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LAND TRANSFER AND TECHNICAL CHANGE IN A DUALISTIC AGRICULTURE: A CASE STUDY FROM NORTHERN TUNISIA

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There is a large body of literature analyzing share tenancy. This literature is concerned with the efficiency of production and the distribution of returns which occurs under the assumption of a landlord class which rents-out its land to a landless tenant class on a output share arrangement.[1/] This, of course, corresponds to conditions which exist in large, irrigated areas of Asia.

But, share tenancy is only a special case of a general category of usufruct relations.[2/] The usufruct relation analyzed in this paper is the rental of land owned by small farmers to large farm operators on an output sharing contract arrangement; it is in certain regards the polar case of share tenancy. Although perhaps not as common as the "tenancy" case, examples of land "rental" case are also widely found, especially in dryland areas of the Middle East and North Africa.[3/]

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1/ See in particular Koo [9] which usefully summarizes the debate. Also, see Cheung [4], Bardhan and Srinivasan [3], Sen [15] and Georgesen-Roegen [6], in that order. There are, of course, many other contributions to this literature.

2/ Usufruct is defined as the right to use of a property without the right to ownership.

3/ Warriner, for instance, discusses the emergence of a land rental market in the Jezira region of northern Syria in response to changes in technology (the introduction of capital-intensive cereals production) that are similar to the Tunisian case. See Warriner, [16, pp. 55-112].

Indeed, it was the frequent observation of rental relationships during the fieldwork conducted by Fraenkel in northern Tunisia in 1972-73 that motivated the present paper. These observations provide the empirical support for the propositions suggested.

We address ourselves to the following questions:

1. Under what conditions does the case of land rental, as distinct from land tenacy,occur?
2. What are the welfare implications of the rental case for the small and large farmer class?

These questions are posed in the context of a "dualistic" agriculture. The impacts of three separate but related elements of this environment will be analyzed. The first relates to the distinction between a modern and traditional technology. The second relates to the indispensibility and indivisibility of production inputs. The last relates to the impact of different market structures on the rental of land and the distribution of land operation between small and large farmers.

The theory presented below has implications for a general theory of institutional development. It is proposed that new institutional arrangements for transferring usufruct of production resources from one operator to another emerge in response to changes in demand and supply conditions related to the potential of maximizing returns from the diffusion of an improved technology within the constraints imposed by existing institutional structures.[4/] In our case, a private land rental market transferring operational control of land from small to large farmers evolved as a mechanism for increasing the spread of adoption of the high yielding cereals technology within the restraints on direct small farmer adoption imposed by the imperfect resource market structures of a dualistic agricultural sector.[5/]

In section I, a model of agricultural production is put forward. It presents the explicit choices of rental or owner-operation of resources. This is followed in section II by consideration of the small and large farmer maximization problems under the restraints imposed by a dualistic agriculture. In the remaining sections the model is used as a means of formulating hypotheses about the land rental market, and evidence from a case study of Tunisian cereal farming is used to exemplify and validate the hypotheses.

4/ See Davis and North /̅ 5_7 for the development of a general model of institutional change. They propose a distinction parallel to ours between "institutional arrangements" and "institutional structures." An institutional arrangement, such as the land rental market discussed here, provides its members with some added income that they would otherwise forego. An institutional structure, on the other hand, consists of the "set of fundamental political, social, and legal groundrules," in our situation, those of a "dualistic" society /̅pp. 6-7_7. Concerning the relation of institutions to technical change in agriculture, specifically, see Hayami and Ruttan /̅ 7_7, and note the following as related to our model: "The modernization of land tenure relationships, involving a shift from share tenure to lease tenure and owner-operator systems of cultivation in much of western agriculture, can be explained in part, as a shift in property rights designed to internalize the gains of entrepreneurial innovation by individual farmers." Ruttan /̅ 13, p.20_7.

