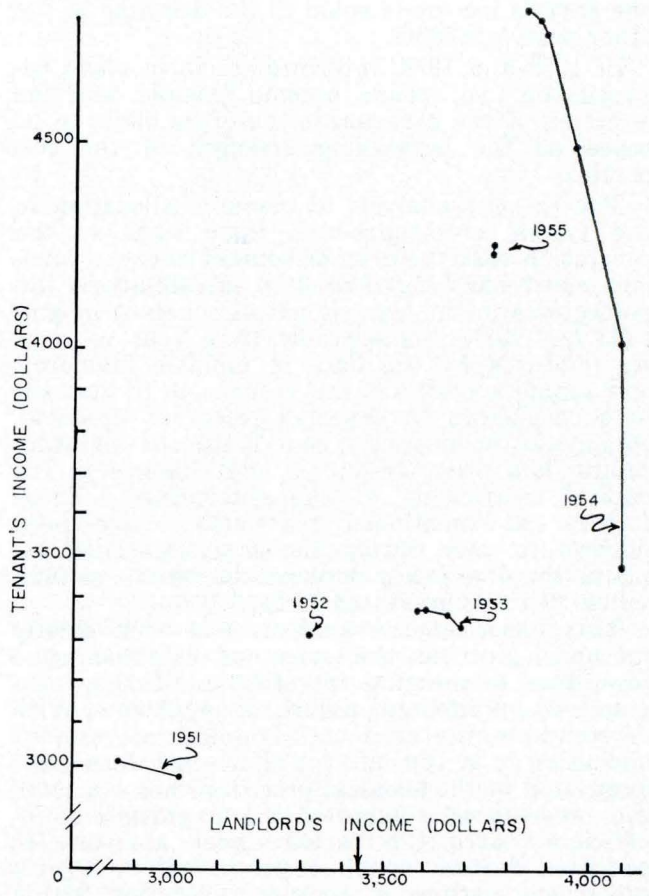

Fig. 5. Income possibility curves for landlord and tenant in a typical crop-share-cash lease, 1951-55.

[41] Although the problem of interfirm resource allocation is beyond the scope of this study, it is relevant to point out that the study of resource contribution within a lease could lead to interesting suggestions pertinent to interindustry allocation of resources.

[42] See Appendix A for the procedure used in selecting the intermediate plans.

landlord's and tenant's optima (as in 1951 and 1955) and (3) the two optima separated by a series of intermediate plans, which generate an income possibility curve (as in 1953 and 1954).

For 1952, the adoption of a farm plan is not a source of conflict between landlord and tenant since a common plan maximizes the return of both parties (see table 9 and fig. 5). This, however, does not indicate that an efficient allocation of resources has been achieved, since coincidence between total return under unified ownership and rented situations is not guaranteed. In effect there is a sizable gap between owner-operator and rented situations for 1952 (see table 5 and fig. 4).

The conflict between two alternative optimum programs (as in 1951 and 1955) could be solved in most instances through compensation. This could be the case when the movement from one optimum to the other implies an increase in total net income large enough to compensate the party whose plan is being abandoned, so as not to leave him worse off, and at the same time to increase the net income of the party whose plan is being adopted. In both years, the increase in total net income which accompanies the adoption of landlord's optimum program is large enough to permit compensation of the tenant. The conflict is less easily reconciled, however, when the increase in one party's income is equal to the decrease in the other party's income.

In 1953 and 1954, intermediate farm plans between the two optima become feasible, and the selection of the program is therefore likely to be based on the bargaining strength of the two parties.

The *ex post* analysis of resource allocation in the typical crop-share-cash lease leads to the conclusion that the area of conflict between landlord and tenant engendered by intratemporal imperfections in the lease is not of constant magnitude but varies considerably from year to year. As indicated by the data in table 9, landlord's and tenant's positions are responsive to changes in such factors as expected prices of products, changes in the amount of contribution of operating capital and other resources and changes in the capital coefficients of the enterprises. These factors, as mentioned previously, have been allowed to vary during the analysis, which explains the divergency between the income of individual years as presented in fig. 5.

This phase of the analysis has been chiefly methodological in the sense of establishing a procedure to measure intrafirm inefficiency engendered by different tenure arrangements. With reference to the area of intratemporal resource allocation in a typical crop-share-cash lease, the suggested methodological procedure has indicated the presence and delimited the magnitude of inefficiency over the period under analysis. In addition, factors which seem to affect significantly the pattern of resource allocation within the lease have been indicated. An analysis of a more specific and diagnostic nature, however, which would allow only one factor to vary at the time, is necessary to determine more precisely the individual impact of these factors on efficiency of resource use and distribution of income.

Alternative Levels of Supplementary Cash Rent

Variations in the typical crop-share lease considered previously are commonly introduced by changing the amount of cash rent paid per acre on meadow and permanent pasture. If it appears that a higher share on grain crops may be in order, the cash rent for hay or pasture or buildings can be increased instead. But, as suggested in the theoretical analysis, cash rent represents an intrafirm "bookkeeping" which distorts the cost structure of some enterprises within the farm and becomes a cause of interenterprise cost transfer and, eventually, of inefficiency.

The analysis has been performed by programming, under alternative levels of cash rent, the bundle of resources available for production in the typical farm in 1955 with price expectations and cost coefficients of that year. The different cash rent was the only varied element between the programmed situations. As indicated earlier, four levels of cash rents were considered: \$6, \$10, \$16 and \$29 per acre. The first amount corresponds to the rent paid in the situation previously analyzed for the years 1951-55; the second and the third are levels of cash rent commonly paid in north-central Iowa, the last is equal to the marginal return to land associated with the owner-operator's optimum plan for the year under analysis.

The results of the programmed solutions are summarized in table 10 and presented graphically in fig. 6. Three main effects appear to be connected with the increase in the cash rent on hay: (1) proportional reallocation of total returns in favor of the landlord, (2) decrease in efficiency expressed as a progressive decrease in total return and (3) increase in conflicts between the landlord and the tenant on the selection of the farm plan, indicated by the increase of intermediate programs between the two optima when the cash rent is progressively increased.

When the cash rent is \$6 per acre, the conflict between the landlord and tenant is a minor one, concerning the levels of the rotations composing the plan. Given the low level of cash rent, the tenant prefers to allocate a larger portion of the tillable area to a meadow rotation than the proportion which is optimum for the landlord. The landlord prefers a more intensive application of the corn-corn-soybeans rotation. The landlord's plan appears to be slightly more profitable than the tenant's plan.

When the cash rent is raised to \$10 per acre, the main impact, particularly between landlord's and tenant's optimum plan, is of a reduction in efficiency rather than a redistribution of income. The tenant's optimum program is, in total, more advantageous, and compensation to the landlord could be easily applied.

When the cash rent is raised to \$16 and \$29

TABLE 10. FARM PROGRAMS AND ASSOCIATED INCOME FOR A TYPICAL CROP-SHARE LEASE IN THE DIFFERENT LEVELS OF CASH RENT ON HAY, 1955.

	Total net income (dollars)	Landlord's net income (dollars)	Tenant's net income (dollars)	Rotations[a] (acres)	Hogs (litters)	Calves (number)	Limiting resources
Cash rent on hay $6							
Tenant's optimum program	8,009	3,761	4,248	80 $CCOM_1$ 16 $CCOM_2$ 72 $CCSb_2$	0	54	Land Landlord's capital Hay Corn
Landlord's optimum program	8,013	3,787	4,226	81 $CCSb_2$ 86 $CCOM_1$	1	48	Land Landlord's capital Hay Corn
Cash rent on hay $10							
Tenant's optimum program	7,821	3,872	3,949	84 $CCOM_1$ 81 $CCSb_2$	1	49	Land Landlord's capital Hay Corn
Landlord's optimum program	7,573	3,873	3,700	84 $CCOM_1$ 81 $CCSb_2$	21	0	Land Landlord's capital Hay Corn
Cash rent on hay $16							
Tenant's optimum program	7,523	3,989	3,534	80 $CCOM_1$ 81 $CCSb_2$ 3 $CCSb_1$	2	48	Land Landlord's capital Hay Corn
First intermediate program	7,535	4,002	3,533	84 $CCOM_1$ 81 $CCSb_2$	2	48	Land Landlord's capital Tenant's capital Corn
Second intermediate program	7,386	4,010	3,376	120 $CCOM_1$ 45 $CCSb_3$	4	46	Land Landlord's capital Tenant's capital Corn
Landlord's optimum program	7,375	4,010	3,365	120 $CCOM_1$ 45 $CCSb_3$	22	0	Land Landlord's capital Corn
Cash rent on hay $29							
Tenant's optimum program	7,178	3,739	3,439	105 $CCSb_1$ 63 $CCSb_2$	18	0	Land Landlord's capital Corn
First intermediate program	7,424	4,068	3,358	84 $CCOM_1$ 81 $CCSb_2$	21	0	Land Landlord's capital Corn
Second intermediate program	7,271	4,102	3,169	120 $CCOM_1$ 45 $CCSb_3$	22	0	Land Landlord's capital Corn
Landlord's optimum program	7,075	4,129	2,846	56 $CCOM_1$ 112 $CCOM_2$	23	0	Land Landlord's capital Corn

per acre, both reduction in efficiency and transfer of income seem to occur. Moreover, the conflicts between the two parties on the selection of the farm plan become more acute. The meadow rotations become less profitable for the tenant while becoming highly profitable for the landlord. The intermediate plans, combining both preferences, bear returns higher than the extreme plans. Their total income, however, is considerably lower than the one characterizing the most convenient farm plan when the cash rent on hay is smaller. A reduction in total return of $589 is suffered in moving from the most profitable plan associated with a cash rent of $6 to the one associated with $29 per acre cash rent.

The empirical evidence obtained through this analysis leads to the conclusion that cash rent on hay, viewed as a measure of income redistribution between the parties of the lease, has a detrimental impact on the efficiency of resource allocation. Interenterprise cost transfer engendered by the distortion in cost structure associated with the payment of cash rent on hay considerably reduces the possibility of achieving an efficient allocation of resources within the farm. It is therefore advisable to adopt other measures to achieve the desired income transfer between the parties and, thus, maintain efficiency.

Variable Operating Capital; A Restriction in Alternative Leases

The total amount of operating capital and the portions contributed by each party also appeared to be relevant elements in determining the level of efficiency achievable in the selected farm. Analysis is now directed to comparing the efficiencies of alternative leases and determining for each lease the optimum levels of operating capital to be contributed by each party.

The allocation of resources and the return obtained under a situation of owner-operatorship is also assumed here to be the norm with which alternative arrangements are compared. The leases for which efficiency is measured and compared are: (1) the typical crop-share-cash lease with $6 cash rent on hay, (2) a crop-share lease modified on the basis of the incentive conditions for intratemporal efficiency and (3) a typical livestock-share lease.[43] The analysis is performed by applying to each of these situations the modification to the linear programming technique whereby the optimum farm organization can be determined with one resource as a continuous variable,

[43] A description of these leases is found in a later section.

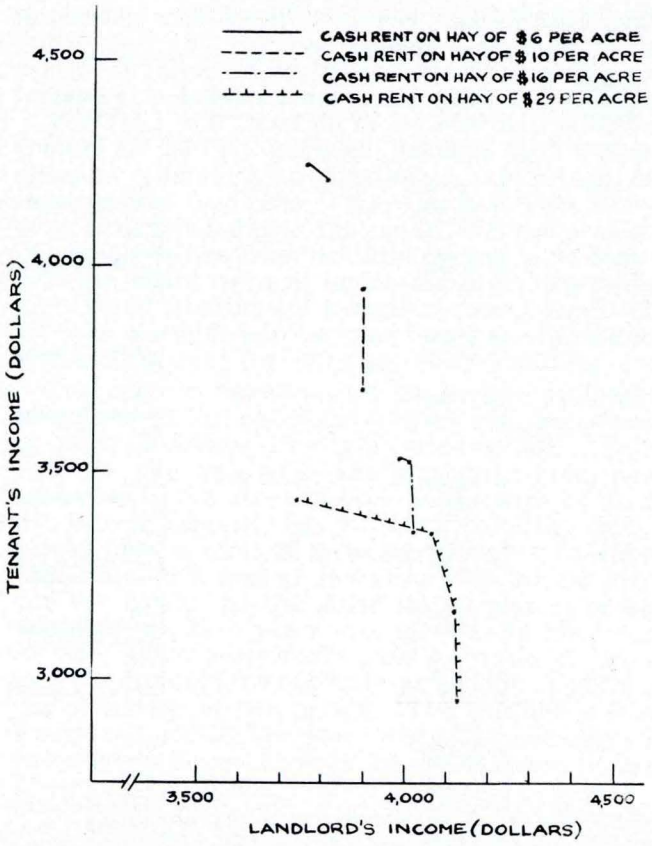

Fig. 6. Income possibility curves for alternative levels of cash rent on hay with a typical crop-share-cash lease.

while all others are held constant.[44] Here, operating capital is the resource which is applied to the bundle of resources available for production in the selected farm with price expectations for the year 1955.

[44] This modification to the simplex solution is described in an article by Candler, **op. cit.** The adaptation of this method to the present study is summarized in Appendix A.

OPTIMUM FARM PLANS UNDER OWNER-OPERATORSHIP

The farm plans resulting from the programming solution for an owner-operator situation when capital is allowed to vary are presented in table 11 and graphed fig. 7. All plans representing "corner" points are included to indicate the capital level at which the farm plan changes because a resource other than operating capital becomes restricting. In the graphical presentation of the results, the total distance to the uppermost line, or the points P_i ($i = 1$ to 9), represents the total returns (on the vertical axis) associated with the amount of capital indicated on the horizontal axis. The total returns are divided into the portions contributed by the enterprises comprising the plan. For example, at P_5 the total returns are made up of hogs and crop returns and amount to $9,580. Of this, $6,720 is credited to the rotation enterprise and the remainder contributed by the hog enterprises. Point P_9 represents maximum profits from fixed resources other than capital; the amount of capital ($15,205) used at this point defines the magnitude where capital is unlimiting.

Under the assumed level of management and price expectations, crops have investment priority at low levels of capital. Up to $5,247 ($P_4$) it appears more convenient to invest in rotations while gradually increasing their level of fertilization. After P_4, livestock enterprises become profitable, and their proportion of total returns

TABLE 11. OPTIMUM FARM PROGRAMS UNDER OWNER-OPERATORSHIP, 1955.

Farm programs and capital optima	Operating capital (dollars)	Total return (dollars)	Rotations (acres)	Hogs (litters)	Calves (number)	Limiting resources
1	2,950	4,555	168 $CSbCOM_1$	0	0	Capital Land
2	3,450	5,154	168 $CSbCOM_2$	0	0	Capital Land
3	4,420	6,047	168 $CCSb_2$	0	0	Capital Land
4	5,247	6,720	168 $CCSb_3$	0	0	Capital Land
5	9,046	9,580	168 $CCSb_3$	24	0	Capital Land Hog housing
6	10,601	10,364	168 $CCSb_3$	24	13	Capital Land Hog housing Hay
7	14,158	11,633	42 $CCSb_2$ 128 $CSbCOM_3$	24	50	Capital Land Hog housing Hay Corn
8	15,000	11,823	30 $CCSb_2$ 56 $CCOM_3$ 80 $CSbCOM_3$	24	58	Capital Land Hog housing Hay May-June labor
9	15,205	11,864	30 $CCSb_4$ 56 $CCOM_3$ 80 $CSbCOM_3$	24	58	Capital Land Hog housing Hay Corn May-June labor

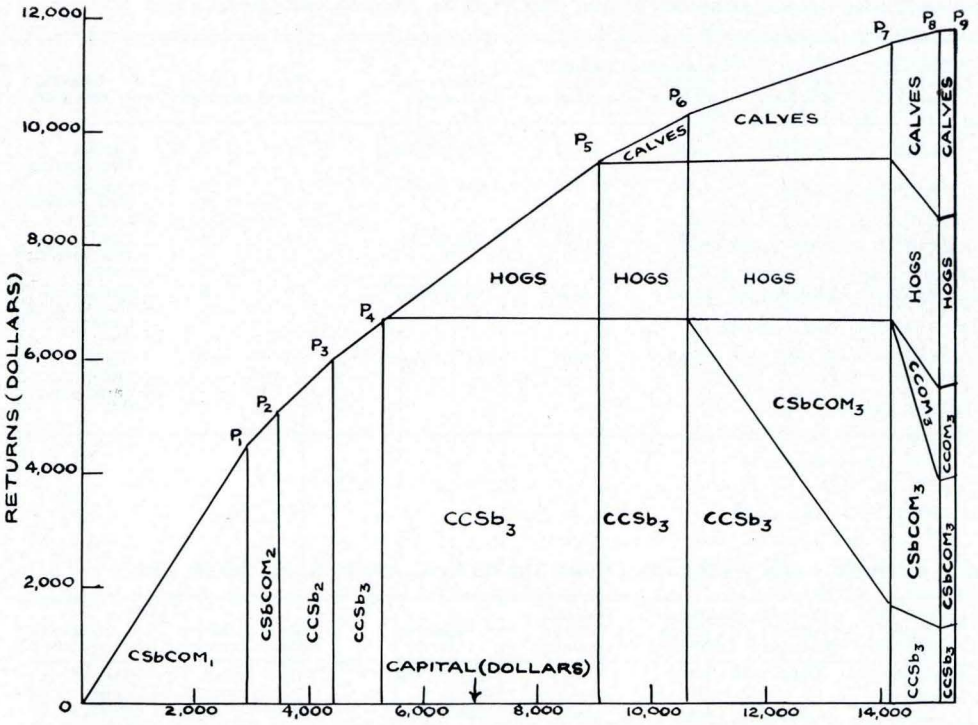

Fig. 7. Optimum farm plans for an owner-operator under variable capital restrictions.

becomes increasingly greater as the point at which capital is not limiting is approached. At high levels of operating captial, pasture-fed calves enter the farm plan as the most profitable enterprise. This induces a modification in the type of rotations to meet the forage requirements for the increased number of livestock.

The farm plans at the various capital levels represent the profit-maximizing plans for a situation of owner-operatorship. Thus, they constitute the norm to be achieved under alternative tenure arrangements and, specifically, alternative leases.

OPTIMUM FARM PLANS UNDER CROP-SHARE-CASH LEASE

The optimum farm plans with variable capital have been computed for both the landlord's and the tenant's profit-maximizing programs. The comparison between the optimum farm plans associated with maximization of returns for the landlord and the tenant provides useful insight into the agreement between the two parties at each capital level and a comparison with capital levels and total returns under owner-operatorship.

Tenant's optimum farm plans under a typical crop-share-cash lease are summarized in table 12 and shown graphically in fig. 8. Table 13 and fig. 9 contain landlord's optimum plans and associated levels of capital.

A comparative analysis of the two situations shows clearly the relevant role played by the total amount of operating capital and the quotas contributed by each party in the efficient use of the fixed bundle of resources. Tenant's optimum plans, given the division of crops specified by the typical lease, show a priority of investment in livestock enterprises even at low capital levels. This is in contrast to the typical situation in soils such as the Clarion-Webster where optimum farm plans call for capital use in crops before livestock. The first capital optimum under the tenant's optimum plans implies high levels of capital investment from both parties ($1,005 from the landlord and $7,785 from the tenant). In the landlord's optimum plans, vice versa, before reaching such a level of capital investments there are two plans requiring only $294 ($P_1$) and $717 ($P_2$) from the landlord. This would explain the relatively small amount of capital (around $500) contributed in practice by the landlord under the typical crop-share-cash lease. The contrast between landlord's and tenant's requirements of capital throws light on the conflicts between the parties of the lease. It is evident that the small quantities of landlord's capital sufficient to arrive at the landlord's first and second capital optima are too restrictive for the tenant's first optimum plan.

To compare more closely and to formulate suggestions about the optimum proportional contributions of capital by both parties, the levels of capital requirements associated with tenant's and landlord's optimum plans have been graphed in fig. 10. Landlord's capital is represented on the horizontal axis and that of the tenant on the vertical axis. The capital to be contributed by each party according to landlord's and tenant's optimum plans are plotted to form two capital requirement curves. Each curve specifies the quantity of capital that the other party has to

TABLE 12. TENANT'S OPTIMUM FARM PROGRAMS UNDER THE TYPICAL CROP-SHARE LEASE, 1955.

Farm programs and capital optima	Total capital (dollars)	Landlord's capital (dollars)	Tenant's capital (dollars)	Total return (dollars)	Landlord's return (dollars)	Tenant's return (dollars)	Rotation (acres)	Hogs (litters)	Calves (number)	Limiting resources
1	8,788	1,005	7,783	9,150	4,309	4,821	159 $CCSb_3$	24	0	Capital Hog housing
2	9,098	1,063	8,030	9,527	4,580	4,947	168 $CCSb_3$	24	0	Capital Hog housing Land
3	9,574	1,068	8,506	9,735	4,580	5,155	168 $CCSb_3$	24	4	Capital Hog housing Land
4	10,837	1,387	9,450	10,034	4,623	5,411	168 $CCSb_4$	24	8	Capital Hog housing Land Corn
5	11,199	1,387	9,812	10,083	4,623	5,480	168 $CCSb_4$	22	14	Capital Land Corn Hay

TABLE 13. LANDLORD'S OPTIMUM FARM PROGRAMS UNDER THE TYPICAL CROP-SHARE LEASE, 1955.