5/ For a pessimistic discussion of the possibilities of "small farmer development," (assumed to be the direct adoption by small farmers of new technologies) within the structures of dualistic, or "bimodal" societies, see Dale W. Adams and E. Walter Coward, /̅ 1, p. 22_7. Our argument is twofold: (1) in the presence of new technological potential, these restraints may deter the diffusion of technology less than is usually supposed because of new institutional arrangements; (2) even the welfare implications may be less adverse than pessimists fear.

I. A Model of Agricultural Land Use and Production

The model presented in this section focuses on the distribution of control of land for cereals production between the small (traditional) and large (modern) farmer classes. It is assumed that the model is closed with the stock of land, labor and capital in fixed supply, but that labor, capital services, and land flow between the two sectors. Production functions are assumed to be neoclassical in four variables; land, labor, capital and variable inputs. Restraints are placed on the model which leads to a distinction between the maximization problems for the large and small farmer classes. Each class is assumed to maximize investable surplus. Based on these maximizations and assumptions about the market structure for capital services, land rental relations and terms are determined.

In general, in a bimodel agriculture, the possible land tenancy relationships can be described by the matrix:

$$(1) \quad A = \begin{pmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{pmatrix}$$

where (A_{11}, A_{22}) represent land owned and operated by the tradition and modern sector and (A_{12}, A_{21}) is owned by the traditional (modern) sector and operated by the modern (traditional) sector.[6/] Thus, A presents the distribution of the ownership and operation of land in the agricultural sector. For simplicity, (and, in fact, realism), the total land (H) is assumed fixed for the sector, i.e.,

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6/ In terms of notation the first index refers to ownership while the second refers to tenancy. The index 1 is used for the traditional and 2 for the modern sector.

$$(2) \quad \sum_{i}^{2} \sum_{j}^{2} A_{ij} = H.$$

The term A_{21} corresponds to the more usual discussion of tenancy, the rental of land from the large land owning to the small cultivating class.[7/] The term A_{12} is in this respect the polar case where the small farmer rents to the large farmer.

Since the preponderance of literature has concentrated on the efficiency and tenancy arrangements of A_{21} and since the phenomenon observed in northern Tunisia was A_{12}, the emphasis of the model is on developing an explanatory framework for A_{12}. As determined in a footnote below, A_{21} must be zero under these conditions (see p.13).

Corresponding to A is an output matrix:

$$(3) \quad X = \begin{pmatrix} X_{11} & X_{12} \\ X_{21} & X_{22} \end{pmatrix}$$

where X_{ij} is output from ith owned land operated by jth group.

Each component of output is produced by a neoclassical production function of four generalized inputs:

$$(4) \quad X_{ij} = F_{ij}(L_{ij}, A_{ij}, \Sigma K_{kij}, S_{ij})$$

where L_{ij} is labor used on ij land and K_{kij} is kth owned capital used on ij land and S_{ji} is variable inputs (seed, fertilizer, herbicide and so

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7/ The difference between this arrangement (A_{21}) and the usual discussion of land tenancy is that the small farmer group may own as well as rent in land. This is important in terms of defining the choices open to small farmers. For instance Cheung /_4_/ assumes that the tenant is landless and owns only a labor resource.

forth) of j used on the land rented from i. Each of these inputs is assumed to be indispensible for production, i.e.,

$$\text{(A.1)} \quad X_{ij} > 0 \qquad \text{iff}(L_{ij},\ A_{ij},\ \Sigma K_{kij},\ S_{ji}) > 0$$

Further from the neoclassical assumptions

$$\text{(A.2)} \quad F_{ijn} > 0 \qquad n = 1, \ldots 4$$

$$\text{(A.3)} \quad F_{ijnn} < 0 \qquad n = 1, \ldots 4$$ [8/]

It is further assumed that the total supply of labor is given exogenously:

$$\text{(5)} \quad \sum_{i}^{2} \sum_{j}^{2} L_{ij} = N$$

where H and N are constant.

Real investable surplus (π_i) in food equivalent for each sector is equal to gross output on owned and rented land minus input costs plus (minus) the rental payment minus household consumption expenses.[9/]

$$\text{(6)} \quad \pi_i = X_{ii} + rX_{ij} + (1-r)X_{ji} - Ma$$
$$- p\sum_{k=1}^{2} K_{jki} + p\sum_{k}^{2} K_{i}k_{j} - P_{a}\sum_{k}^{2} S_{ki}$$
$$- c(K_i + \sum_{k}^{2} S_{ki})$$

8/ F_{ijn} refers to the nth partial derivative of F_{ij} and F_{ijnn} refers to the nth second order partial i.e., F_{ij2} is the marginal productivity of land and F_{ij22} is the rate of change in marginal productivity.

9/ Since the purpose of the present model is an analysis of resource transfer, no account is taken of wage payments. Implicitly this assumes that all labor is household labor and that payment is in terms of consumption allowance.

II. Restraints of Dual Agricultural Sector

Until this point, the farmer classes have been treated in an entirely symmetric fashion. However, because of institutional factors characteristic of a dualistic agricultural sector, certain restraints must be introduced. In the context of the model, these amount to restricting the possible alternatives to acquiring resources for production.

The most obvious restraint is the indivisibility of the indispensable capital input. The implication of this capital indivisibility is that the traditional sector must purchase capital services from the modern sector. Indeed, this dependence is a primary defining characteristic of the small farmer class. Thus:

(R.1) $K_1 = 0$

(R.2) $cK_1 = 0$

where K_1 is the ownership of capital of the 1th sector and c is the credit charge. In other words, because of a credit and ownership restraint, all indivisible capital is owned by the modern sector.

A second type of restraint relates to the variable inputs. In many developing economies, small farmers are unable to obtain modern inputs because of credit restraints or other exclusionary practices. Adoption of modern technology depends on greater use of purchased inputs than the traditional technology.[10/] These institutional restraints may have the effect of restricting the small farmer to the use of the traditional technology even where he has the capacity to self finance adoption of the modern technology.[11/] Thus:

$$(R.3) \quad c \sum_{k}^{2} S_{k1} = 0$$

A. Small Farmer Maximization

In addition to the general restraints imposed above, other factors characteristic of a dualistic agriculture effect the range of choice of the small farmer. First, there is the economic viability of the farm unit in terms of its income generating capacity. Second, there are alternative market structures for resources and land rental. The income of the small farm determines its ability to generate an investable surplus, while the land rental and resource markets determine the returns to the alternatives of direct operation or rental.

10/ The traditional technology is considered to consist of the following: (1) two disc cultivations by tractor, (2) hand broadcasting of unselected seed, and (3) machine harvesting. The modern technology is as follows: (1) 1 deep plowing and 3 superficial, disc cultivations by tractor, (2) drilling of selected seed, (3) 100 kilos each of nitrogenous and phosphatic fertilizers, (4) weeding by hand or herbicide, (5) machinery harvesting. One notes that the modern technology alone includes yield-increasing, biological-chemical inputs. For further information concerning the traditional and modern technologies, see the partial budgets on page 24a.

11/ Thus, in the diffusion of innovation the land rental market plays analogous to a capital market. Both rental and credit are, of course, instances of usufruct relations. For a discussion of the relation of capital markets to technological change with obvious implications for our analysis, see Ronald I. McKinnon, [11, p. 5-21].

There are three possible situations which can face the small farmer under the assumption of a dual technology. (1) Total income generated on his property using traditional technology is less than that necessary for continued operation and household subsistence,

$$\text{(C.1)} \quad X_{11} < Ma^{*} + pK'_{211} + P_{s}S'_{11}$$

and

$$X_{12} = X_{21} = 0$$

where M is average family size, a* is minimum per capita subsistence consumption, p is the price of custom capital services, K'_{211} is capital services necessary for traditional technology.[12/] P_s is the price of variable inputs and S'_{11} is the minimum amount of inputs possible for production.[13/] If a farmer is in class (C.1) and has no additional income, then he is forced to rent or, of course, to sell his land in order to get a consumption advance on his share of the harvest. Although we are analyzing explicitly only the rental decision, the decision to sell follows where $X_{11} < Ma^{*}$ over a period of years.[14/]

(2) Total income from X_{11} is greater than household consumption requirements and the investment needed for operation using the traditional

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12/ This is an assumption of minimum tillage needed for operation.