Farm programs and capital optima	Total capital (dollars)	Landlord's capital (dollars)	Tenant's capital (dollars)	Total return (dollars)	Landlord's return (dollars)	Tenant's return (dollars)	Rotation (acres)	Hogs (litters)	Calves (number)	Limiting resources
1	3,129	294	2,835	4,180	3,382	789	168 $CCOM_1$	0	0	Capital Land
2	4,419	717	3,702	6,046	4,210	1,835	168 $CCSb_2$	0	0	Capital Land
3	5,246	1,068	4,178	6,720	4,580	2,140	168 $CCSb_3$	0	0	Capital Land
4	5,945	1,387	4,558	6,773	4,623	2,150	168 $CCSb_4$	0	0	Capital Land

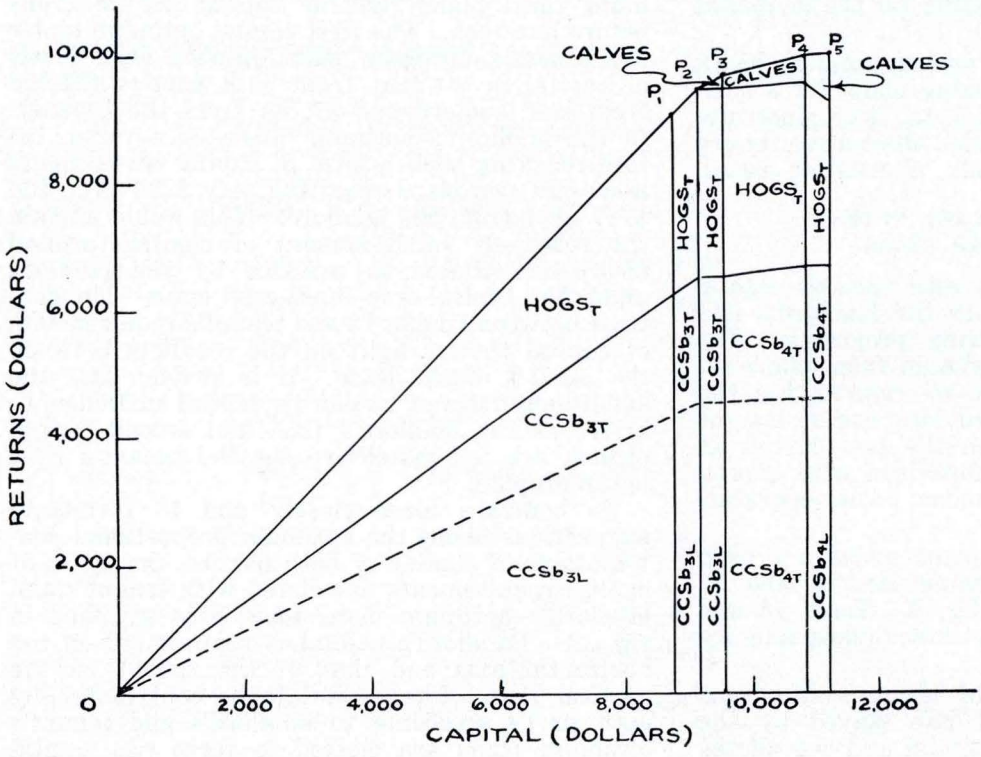

Fig. 8. Optimum farm plans for the tenant in a typical crop-share-cash lease under variable capital restrictions.

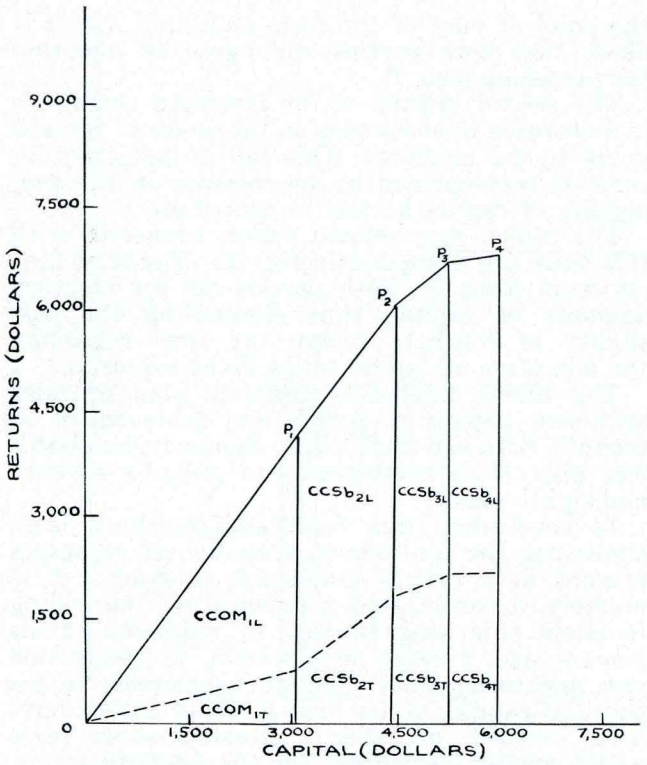

Fig. 9 Optimum farm plans for the landlord in a typical crop-share-cash lease under variable capital restrictions.

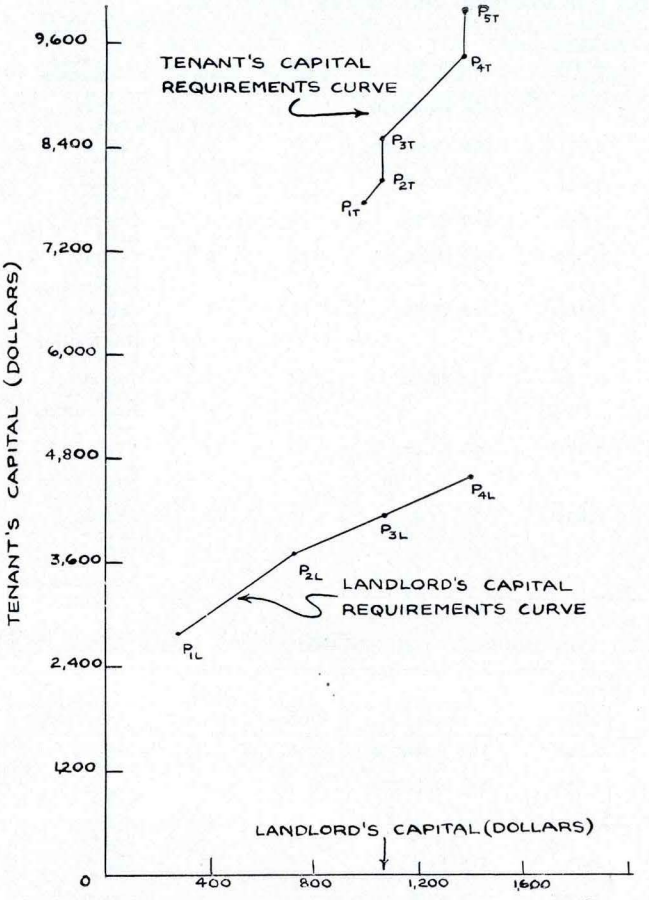

Fig. 10. Landlord's and tenant's capital requirement curves for respective optimum plans in a typical crop-share lease.

contribute to achieve a specified capital optimum. The capital optima are labeled as in the previous figures with subscripts specifying landlord's and tenant's optima. For example, P_{2L} refers to the second capital optimum for the landlord, while P_{5T} indicates the fifth capital optimum for the tenant.

The space above the landlord's capital requirement curve indicates feasible amounts of tenant's capital, while the space below contains quantities too restricting to achieve the landlord's optimum. Analogously, the space to the right of the tenant's capital requirement curve includes feasible quantities of landlord's capital, whereas the quantities to the left of the curve are insufficient for the tenant's optimum plans. It becomes possible, on the basis of the capital requirements of both parties, to determine the respective quantities of capital which would eliminate conflicts in the use of operating capital within the farm. As indicated in fig. 10, the capital associated with P_{3L} permits the achievement of P_{2T} and P_{3T}; similarly, the quantity of landlord's capital required by P_{4L} permits the attainment of P_{4T} and P_{5T}. Both P_{1L} and P_{2L} would become sources of conflict between the landlord and the tenant, because the amount of landlord's capital is too limited to attain even the first optimum plan of the tenant.

In conclusion, it appears that, given the level of technology, quantities of fixed resources, level of management and price expectations assumed in this study, to eliminate the intratemporal conflict between the two parties in the typical crop-share-cash lease, the landlord's contribution of capital ought not to be inferior to the quantity required by P_{3T} ($1,068). Assuming that the landlord has to borrow the capital on the market, both plans would appear to be profitable since P_{3L} and P_{4L} give marginal net returns to capital of $1.08 and $0.13, respectively. In practice, these rates will be discounted for risk and uncertainty but, even then, it is likely that both P_{3L} and P_{4L} would be profitable for the landlord.

The comparison between the efficiency of the typical crop-share lease with the owner-operated situation is shown in a later section when all the alternative leases considered are compared simultaneously with the norm.

OPTIMUM FARM PLANS UNDER MODIFIED CROP-SHARE LEASE

A set of incentive conditions for attaining efficiency and equity has been advanced in the literature dealing with the problem of resource allocation in leasing arrangements.[45] Of the four incentive conditions, two deal specifically with the problem of intratemporal resource allocation. They state that: (1) The share of the factor of variable input must be the same as the share of output of product obtained from it. (2) The shares of all products must be the same.

The empirical investigations dealing with these

[45] See Hurlburt, **op. cit.**, p. 86.

conditions have been restricted thus far to ascertaining the extent of their existence in representative types of leases. The previous sections of this study have indicated the impact on intrafirm efficiency when the division of costs and benefits is not based on these conditions. Attention now turns to determining the effect on efficiency and sharing of income when these two incentive conditions are applied to the typical crop-share lease.[46]

Tenant's and landlord's optimum plans are presented in tables 14 and 15 and illustrated graphically in figs. 11 and 12.

The modifications in the sharing rules engender an agreement between the parties on the farm plans to be adopted even at low levels of capital. For the tenant, because of the reduced amount of capital he has to contribute to each crop enterprise, investment in livestock at low capital levels loses priority with respect to rotations and fertilizer. Investment in livestock takes place only when total capital has increased to \$9,046 (P_5). The last plan, P_9, involves a decrease in total return because of the sizable fall in landlord's return and the slight increment in tenant's income. This plan, however, is nonprofitable from the point of view of the farm as a unit, and it is likely that both parties will agree on adopting the preceding plan, P_8.

The second impact of the incentive conditions is a decrease in every plan in the share of returns going to the landlord. This fall in landlord's income is accompanied by an increase in the proportion of capital he has to contribute.

The capital requirement curves connected with this lease are presented in fig. 13. The first four optimum plans for both parties call for identical amounts of capital, thus eliminating the possibility of conflicts within the firm regarding the allocation of capital to the fixed resources.

The fourth landlord's optimum plan provides sufficient capital to permit the achievement of tenant's fifth and sixth plan. Similarly, landlord's last plan (P_{5L}) corresponds to tenant's seventh and eighth plans.

In conclusion, this modified crop-share lease eliminates the conflicts in allocation of resources present in a typical crop-share contract. It is unlikely, however, that a landlord will be willing to adopt this lease because of reduction of his income and greater involvement in production risk and uncertainty through an increase in his share of capital. Once high levels of capital have been reached, probably a livestock-share lease would appear convenient for the landlord.

[46] A description of the specific arrangements of this modification is given in table 4.

TABLE 14. TENANT'S OPTIMUM PROGRAMS UNDER THE MODIFIED CROP-SHARE LEASE, 1956.

Farm programs and capital optima	Total capital (dollars)	Landlord's capital (dollars)	Tenant's capital (dollars)	Total return (dollars)	Landlord's return (dollars)	Tenant's return (dollars)	Rotation (acres)	Hogs (litters)	Calves (number)	Limiting resources
1	2,950	1,475	1,475	4,534	2,267	2,267	168 $CSbCOM_1$	0	0	Capital Land
2	3,460	1,730	1,730	5,154	2,577	2,577	168 $CSbCOM_2$	0	0	Capital Land
3	4,420	2,210	2,210	6,044	3,022	3,022	168 $CCSb_2$	0	0	Capital Land
4	5,246	2,624	2,629	6,720	3,360	3,360	168 $CCSb_3$	0	0	Capital Land
5	9,046	2,624	6,422	9,590	3,360	6,220	168 $CCSb_3$	24	0	Capital Land Hog housing
6	9,501	2,624	6,577	9,810	3,360	6,450	168 $CCSb_3$	24	4	Capital Land Hog housing Corn
7	10,737	2,972	7,765	10,135	3,356	6,749	168 $CCSb_4$	24	8	Capital Land Hog housing Cash
8	11,071	2,972	8,099	10,289	3,385	6,673	168 $CCSb_4$	22	14	Capital Land Hay Corn
9	12,745	2,698	10,030	9,791	2,895	6,694	10 $CCSb_4$ 78 $CCOM_4$	7	52	Capital Land Hay Corn May-June labor

TABLE 15. LANDLORD'S OPTIMUM PROGRAMS UNDER THE MODIFIED CROP-SHARE LEASE, 1955.

Farm programs and capital optima	Total capital (dollars)	Landlord's capital (dollars)	Tenant's capital (dollars)	Total return (dollars)	Landlord's return (dollars)	Tenant's return (dollars)	Rotation (acres)	Hogs (litters)	Calves (number)	Limiting resources
1	2,950	1,475	1,475	4,534	2,267	2,267	168 $CSbCOM_1$	0	0	Capital Land
2	3,460	1,730	1,730	5,154	2,577	2,577	168 $CSbCOM_2$	0	0	Capital Land
3	4,420	2,210	2,210	6,044	3,022	3,022	168 $CCSb_2$	0	0	Capital Land
4	5,248	2,624	2,624	6,720	3,360	3,360	168 $CCSb_3$	0	0	Capital Land
5	5,945	2,972	2,972	6,772	3,385	3,368	168 $CCSb_4$	0	0	Capital Land

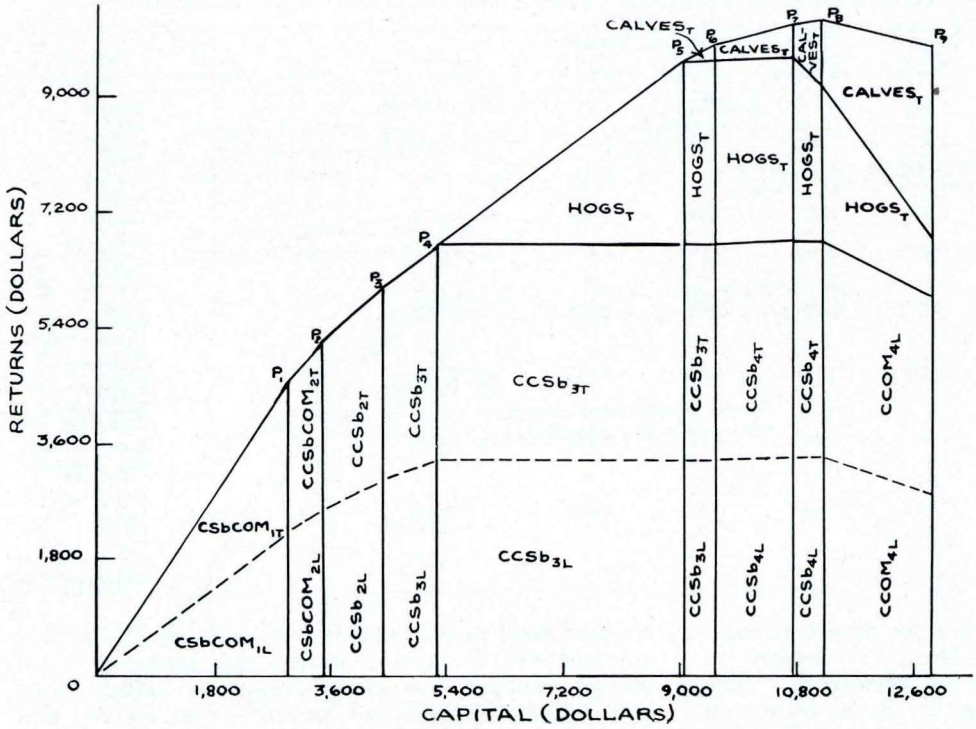

Fig. 11. Optimum farm plans for the tenant in a modified crop-share lease under variable capital restrictions.

OPTIMUM FARM PLANS UNDER LIVESTOCK-SHARE LEASE

In a livestock-share contract, the equal sharing of benefits and costs between the two parties of the lease is not limited to the crop enterprises but also includes the livestock activities which enter the farm plan.[47]

[47] See table 4 for a description of the characteristics of this lease.

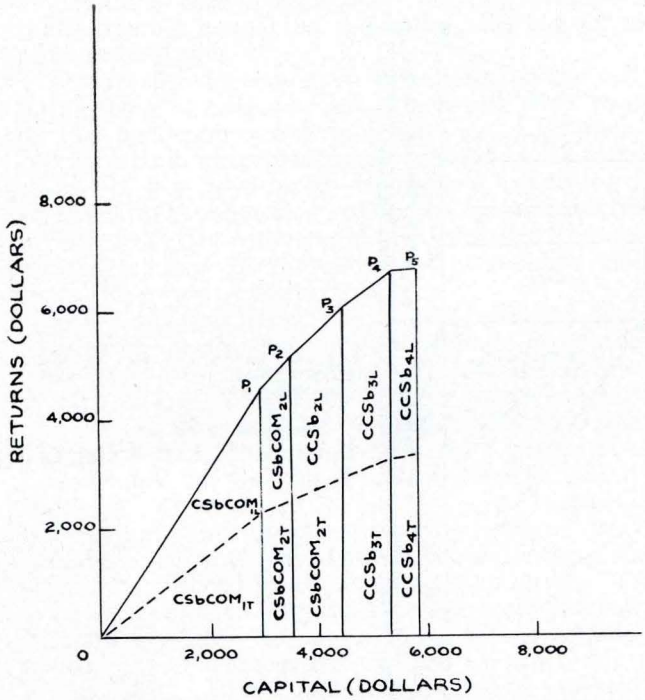

Fig. 12. Optimum farm plans for the landlord in a modified crop-share lease under variable capital restrictions.

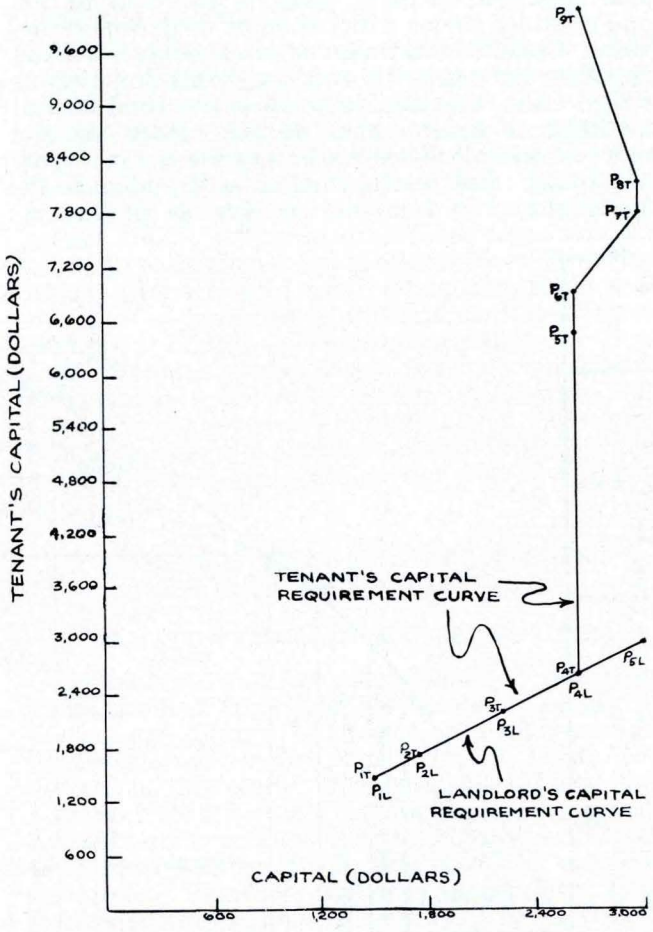

Fig. 13. Landlord's and tenant's capital requirement curves for respective optimum plans in a modified crop-share lease

TABLE 16. TENANT'S AND LANDLORD'S OPTIMUM PROGRAMS UNDER A TYPICAL LIVESTOCK-SHARE LEASE, 1955.

Farm programs and capital optima	Total capital (dollars)	Landlord's capital (dollars)	Tenant's capital (dollars)	Total return (dollars)	Landlord's return (dollars)	Tenant's return (dollars)	Rotation (acres)	Hogs (litters)	Calves (number)	Limiting resources
1	2,950	1,475	1,475	4,534	2,267	2,267	168 $CSbCOM_1$	0	0	Capital Land
2	3,460	1,730	1,730	5,154	2,577	2,577	168 $CSbCOM_2$	0	0	Capital Land
3	4,420	2,210	2,210	6,046	3,023	3,023	168 $CCSb_2$	0	0	Capital Land
4	5,248	2,624	2,624	6,720	3,360	3,360	168 $CCSb_3$	0	0	Capital Land
5	9,046	4,523	4,523	9,580	4,790	4,790	168 $CCSb_3$	24	0	Land Capital Hog housing
6	10,600	5,300	5,300	10,364	5,182	6,182	168 $CCSb_3$	24	13	Land Capital Hog housing Hay
7	14,158	7,079	7,079	11,634	5,817	5,817	42 $CCSb_3$ 125 $CSbCOM_3$	24	50	Land Capital Hog housing Corn, Hay
8	15,000	7,500	7,500	11,822	5,911	5,911	33 $CCSb_3$	24	57	Land, Capital Hog housing Corn, Hay May-June labor
9	15,206	7,603	7,603	11,864	5,932	5,982	30 $CCSb_4$ 85 $CSbCOM_1$ 52 $CCOM_3$	24	58	Land Capital Corn Hog housing May-June labor

This rental arrangement brings about a complete agreement between landlord and tenant in the intratemporal allocation of resources. The agreement exists at all capital levels, as indicated by the data in table 16, illustrated in fig. 14. The selection of farm plans is identical to the one obtained under a situation of owner-operatorship. Capital investment in crop enterprises and fertilizer have priority over the livestock activities which enter the plan only when the total capital available is greater than $5,248. Hogs are the more profitable livestock enterprise up to $9,000 of capital. Beef cattle then enter the plan, modifying the crop combination because of the increased feed requirements. Finally, at P_9 further application of capital would not increase total return because the fixed resources (land, labor and livestock housing) become restrictive, and only a change in their quantities would permit expansion of output.