13/ S_{11} refers to unselected seed under the traditional technology.

14/ In fact, during the colonial period, sale by the small Tunisian land owner to the large French operator occurred automatically once the value of the consumption advances taken by the farmer to meet Ma* exceeded the value of the land. Definitive transfer of title under these conditions has been institutionally restrained by the nationalist government, apparently in the hope of preserving a small landowing -- if not operating -- class.

technology but less than what is necessary to acquire resources for modern technology, i.e.,

$$\text{(C.2)} \quad Ma^* + pK'_{211} + P_s S'_{11} \leq X_{11} < Ma^* + pK^2_{211} + P_s S^2_{11}.$$

and

$$X_{12} = X_{21} = 0.$$

where the superscript 2 on K and S implies levels necessary to achieve the modern technology.

(3) Class (C.3) has the ability to achieve the modern technology, i.e.,

$$\text{(C.3)} \quad X_{11} > Ma^* + pK^2_{211} + P_s S^2_{11}$$

and

$$X_{12} = X_{21} = 0.$$

(C.2) and (C.3) have the alternative of renting out or direct operation. These are the classes that determine the equilibrium price of rental land.

Given the indispensibility assumption made above (A.1) and the assumption that the small farmer sector must purchase capital inputs, the structure of this market becomes a central determinant of decisions regarding land control. Outcomes in three market structures are analyzed: (1) purely competitive market in long-run equilibrium, (2) an oligopolistic market involving price fixing above the competitive rate and (3) a collusive oligopolistic market structure where custom capital services are unavailable at any price. Arraying the three economic classes and the three market structures for capital services in Table 1, the decisions of six of the nine cases are immediately determined. Table 1 summarizes this result. Case (C.1.1) - (C.1.3) are forced to rent because they cannot achieve a high enough income to operate. Cases (2.3) and (3.3) are renters because they cannot purchase custom capital services, an indispensible input. Case (3.1) is an operator since he can obtain the entire advantage of the increased yields of modern technology and has access to custom tractor services on a minimum average cost basis. The outcome of cases (2.1), (2.2) and (3.2) will depend on the rental terms (r), the prices of custom services (p) and the advantage to be gained by utilizing the modern instead of the traditional technology.

We will now turn to analyzing the outcome of an optimizing strategy of the remaining small farmer cases (2.1), (2.2) and (3.2).

It is hypothesized that the small (traditional) farmer will attempt to maximize his utility, a function of his profits and labor input, subject to the possible alternatives he faces. Specifying this formally we have to maximize

$$(7)\quad U_1 = U_1(\pi_1, L_{11})$$

where due to (R.1) - (R.3)

$$(8)\quad \pi_1 = X_{11} + rX_{12} - Ma - pK_{211} - P_sS_{11}$$

Table 1

The Small Farmers Rental Decision and the Structure of the Capital Custom Service Market

Small Farmer Income Class	Market Structures: Competitive	Oligopolistic Price Fixing	Collusive Oligopoly
(C.1) $X_{11} < Ma^* + pK'_{211} + p_s S'_{11}$	(C.1.1) Renter	(C.1.2) Renter	(C.1.3) Renter
(C.2) $Ma^* + pK'_{211} + p_s S'_{11} < X_{11} < Ma^* + p_s S^2_{11} + pK^2_{211}$	(C.21) ?	(C.2.2) ?	(C.2.3) Renter
(C.3) $X_{11} \geq Ma^* + p_s S^2_{11} + pK^2_{211}$	(C.3.1) Operator	(C.3.2) ?	(C.3.3) Renter

subject to:

$$(9) \quad a - a^* \geq 0$$

a subsistence consumption constraint.