COMPARISON OF OPTIMUM PROGRAMS

The discussion in the previous sections has been focused on the conflict between the landlord and the tenant within a specified lease.

To test the over-all efficiency of the leasing arrangements considered here, the optimum plans

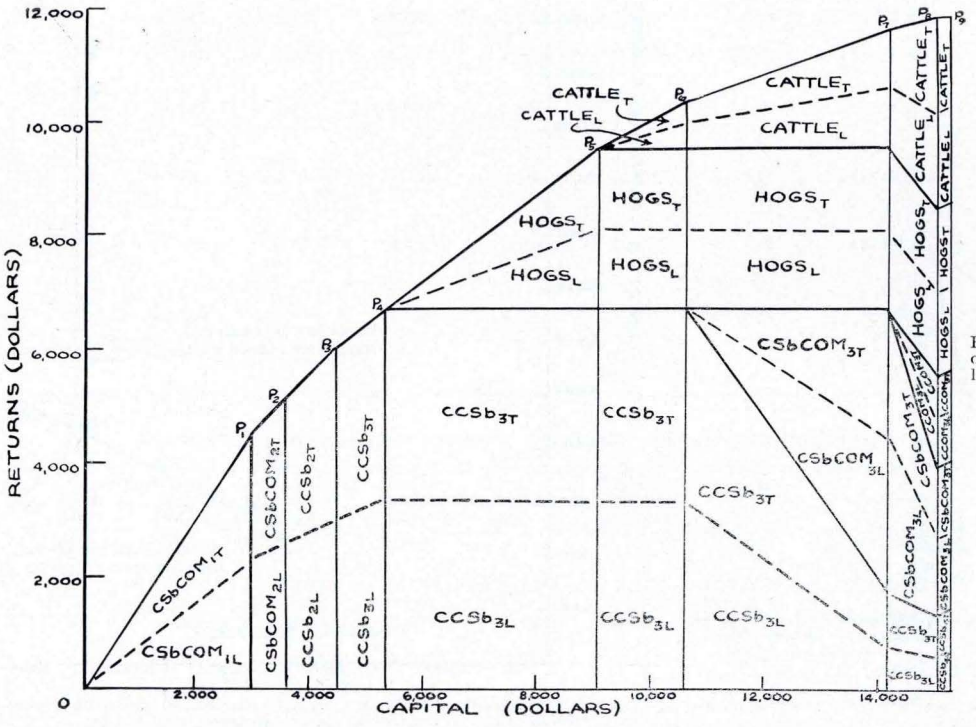

Fig. 14. Landlord's and tenant's optimum plans in a livestock-share lease under variable restrictions.

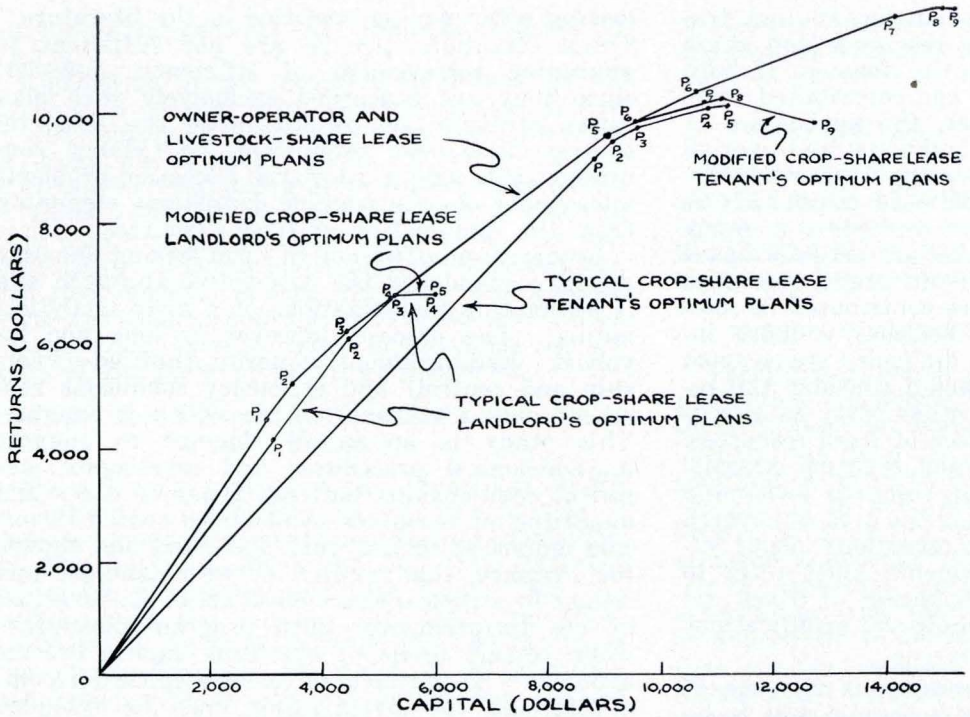

Fig. 15. Optimum farm plans for alternative tenure arrangements under variable capital restrictions.

of each party of a lease are compared with the plans attainable under owner-operatorship. For clarity of illustration, the relationship between capital and returns for each situation is illustrated graphically in fig. 15.

The figure indicates coincidence between optimum plans of owner-operatorship and livestock-share lease. The association between benefits and costs guaranteed by the terms of the livestock-share lease eliminates the intratemporal inefficiencies connected with the sharing of inputs and outputs.

The modified crop-share lease induces the optimum plans of both parties to coincide with those of the owner-operator up to the point at which the livestock enterprises are introduced into the plan. In the last plans, there is a reduction in efficiency, as shown graphically by a deviation of the lines representing landlord's and tenant's optimum plans in the modified crop-share lease from the owner-operator's curve.

The deviation from the owner-operator curve is greater in the case of the typical crop-share lease. At low levels of capital, the inefficiency is particularly conspicuous; it decreases considerably when the amount of capital is increased. Tangency with the owner-operator's curve is attained only at the third optimum plan for the landlord. The tenant's curve, even though it approaches the owner-operator's curve, never achieves tangency because of the intrafirm cost transfers induced by the cash rent on hay.

This comparative analysis, focused on efficiency, permits selection of the most efficient arrangements, given certain restrictions on the amount of capital available, and selection of optimum quantities of capital, given a specific lease. The illustrations of these twofold advantages connected with the analysis are evident from the preceding tables and figures.

It is obvious, however, that efficiency both within and between leases is not the only criterion to determine the practical selection of a given rental contract. The sharing of income connected with each lease definitely will influence the type of contract that both landlord and tenant will be willing to accept. It is thus reasonable to expect that the typical crop-share lease will not be easily abandoned by landlords because of the higher proportion of total return connected with it. This is particularly relevant at low levels of landlord's capital. The previous analysis, however, provides useful suggestions on the capital arrangements between parties even when the typical crop-share lease is maintained. At higher capital levels, the livestock-share lease becomes more profitable to both parties and is likely to be adopted.

POSSIBLE USES AND EXTENSION OF RESULTS OF THE STUDY

Maximizing Productivity of Resources

Efficiency, that is attainment of maximum value product from a given bundle of resources, has been assumed to be the goal commonly pursued by both landlord and tenant in the leases considered in this study. Nevertheless, it is realistic to expect that, within a certain range, both parties are actually concerned with maximization of their individual returns from the stock of available resources. Conflicts between these two alternative positions, not necessarily present from a theoretical standpoint, arise in practice because of (1) qualitative distribution of resources be-

tween individuals and (2) customary and traditional ways to contribute resources and share returns. With respect to the former, if both landlord and tenant owned and contributed some portion of all the resources, the application of conditions leading to both individual and over-all efficiency would follow naturally. But when the distribution of resources between individuals is such, as in our society, that ownership is fairly well specialized so that leases are actually based on lumpy contributions of different resources and only a few resources are contributed in common, achieving efficiency becomes a more involved problem. The main difficulty stems from the fact that each party would consider the resources contributed by the other party as a variable factor applied to his stock of fixed resources.

Since recommendations about eventual dissatisfaction with the pattern of resource ownership among individuals fall outside the area of concern of the research worker, suggestions about efficiency in leasing arrangements must refer to the most appropriate contribution of fixed resources by landlords and tenants and modifications in current leasing provisions.

In the first area, the problem is the one of determining the size of the economic unit to be organized through leasing. The norm to be achieved is contributions of resources of a quality and quantity that would be achieved by an entrepreneur in traditional firm analysis. In other words, the conditions regulating achievement of production equilibrium in the firm also would apply in determining the quantities of resources to be contributed by landlord and tenant. Basically, the criterion which determines the quantity of each factor to be used in the firm is equation of the marginal value product with the market price. In practice, resources are owned in a discrete manner which makes the possibilities of substitution between factors relatively limited. This criterion, however, may be approximated. Intersectoral mobility of resources is relevant and cannot be excluded from consideration in determining optimum farm size.

The initial contribution of fixed resources by landlord and tenant is essential for the use and productivity of variable resources and the final achievement of efficiency. The institutional environment has established relatively inflexible provisions for sharing costs and benefits, regardless of the quantities and productivities of the various resources. In the light of these considerations, research devoted to efficiency in leasing arrangements ought to be directed toward (1) determining optimum combinations of fixed resources and (2) suggesting leasing provisions which would not lead to conflicts between parties on allocation of resources and which would result in a production structure similar to the one characteristic under unified resource ownership and control.

Optimum allocation of resources under a situation of unified ownership and control is attained through the application of the four conditions for leasing efficiency as specified in the literature.[48] These conditions *per se* are not sufficient to guarantee achievement of efficiency, however, since they are concerned exclusively with allocation of costs and benefits after the fixed resources have been committed. Efficiency conditions apply only to short-run allocation problems and cannot obviate possible distortions stemming from the combination of fixed resources.

Research on efficiency in farm leasing has only recently abandoned the descriptive approach and is attempting investigations of a more analytical nature. The process, however, is long and involved. Establishment of norms (unified ownership and control) and efficiency conditions represent only the frame within which to operate. This study is an initial attempt to suggest methodological procedures and investigate empirical relationships between types of cases and quantities of resources available in rented farms. The empirical section just presented has shown, for instance, that conflict between landlord and tenant in a typical share lease about the selection of the intratemporal farm program disappears when certain levels of operating capital become available. To be able to make empirical recommendations, the investigation must be extended to other situations with respect to the availability of resources and to the degree of control of them by both parties. A complete investigation would require the analysis of the two continua: (1) quantity and quality of resources and (2) degree of ownership and control on the resources and their allocation. Empirical knowledge of the range and frequency distribution of these two populations would permit the formation of a composite population which would include the characteristics of both continua. Selection and detailed study of cases throughout the resulting population would render greater reliability to the empirical recommendations.

Sharing Income and Resource Contributions

Efficiency of resource use is only one side of the economic problem of farm leasing. Distribution of revenue within the firm between the leasing parties is another crucial aspect, strictly related to the problem of efficiency. The divergency between distribution of revenue and efficiency is induced by the rigidity of customary sharing provisions, as compared with the relative variability of resource contributions. Rigid leasing arrangements obviously cannot be appropriate for the variety of resource contributions, both quantitative and qualitative. The inflexibility of sharing provisions is partly understandable. This applies specifically to cases in which one of the fixed resources is present in such a quantity that its marginal product is not significantly different from zero. Therefore, it is necessary also from the distributive standpoint to investigate the two continua, quantity of resources and degree of ownership and control, to gain a more accurate understanding of the impact of insti-

[48] Hurlburt, op. cit., p. 86.

tutional arrangements on economic aspects of leasing.

Application of the incentive conditions for efficiency in leasing also determines the pattern of distribution of revenue within the firm, but, as from the efficiency point of view, possible disequalities originating from initial contribution of fixed resources are not taken into account. This confirms the need to investigate, over the populations of leases and quantities of resources, the relationships among revenues forthcoming from customary sharing provisions and those which would exist if other subdivisions on the basis of marginal products were applied.

Resolving Conflicts Between Landlord and Tenant

The empirical section of this study has shown the presence of conflicts between the parties of the lease induced by customary leasing provisions. Conflicts originate from the fact that different production programs maximize returns for the landlord and the tenant. At the same time, intermediate positions between the two extremes also may be feasible. Strictly from an efficiency standpoint, the position involving the largest total return is identified by the point of tangency of a 45° line to the income possibility curve. The distributive aspect of the lease brings about some difficulties because of the contrasting positions that landlord and tenant would select along the income possibility curve. The relationship is highly analogous to the one characteristic of bilateral monopoly, where the position involving the largest value of the sum of the returns of the two parties is identifiable, but the sharing of the total return is decided through bargaining. Movements from one corner to another along the income possibility curve could become feasible in the cases in which the increase in total income were sufficiently large to allow compensation to the losing party. Conflicts of this nature are associated with customary leasing provisions.

Improvement of leasing arrangements, in the sense of eliminating conflicts between the parties, has to be pursued through appropriate modifications of contributions of costs and reception of benefits. Application of the incentive conditions, accompanied by the necessary adjustments in variable and fixed resources, would eliminate disagreements between the parties on the farm program to be adopted. Abandonment of customary and traditional arrangements is not easily induced, however, because of the necessary readjustment in sharing of returns and resource contribution. It is likely that the party negatively affected by the modification would call on institutional inflexibility of leases to maintain the status quo.

Also in this area, future research might be efficiently directed toward examining over the two continua the degree of conflicts between the parties of the lease. Adjustments needed at various levels of the two continua (quantity of resources and degree of ownership and control) might be proficiently pointed out, thus providing landlords and tenants with a more complete, accurate framework of information on which to base decisions.

Further Research Suggested by Study

This study might be considered as an initial step in a series of investigations into the manifold economic aspects of farm leasing. Expansion of the present study may consist of various sections which are briefly described.

EFFECTS OF VARIATION IN PRICES AND COSTS

Variation in prices of products and factors of production considerably affects return expectations of both landlords and tenants and, consequently, the extent of agreement about the farm program to be adopted. While this is theoretically evident, it is not easy to predict the concrete impact of price fluctuations on leasing. A more accurate knowledge could be attained by extending the approach used in the present study and determining the reaction of alternative leasing arrangements to variations in prices. The modified simplex solution allowing for price variability could be profitably used in analyzing this aspect of leasing.[49] This technique could be combined with the modification to the simplex solution suggested in this study and with the procedure allowing variation in operating capital.

Knowledge of the reaction of landlord and tenant to changes in prices under alternative leasing provisions would be a further contribution to the problem of intertemporal allocation of resources in leasing arrangements. The study of reaction to price variation should also be performed for representative cases throughout the two continua.

INTERTEMPORAL RESOURCE ALLOCATION

Intertemporal resource allocation includes problems stemming from tenure uncertainty and allocation of resources over time. Little empirical work has been undertaken in this relatively new field.[50] More information is needed about the subjective discount rate attached by tenants to tenure uncertainty and consequent patterns of preference of investment between time periods. Information of this nature could also be collected while investigating the two continua of resource availability and degree of resource control. Once empirical knowledge about discount rates becomes available and, therefore, input-output coefficients adjustable accordingly, representative situations out of the two continua could be programmed over time. Eventual deviation in efficiency and conflict between parties engendered by alternative systems of allocating resources over time could thus be pointed out. This segment of analysis

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[49] See Candler, Wilfred. A modified simplex solution for linear programming with variable prices. Jour. Farm Econ. 39:409-428. 1957.

[50] See Smith, Wesley G. Dynamic linear programming of conservation alternatives, including household consumption. Unpublished Ph.D. thesis. Iowa State University Library, Ames. 1958; and Loftsgard, Laurel D. Linear programming of dynamic plans for an actual farm and household. Unpublished Ph.D. thesis. Iowa State University Library, Ames. 1958.

would be the complement of the investigation on intratemporal allocation initiated by this study. Customary leasing provisions could then be wholly evaluated and confronted with alternative arrangements in terms of efficiency and conflicts between parties.

ANALYSIS OF FIXED RESOURCE CONTRIBUTIONS

Intratemporal problems refer only to *allocation* of variable resources *to* the bundle of fixed resources contributed by both parties. As mentioned previously, however, proportions and total amount of fixed resources are essential elements for the achievement of long-term efficiency.

Analysis of optimum contributions of fixed resources may be performed by applying linear programming with variable resource restriction. The procedure which, in this study, has been applied to capital may be used to determine changes in farm programs and variation of marginal return to all the resources limiting the production possibility of the firm. The criterion of relating the marginal return of each resource to its market price would indicate the optimum quantity of each factor to be used by the firm and, therefore, to be contributed by the parties.

INSTITUTIONS AS FACILITATING AND OBSTRUCTING FACTORS

Both this study and those previously suggested have been based on the fundamental assumption that achievement of efficiency is the major and common objective pursued by landlord and tenant. It is reasonable to expect, however, that in practice actions of both parties are guided and motivated by many factors besides "maximization of returns." Observance of institutional arrangements plays an essential role in the determination of rental contracts and in guiding and controlling their rate of change over time. While it is outside the competence of the research worker to modify institutional arrangements directly, his main function is to provide the parties involved with information about the loss or the gain in terms of alternative objectives when institutional arrangements are adopted. The framework within which decisions are made by landlords and tenants would then become more complete. Lack of knowledge, if not abolished, will be eminently decreased.

SUMMARY

This report presents methodological procedures for analyzing the impact of alternative farm tenure arrangements on intrafirm resource allocation. The linear programming technique was used to determine optimum farm plans for intratemporal use of resources under owner-operatorship and alternative kinds of farm leases. The simplex method of solution was modified to attain maximum net returns to the parties of the lease with the solution of one simplex tableau. This modified solution was used to test inherent conflicts between landlord and tenant operating a particular farm in north-central Iowa under various forms of leases found in the area.

The tests were based on the specific assumption that both parties desire to maximize their net income from the use of a particular bundle of resources. In applying the modified simplex solution for linear programming, variable capital restrictions were employed to determine quantities of operating capital to be contributed by both parties to the lease. Major attention was focused on the crop-share-cash lease since it was the most prevalent form of lease in the area. The analysis also extended to owner-operatorship, livestock-share leasing and certain variations in leasing provisions.

Results of the study are summarized under the following four tests.

Test No. 1 concerns inefficiency in allocation of resources under customary provisions of leases. The optimum farm plan derived for an owner-operator situation was selected as the norm with which landlord's and tenant's optimum plans were compared. An *ex post* analysis was made for the period 1951-55. Results revealed that the crop-share-cash lease arrangement did not meet the efficiency conditions. Each year, aggregate landlord and tenant net returns were less than net returns under the owner-operator optimum plan. With the exception of 1952, landlord's and tenant's programs did not coincide. These results lead to the conclusion that resource allocation according to provisions of existing crop-share-cash leases brings less efficient use of the bundle of resources than would be the result under owner-operatorship. Both landlord's and tenant's optimum plans leave part of the tenant's capital idle as a consequence of the limited capital contributed by the landlord.

Major conflicts between landlord's and tenant's plans arose in the selection of the rotation and in the level of fertilization. The most profitable landlord's plan included that rotation and that fertilizer level which provided him the highest return for dollars invested by him. Available landlord capital, however, did not provide sufficient operating capital for the optimum level of fertilizer for either the tenant or the owner-operator. On the other hand, feeding requirements for livestock enterprises induced selection of a rotation and fertilizer level under the tenant's plan which complemented his livestock program.

Test No. 2 concerns effects of operating capital on optimum landlord, tenant, and owner-operator plans. Marginal returns to operating capital were computed for optimum plans of each. Under owner-operatorship, operating capital was a restricting resource throughout the period. Marginal net returns varied from \$0.63 to \$0.36 because of changes in quantity of capital available and prices of products. Under the landlord's op-

timum plan, the marginal return to the landlord for his operating capital varied from $1.11 to $1.95, while under the tenant's optimum plan landlord's marginal returns varied from $1.64 to −$1.11. For the two plans, comparable net returns to the tenant varied from $2.44 to −$3.93 and from $2.44 to $0.43, respectively. Thus, landlord and tenant returns from operating capital varied widely from landlord's to tenant's optimum plan.

Test No. 3 involves optimum amounts of operating capital to be contributed by the parties in order to eliminate conflicts stemming from application of this variable resource to the bundle of fixed factors. The analysis was performed for resources available on the case farm in 1955 and for expected prices the same year. Comparison of optimum landlord and tenant plans under variable capital restrictions led to the determination of capital requirement curves. The curve for each party specifies the amount of capital to be contributed by the other party if the optimum plan would be implemented. The comparison of the landlord's and tenant's capital requirement curves defined the ranges of capital at which there is agreement between the optimum plans of the two parties. Interpretation of the capital requirement curves revealed that conflicts stemming from amounts and allocations of operating capital would be eliminated if the landlord's contributions were at least $1,068. Thus, reserve allocation conflicts between parties would be eliminated if the landlord increased his contribution of operating capital around $500 as a minimum determined by the capital requirement curves. Under this adjustment, returns from the optimum plan remained slightly lower than for the owner-operator optimum. This was caused by interenterprise cost transfers engendered by the distortion in cost structure associated with the payment of cash rent for hay land.