$$(10) \quad F_{11}(L_{11}, A_{11}, K_{211}, S_{11}) - X_{11} \geq 0$$

a production function constraint

$$(11) \quad H - A_{11} - A_{12} - A_{22} \geq 0$$

a land restraint and

$$(12) \quad rF_{12}\,(L_{12}, A_{12}, K_{212}, S_{21}) - rX_{12} \geq 0$$

a rental production function restraint.[15/]

15/ The share tenancy possibility (A_{21}) could be analyzed with only slight modification of the above. Equation (8) must be modified to allow rented in as well as rented out land

$$(8') \quad \pi_1 = X_{11} + rX_{12} + (1-r)X_{21} - Ma - p(K_{211} + K_{221}) - P_s(S_{11} + S_{12})$$

and one restraint for rented in land must be added:

$$(12') \quad (1-r)\; F_{21}(L_{21}, A_{21}, K_{221}, S_{12}) - (1-r)\; X_{21} \geq 0.$$

The Lagrangian function can then be reformed and the modified first order necessary conditions derived:

$$(P.1') \quad U_{12}/U_{11} = F_{111} = (1-r)F_{211}$$

$$(P.2') \quad F_{112} = rF_{122} = (1-r)F_{212}$$

$$(P.3') \quad F_{113} = (1-r)F_{213} = p$$

$$(P.4') \quad F_{114} = (1-r)F_{214} = p_s$$

$$(P.5) \quad U_{11}M = \lambda_1$$

Notice, as distinct from what happens in the case analyzed in the text, the marginal productivities of tenant land must also be higher than owner-operated land. This is precluded from happening based on the dual technology assumption. However, in labor intensive agriculture the empirical counterpart of the land tenancy literature, this condition is

By assuming efficient production-equalities on (10) and (12), substituting (8) into (7), the following Lagrangian function can be formed.

$$(7.1)\quad A = U_1(F_{11}(L_{11}, A_{11}, K_{211}, S_{11}) + rF_{12}(L_{12}, A_{12}, K_{212}, S_{12})$$

$$- Ma - pK_{211} - p_s S_{11}, L_{11})$$

$$+ \lambda_1(a - a^*) + \lambda_2(H - A_{11} - A_{12} - A_{22})$$

The decision variables for this problem are L_{11}, A_{11}, A_{12}, K_{211}, S_{11}, a. For the small farmer r, the rental terms, F_{12}, large farmer production function M the family size, p and p_s, the price of inputs, and a*, the minimum subsistence parameters are given.

From the first order necessary conditions for maximization the following can be derived:

$$(P.1)\quad U_{11}F_{111} = U_{12}$$

$$(P.2)\quad F_{112} = rF_{122}$$

$$(P.3)\quad F_{113} = P$$

$$(P.4)\quad F_{114} = P_s$$

$$(P.5)\quad U_{11}M = \lambda_1$$

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realized. An interesting point is that historically in northern Tunisia, prior to the introduction of mechanization and the modern inputs, the khammessat tenancy relation was widely found. (Khammessat refers to the 20% share allocated to labor under traditional tenancy). Significantly, on non-mechanizable land, tenancy relations still exist in northern Tunisia. For a historical treatment of the colonial period in Tunisian agriculture which stresses the interaction of changes in cereals production technologies and land usufruct relations, see Poncet / 12 /, Part I.

Condition (P.1) states that labor will be used until the value marginal productivity in utility terms is equal to the marginal utility of labor. Condition (P.2) states that the marginal productivity of alternative land uses valued in terms of what the traditional sector receives must be equal, that the marginal productivity of rented land must exceed the marginal productivity of owner operated land. (P.3) and (P.4) are usual marginal cost, marginal productivity conditions, i.e., utilize inputs until the marginal revenue equals the marginal cost. Lastly (P.5) states the implicit value for exceeding subsistence consumption (λ_2). It is a joint product of the marginal utility of income (π) and family size (M).