Test No. 4 concerned application of Hicksian factor-factor and factor-product interrelationships as incentive conditions to the sharing of costs and returns. Modifications in the sharing provisions of leases toward equal shares of variable inputs and of the products, induces agreement between the parties on farm plans—even at low levels of capital. Identity is attained between the landlord's and tenant's capital requirement curves. In addition, optimum plans of both parties coincide with optimum plans for the owner-operator to the level of capital where livestock activities enter the plan. At this point, cash rent on meadow and pasture land again causes intrafirm cost transfers and induces a distortion in the cost structure of livestock enterprises resulting in decreased efficiency. However, optimum plans under livestock-share leases were identical with owner-operators when programming with variable capital restriction was applied.

Extension of this study toward more comprehensive analysis of efficiency and equity in leases could proceed as follows:

First, study effects of variation in product prices on efficiency and conflicts between parties to the lease. Linear programming modified to allow variation in prices would appear to provide a valuable technique of analysis.

Second, study the impact of lease-engendered intertemporal conflicts on efficiency and equity. This area of investigation is complex and concerns tenure uncertainty and resource allocation over time. Dynamic programming might provide a useful technique of analysis.

Third, study combinations of fixed resources contributed by landlord and tenant. Linear programming with variable resource restrictions could be used in this analysis.

Fourth, study provisions of leases rooted in custom and tradition in terms of economic consequences. This inquiry could provide results of economic sacrifices associated with particular lease provisions. Thus, landlords and tenants could consider altering customary lease provisions in light of the associated consequences.

APPENDIX A: MODIFIED SIMPLEX SOLUTION TO DETERMINE THE OPTIMUM PLAN IN A RENTED FARM

To determine optimum plans for landlord and tenant with a single programming solution, a modification of the simplex solution has been introduced. Table A-1 contains a schematic presentation of the modified simplex tableau. Since the purpose of the table is exclusively illustrative, only the iterations essential for understanding the procedure have been included. The activities and resources used in the simplex solution are specified in table A-2. Symbols used for identifying each item in the solution are identified in this table.

In the initial iteration, the only difference with respect to the usual tableau is the division of the rows on the basis of the resource contribution by landlord and tenant to each activity and to the total resource supply. For example, in table A-1 the row of operating capital, which is the only resource to be contributed by both landlord and tenant in the lease under consideration, is divided into the landlord capital row and the tenant capital row (P_{16L} and P_{16T}, respectively). Similarly, the net income row ($z_j - c_j$) has been divided into the landlord and tenant net income rows ($z_j - c_{jL}$ and $z_j - c_{jT}$, respectively).

To solve the matrix, the tenant net income row is chosen as the vector to be maximized, and the activity with the largest negative net price becomes the incoming activity (P_{13} in the attached example, since –79.72 is the largest negative net price in the tenant's row). The solution proceeds as in the standard simplex method until all the elements of the tenant's net income row have become positive (iteration X in table A-1). This indicates that the tenant, who has been the decision-maker, has selected the plan which will

TABLE A-1. SCHEMATIC PRESENTATION OF A SIMPLEX SOLUTION MODIFIED TO DETERMINE OPTIMUM PLANS FOR A RENTED FARM.[a]

Itera-tions		Resource supply	Disposals				Activities				
		P_0	P_{15}	P_{16L}	P_{16T}	P_{25}	P_1	P_5	P_9	P_{13}	P_{14}
I	P_{15}	160	1	0	0	0	3	4	5	0	0
	P_{16L}	625	0	1	0	0	6.62	6.62	10.92	0	0
	P_{16T}	175	0	0	1	0	60.03	59.07	72.44	161.38	137.44
	P_{18}	1,680	0	0	0	0	0	0	0	70.4	0
	P_{24}	57	0	0	0	0	0	−1.0	−1.9	0.81	1.6
	P_{25}	0	0	0	0	1	−0.36	−62.06	−63.6	125.85	.50
	$z_j - c_{jT}$	0	0	0	0	0	−23.49	−22.69	−40.22	**−79.72**	−41.56
	$z_j - c_{jL}$	0	0	0	0	0	−57.83	−57.83	−92.86	0	0
X	P_{10}	10.61									
	P_3	0.75				**0.05**					
	P_2	34.90									
	P_{18}	262.07									
	P_{24}	64.03									
	P_{13}	20.14									
	$z_j - c_{jT}$	3,376.19	1.56	0.43	0.46	0.04	5.59	11.19	3.23	0	24.00
	$z_j - c_{jL}$	3,583.69	−1.18	−1.11	0.72	−0.93	1.20	12.56	0.49	0	53.00
	q_j		−0.76	−2.58		**−22.73**					
XI	P_{19}	9.34							**2.68**		
	P_{25}	16.06									
	P_2	37.76									
	P_{18}	268.75									
	P_{24}	**61.32**									
	P_{13}	20.04									
	$z_j - c_{jT}$	3,375.53	1.25	0.20	0.49	0	6.23	12.80	3.99	0	26.33
	$z_j - c_{jL}$	3,598.59	5.99	4.22	0	0	−13.25	−24.21	−16.77	0	0
	q_j						−2.13	−1.89	**−4.20**		
XII	P_9	3.48						**1.02**			
	P_{25}	80.92									
	P_2	47.53									
	P_{18}	298.63									
	P_{24}	47.73									
	P_{13}	19.62									
	$z_j - c_{jT}$	3,361.63	−0.45	0.61	0.49	0	3.73	8.73	0	0	26.33
	$z_j - c_{jL}$	3,657.04	13.14	2.48	0	0	−2.74	−7.11	0	0	0
	q_j						−0.72	**−0.81**			
XIII	P_5	3.42									
	P_{25}	151.58									
	P_2	**48.78**									
	P_{18}	308.19									
	P_{24}	**47.71**									
	P_{13}	19.48									
	$z_j - c_{jT}$	3,331.77	−4.10	1.50	0.49	0	−1.64	0	−8.57	0	26.33
	$z_j - c_{jL}$	3,681.36	16.11	1.76	0	0	1.63	0	6.98	0	0

[a] The symbols relating to resources and activities (P_j) are illustrated in table A-2. All the figures have been rounded to two decimal places. The check rows and columns have been omitted.

TABLE A-2. LIST OF ACTIVITIES AND RESOURCES WITH CORRESPONDING SYMBOLS USED IN THE SIMPLEX SOLUTION.

Items	Symbols
Activities	
$CCSb_1$	P_1
$CCSb_2$	P_2
$CCSb_3$	P_3
$CCSb_4$	P_4
$CCOM_1$	P_5
$CCOM_2$	P_6
$CCOM_3$	P_7
$CCOM_4$	P_8
$CSbCOM_1$	P_9
$CSbCOM_2$	P_{10}
$CSbCOM_3$	P_{11}
$CSbCOM_4$	P_{12}
Spring hogs	P_{13}
Pasture-fed calves	P_{14}
Resources	
Land	P_{15}
Capital	P_{16}
Landlord capital	P_{16L}
Tenant capital	P_{16T}
Cattle housing	P_{17}
Hog housing	P_{18}
Labor group A	P_{19}
Labor group B	P_{20}
Labor group C	P_{21}
Labor group D	P_{22}
Labor group E	P_{23}
Hay	P_{24}
Corn	P_{25}

maximize his income. During this first phase of the solution, the landlord net income row has been carried along, as any other row, but has never been taken into consideration in deciding what enterprises to bring into the plan. Hence, enterprises with negative net prices might still exist in the landlord's row. This indicates that a readjustment of the plan, either by introducing different enterprises or by modifying the level of intensity of those now composing the plan, would increase the landlord's returns.

As mentioned earlier, the movement from the tenant's to the landlord's optimum combination of enterprises may proceed along different paths according to the selection of the enterprise to be introduced in the following iterations. We are particularly interested, however, in those intermediate positions between the two optima which form the upper boundary of the feasible combination of enterprises in the landlord-tenant income plane. An initial approximation of the relevant boundary may be obtained in introducing, in the

intermediary iterations between the tenant's and the landlord's optimum plans, the enterprise which involves the maximum increase in landlord's income for each unit of tenant's income given up. To this purpose, a new row is introduced (q_j), whose elements are obtained by dividing the negative landlord's net price coefficients by the corresponding coefficients in the tenant's row.

The largest ratio will indicate the incoming activity which will increase landlord's income and at the same time induce the minimum decrease in tenant's income. In table A-1, −22.73 is the largest ratio in iteration X, and, therefore P_{25} becomes the incoming activity. In iteration XI, landlord's total net income has increased (from $3,583 to $3,598), and tenant's income has very slightly decreased (from $3,376 to $3,375). The same criterion is followed in selecting the incoming activities in iterations XI and XII (−4.20 and −0.81 are the largest ratios). Finally, in iteration XIII, all the coefficients of the landlord's net income row have become positive, thus indicating that the combination of enterprises and their intensities which maximize landlord's net income has been selected.

Naturally, in going from iteration X to iteration XIII—that is, from tenant's net income maximizing plan to landlord's net income maximizing plan — some tenant's net price coefficients will change from positive to negative. This indicates that the matrix opens the possibility of moving back to the optimum position specified by iteration X. The collection of points so obtained, however, does not necessarily guarantee circumscription of all the feasible points between the two optima. The correctness of the boundary may be checked through the introduction of alternative profitable enterprises moving from the tenant's optimum position and in the following intermediary points.

This trial and error procedure explores the possible paths of movement from tenant's to landlord's optimum and thus tests the correctness of the boundary traced previously. With reference to table A-1, the check is performed by introducing P_{15} (−1.18) and P_{16} (−1.11) in iteration XI and then exploring all the alternatives stemming from the introduction of these two enterprises. The computational procedure is the standard one, therefore these iterations are not included in table A-1.

APPENDIX B: INPUT-OUTPUT DATA FOR CROP ENTERPRISES

The labor requirements for the crops considered in this study and the costs associated with their production are presented in tables B-1 through B-5.

The labor requirements have been assumed to remain unchanged during the period considered in the analysis. The labor coefficients for the rotations included in the study can be easily deduced, summing the requirements of the crops composing one unit of rotation.

The items of the capital coefficients also have been presented on a crop basis. Therefore, the operating capital required by each rotation is obtained by summing the costs attached to each component crop.

In the programming dealing with leases, the capital coefficients of landlord and tenant for each rotation are computed by summing landlord's and tenant's contribution as specified by the rental contract. For example, in the typical crop-share lease, landlord's capital coefficient of a rotation of corn-corn-soybeans at the second level of fertilization is obtained by adding half the fertilizer expense, half the corn seed expense and the entire expense for soybean seed. The tenant's coefficient is computed analogously.