In terms of the question of land rental (P.2) is a central result. Assuming that r, the rental share, is less than one, this condition implies that the small farmer will choose to rent only if the rental operator can achieve higher productivity than the owner operator. Although this is self-evident, it does provide an insight into the solution of the rental problem. We can now see why case (3.1) is an operator. For him there is by assumption no productivity advantage to be gained by renting. Case (3.2) would be an operator if the competitive price for custom services prevailed since he could directly adopt the modern technology. However, since by assumption the price of custom services is higher than under the competitive structure, some of the individuals in (3.2) will fall back into the situation of (2.1). Cases (2.1) and (2.2) cannot achieve the higher technology solutions as operators. Their decision will depend on rental terms (r) and the difference in yields of the two technologies. Obviously the larger the productivity gain and the higher the rental share, the more likely is it that (2.1) and (2.2) will choose to be renters.

As in case (3.1) and (3.2) because of the difference in custom service price, (2.2) is more likely to rent than (2.1) since he can not only benefit from higher productivity but also avoid paying the higher custom service prices.

B. Large Farmer Maximization

The analysis has placed a lower bound on r. In no case will the small farmer rent out his land unless his return from doing so at least equals what he would make by operating it himself. This provides us with an explanation of the supply function of rental land. As r increases the land available for rental goes from the forced-choice cases (1.1) - (1.3), (2.3), and (3.3) -- to include all of the mechanizable land owned by the small farmer class, since r approaching 1 provides income greater than that gained from working the land directly. A further incentive for the small farmer to rent, not taken into consideration in this model, is the assymmetry of risks provided for by the usual share rental arrangement. According to this arrangement, output is shared but all inputs costs are paid by the large farmer. As a result, large farmers may suffer losses from adoption of the modern technology, but the small farmer cannot.

It is the large farmer maximization problem which can help us determine the demand for rental land, the upper bound of r. Because of their access to credit and capital equipment, large farmers can increase the productivity of the small farmer holdings by utilizing the improved methods and still compensate the small farmer.[16/] Indeed, it is the productivity dividend

16/ This is to be contrasted with the welfare implications of mechanical innovations in the more frequently analyzed, and perhaps more commonly found situation where landlords and laborers are mutually exclusive classes. Cf., Schmitz and Seckler [14].

which provides leverage for the rental arrangement in all but cases of forced choice rental. At the lower end, as we have seen the rental payment must at least equal what the small farmer could earn using traditional technology. As an upper bound, the payment must equal the traditional return plus the productivity advantage, leaving to the large farmer an income exactly equal to his marginal costs. This is analyzed further below.

It is assumed that the large farmer like the small farmer attempts to maximize utility as a function of profits and labor. The difference is due to the assymmetrical restraints. The large farmer has access to long- and short-term credit, modern inputs and owns the indivisible capital stock which he may utilize on his own land, rented land and to provide custom services. This problem can be specified as the maximization of:

$$(13) \quad U_2 = U_2(\pi_2, \sum_k^2 L_{k2})$$

where from (6) with (R.1) - (R.3)

$$(14) \quad \pi_2 = X_{22} + (1-r)X_{12} - Ma + pK_{211} - p_s \sum_k^2 S_{ki})$$

subject to:

$$(15) \quad F_{22}(L_{22}, A_{22}, K_{222}, S_{22}) - X_{22} \geq 0$$

$$(16) \quad (1-r)F_{12}(L_{12}, A_{12}, K_{212}, S_{12}) - (1-r)X_{12} \geq 0$$

$$(17) \quad K_{2T} - K_{211} - K_{212} - K_{222} \geq 0$$

$$(18) \quad H - A_{11} - A_{12} - A_{22} \geq 0$$

It is assumed that the consumption level (a) is given when the firm decisions are made. Equation (17) is a capital restraint which simply states that the total flow of capital services (K_{2T}) possible from the capital stock (K_2) must be greater than the sum of capital uses. In the indivisible capital assumption employed here there is presumably a simple conversion factor between K_2 and K_{2T} such as

$$(19) \quad K_{2T} = \gamma K_2$$

where γ gives the amount of land that can be serviced by a stock of capital in a given time period. The remaining restraints have been presented above.

For the large farmer L_{22}, L_{12}, A_{12}, A_{22}, K_{211}, K_{212}, K_{222}, S_{12}, S_{22} are control variables, Whereas, H, A_{11}, P, P_a, r are viewed as parameters (at least for the initial competitive solution). Substituting (14) into (13) and assuming efficient production -- the equality of (15) and (16) -- the first order necessary conditions for maximization yield:

$$(P.6) \quad F_{221} = (1 - r)F_{121} = \frac{-U_{22}}{U_{21}}$$

$$(P.7) \quad F_{222} = (1 - r)F_{212}$$

$$(P.8) \quad F_{223} = (1 - r)F_{123} = P$$

$$(P.9) \quad F_{224} = (1 - r)F_{124} = P_s$$

Conditions (P.6) through (P.9) all contain the rental payment (1 - r) as a parameter. In each case the marginal productivity of the inputs on the rented land must be higher than on the owner-operated land. This can be interpreted two ways. Under (A.1) and (A.2) either less inputs would be used on rented land than owner-operated land or there is a productivity advantage to rented in land under the same input-levels, i.e., productivity gain from using new technology on previously traditionally-operated land could be very high. The central conclusion of this section is that the demand for rented land is fundamentally related to the increases in productivity that can be obtained by utilizing modern inputs on land that otherwise would be operated with the traditional technology.