TABLE B-1. MONTHLY LABOR REQUIREMENTS OF CROPS PER ACRE IN MAN-HOURS.[a]

Months	Corn	Oats	Soybeans	Meadow[b]
Jan.	0	0	0	0
Feb.	0	0	0	0
March	0	0.355	0	0
April	0.826	0.895	0.60	0
May	1.540	0	1.44	0
June	0.917	0	0.90	0
July	0.749	1.875	0.66	4.520
Aug.	0	1.875	0	3.850
Sept.	0.140	0	0.18	0
Oct.	1.036	0	1.86	3.250
Nov.	1.428	0	0.36	0
Dec.	0.364	0	0	0
Total	7.00	5.00	6.00	11.62

[a] Unpublished data from Ross Baumann, Department of Economics and Sociology, Iowa State University, Ames, Iowa. The monthly coefficients do not include labor for fertilizing. For fertilization: add 0.1 hour per acre in May and June for corn; add 0.3 hour per acre in April for oats; and add 0.2 hour per acre in May for soybeans. These coefficients have been assumed to remain unchanged during the period considered in the analysis.

[b] Assumes all hay harvested and yield of 2.5 tons per acre.

TABLE B-2. COSTS PER ACRE FOR CORN, YEARS 1951-55, DOLLARS.[a]

Items	Units	1951	1952	1953	1954	1955
Tractor overhead	$/ac.	2.60	2.60	2.63	2.66	2.68
Tractor operating	$/ac.	2.92	2.92	2.97	3.01	3.06
Machinery overhead	$/ac.	6.23	6.23	6.30	6.45	6.61
Seed	$/ac.	2.00	2.00	2.00	2.00	2.00
Building repair	$/ac.	2.99	2.99	3.00	3.02	3.02
Total constant cost	$/ac.	16.74	16.74	16.90	17.14	17.37
Harvesting	$/bu.	0.06	0.07	0.07	0.08	0.13

[a] These costs are estimates of those expenses normally required to seed and cultivate corn with the average technique used in the area. Fertilization costs are not included; they can be obtained by multiplying the fertilization rates given in table 2 in the text by the fertilizer prices. With the addition of the fertilizing expense, the items composing the capital coefficient for corn are complete. These data are adapted from Bowlen, B. and Heady, E. O. Optimum combinations of competitive crops at particular locations. (Application of linear programming: 1) Iowa Agr. Exp. Sta. Res. Bul. 426. 1955.

TABLE B-3. COSTS PER ACRE FOR OATS, YEARS 1951-55, DOLLARS.[a]

Items	Units	1951	1952	1953	1954	1955
Tractor overhead	$/ac.	2.69	2.69	2.72	2.75	2.77
Tractor operating	$/ac.	1.50	1.50	1.53	1.55	1.57
Machinery overhead	$/ac.	4.12	4.12	4.24	4.30	4.37
Seed	$/ac.	1.86	1.98	1.58	1.58	1.58
Building repair	$/ac.	2.43	2.43	2.50	2.50	2.51
Total constant cost	$/ac.	12.60	12.72	12.57	12.68	12.60
Harvesting	$/bu.	0.04	0.04	0.04	0.05	0.08

[a] These costs are estimates of those expenses normally required to seed and cultivate oats with the average technique used in the area. Fertilization costs are not included; they can be obtained by multiplying the fertilization rates given in table 2 in the text by the fertilizer prices. With the addition of the fertilizing expense, the items composing the capital coefficient for oats are complete. These data are adapted from Bowlen and Heady, **ibid.**

TABLE B-4. COSTS PER ACRE FOR SOYBEANS, YEARS 1951-55, DOLLARS.[a]

Items	Units	1951	1952	1953	1954	1955
Tractor overhead	$/ac.	2.59	2.59	2.62	2.65	2.67
Tractor operating	$/ac.	2.86	2.86	2.86	2.88	3.00
Machinery overhead	$/ac.	5.33	5.32	5.40	5.55	5.65
Seed	$/ac.	4.92	4.20	4.30	4.45	4.63
Building repair	$/ac.	1.47	1.55	1.55	1.55	1.56
Total constant cost	$/ac.	17.17	16.52	16.73	17.08	17.51
Harvesting	$/bu.	0.04	0.04	0.04	0.05	0.08

[a] These costs are estimates of those expenses normally required to seed and cultivate soybeans with the average technique used in the area. Fertilization costs are not included; they can be obtained by multiplying the fertilization rates given in table 2 in the text by the fertilizer prices. With the addition of the fertilization expense, the items composing the capital coefficient for soybeans are complete. These data are adapted from Bowlen and Heady, **ibid.**

TABLE B-5. COSTS PER ACRE FOR MEADOW, YEARS 1951-55, DOLLARS.[a]

Items	Units	1951	1952	1953	1954	1955
Tractor overhead	$/ac.	2.60	2.60	2.63	2.65	2.68
Tractor operating	$/ac.	2.99	2.99	3.05	3.10	3.13
Machinery overhead	$/ac.	4.84	4.84	4.90	4.95	5.14
Seed	$/ac.	4.08	4.56	4.62	4.24	6.42
Building repair	$/ac.	2.83	2.83	2.83	2.83	2.83
Total constant cost	$/ac.	17.34	17.82	18.03	17.77	20.20
Harvesting	$/ton	4.87	4.87	4.90	4.94	4.94

[a] These costs are estimates of those expenses normally required to seed and cultivate an alfalfa-red clover-timothy meadow with the average technique used in the area. Fertilization costs are not included; they can be obtained by multiplying the fertilization rates given in table 2 in the text by the fertilizer prices. The harvesting cost is not included in the capital coefficient of the rotations but it is charged to the livestock enterprises under the assumption that in the eventual absence of livestock the hay would not be harvested. These data are adapted from Bowlen and Heady, **ibid.**

APPENDIX C: INPUT-OUTPUT DATA FOR LIVESTOCK ENTERPRISES

The input-output data for the livestock enterprises considered in this study are presented in tables C-1 and C-2. With the exception of the capital coefficients, the input requirements have been assumed to remain unchanged during the period under analysis.

The data presented in tables C-1 and C-2 refer to the enterprises produced under a situation of owner-operatorship. In a crop-share-cash lease, the cash rent which is paid on meadow and permanent pasture would be added to the capital coefficients.

TABLE C-1. INPUT-OUTPUT DATA FOR SPRING HOG ENTERPRISE, 1951-55, ON A LITTER BASIS.[a]

Items	Units	1951	1952	1953	1954	1955
Operating capital[b]	dollars	159.18	160.85	162.60	161.57	159.90
Housing	sq. ft.	70.40	70.40	70.40	70.40	70.40
Labor	man-hours	26.00	26.00	26.00	26.00	26.00
Jan.	man-hours	1.48	1.48	1.48	1.48	1.48
Feb.	man-hours	1.48	1.48	1.48	1.48	1.48
March	man-hours	7.02	7.02	7.02	7.02	7.02
April	man-hours	0.99	0.99	0.99	0.99	0.99
May	man-hours	0.99	0.99	0.99	0.99	0.99
June	man-hours	2.16	2.16	2.16	2.16	2.16
July	man-hours	2.16	2.16	2.16	2.16	2.16
Aug.	man-hours	1.69	1.69	1.69	1.69	1.69
Sept.	man-hours	3.17	3.17	3.17	3.17	3.17
Oct.	man-hours	1.48	1.48	1.48	1.48	1.48
Nov.	man-hours	1.69	1.69	1.69	1.69	1.69
Dec.	man-hours	1.69	1.69	1.69	1.69	1.69
Hay	tons	0.81	0.81	0.81	0.81	0.81
Corn and equivalent	bushels	125.85	125.85	125.85	125.85	125.85

[a] The data have been obtained from the records of the Farm Business Asssociation for the selected farm in Hamilton County. The labor coefficients are those adapted by Mackie, A. B. **et al., op. cit.** The data refer to the enterprise produced under a situation of owner-operatorship; under tenancy the quota of cash rent paid on hay is added to the capital coefficient.
[b] The items composing the capital expense are: protein, power, equipment, miscellaneous.

TABLE C-2. INPUT-OUTPUT DATA FOR PASTURE-FED CALVES ENTERPRISE, 1951-55, ON A HEAD BASIS.[a]

Items	Units	1951	1952	1953	1954	1955
Operating capital[b]	dollars	106.77	120.26	131.74	116.76	120.41
Labor	man-hours					
Jan.	man-hours	1.08	1.08	1.08	1.08	1.08
Feb.	man-hours	1.06	1.06	1.06	1.06	1.06
March	man-hours	1.06	1.06	1.06	1.06	1.06
April	man-hours	1.49	1.49	1.49	1.49	1.49
May	man-hours	2.42	2.42	2.42	2.42	2.42
June	man-hours	2.42	2.42	2.42	2.42	2.42
July	man-hours	2.42	2.42	2.42	2.42	2.42
Aug.	man-hours	2.42	2.42	2.42	2.42	2.42
Sept.	man-hours	1.07	1.07	1.07	1.07	1.07
Oct.	man-hours	1.06	1.06	1.06	1.06	1.06
Nov.	man-hours	1.06	1.06	1.06	1.06	1.06
Dec.	man-hours	1.08	1.08	1.08	1.08	1.08
Hay	tons	1.60	1.60	1.60	1.60	1.60
Corn and equivalent	bushels	50	50	50	50	50

[a] The data have been obtained from the records of the Farm Business Association for the selected farm in Hamilton County. The labor coefficients are those adapted by Mackie, A. B. **et al., ibid.** The data refer to the enterprise produced under a situation of owner-operatorship; under tenancy the quota of cash rent paid on hay is added to the capital coefficient.
[b] The items composing the capital expense are: protein, power, equipment, miscellaneous, feeder stock and hay harvesting cost.

APPENDIX D: PRICES USED IN PROGRAMMING

The prices of the crops and livestock enterprises used in programming are presented in table D-1.

It is assumed that the price expectation models do not vary in the alternative tenure situations considered. The prices of crops correspond to the arithmetic mean of the prices occurred in the previous 10 years, while the length of time assumed for the expected prices of livestock is 5 years.

TABLE D-1. PRICES OF CROPS AND LIVESTOCK ENTERPRISES USED IN PROGRAMMING, 1951-55.

Items	Units		1951	1952	1953	1955
Crops:						
Corn	dollars/bu.	1.08	1.19	1.26	1.30	1.35
Oats	dollars/bu.	0.69	0.75	0.78	0.77	0.78
Soybeans	dollars/bu.	2.29	2.36	2.47	2.56	2.60
Livestock:						
Butcher hogs	dollars/cwt.	18.93	19.52	18.12	17.62	18.68
Sows	dollars/cwt.	16.93	17.52	16.12	15.62	16.68
Calves	dollars/cwt.	16.90	20 44	22.85	82.98	22.76