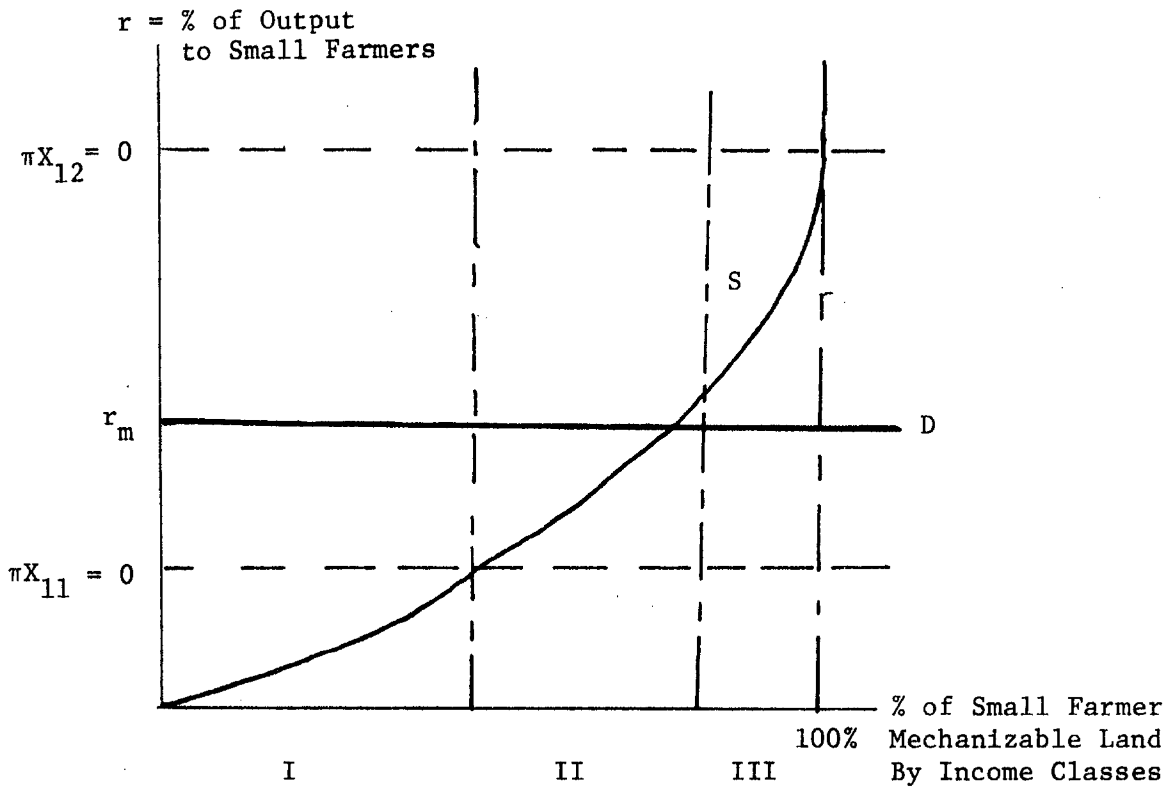
III. The Land Rental Market

As we have seen, the small farmer will rent in exchange for a share of the gains of the high-yield technology where he does not have access to modern inputs or credit because of insufficient investment surplus or exclusion from resource markets. The large farmer is a demander of rented land because he can use the high yield technology over a wider hectarage, more fully utilize the capacity of his indivisible capital, and exploit his access to credit.

We can now compute a supply and demand function for rental land. Figure 1 represents such a market. The vertical axis represents r, the percentage of output per hectare earned as rent by the small farmer landowner. On the horizontal axis is the percentage of mechanizable land owned by small farmers that is rented to large farmer operators. It is assumed that this land is distributed among Classes I, II, and III of the model.

Figure 1:

Land Rental Market



Several observations concerning the equilibrium value of r are in order. Despite the existence of Class I small farmers (who are forced to rent, the value of r can never be less than the return to the traditional technology (πX_{11}). This is because of the existence of Class II farmers who are capable of operating with the traditional technology and, as marginal renters, permit the forced choice, Class I farmers to enjoy a renters' surplus. Moreover, since large farmers are willing to pay a share based on the return to the modern technology (πX_{12}), r can be assumed to be greater than the return to the traditional technology (πX_{11}). However, r is less than the full return to the modern technology, because the large farmers will not rent unless they can cover something more than variable costs.

It should also be noted that to bid away land owned by Class III small farmers, large farmers would have to offer r approaching πX_{12}, since Class III farmers have the capacity to self-finance direct adoption of the modern technology. We say 'close' to πX_{12} because of the assymmetry of risks of the rental arrangement under discussion (where output, but not input costs, are shared).

IV. Case Study of the Locality of Ebba-Ksour

Fieldwork was conducted in 1972-73 on three plains situated near the town of Ebba-Ksour (gouvernorat of Kef).[17/] Information collected during fieldwork is presented to exemplify the model and to validate certain of its hypotheses.

17/ For background information concerning agriculture in the gouvernorat of Kef, see the excellent monograph by Makhlouf [10]. The town of Ebba-Ksour is also known as Dahmani. Fieldwork was conducted on the plains of Zouarines, Abida, and Lorbeus.

Table 2 presents the official statistics for land use for the delegation of Ebba-Ksour. One notes the high percentages of cropland to total land area, and of cereals to cropland. This indicates that the 'extensive margin' at which the expansion of the large, modern farms must take place is the mechanizable land operated by small farmers with the traditional technology, the assumption presented in equation (2) of the model; there is no additional cropland potential.

Not all of the land used for cereals production in the locality is cultivable by machinery; the hilly land around the plains can be worked only with draft animals. Estimates of the hectarage by plain of mechanizable land, the focus of our analysis, are presented in Table 3. Interestingly, it is on the remaining, non-mechanizable land that one still finds tenancy relations.

Sixty-five percent of total cereals hectarage in the locality is planted to durum wheat. Most of this land is in biennial rotation with unworked fallow or barley alternating with durum.

Official statistics for the delegation of Ebba-Ksour also document the existence of a dualistic agricultural structure, that is, a bimodal distribution of land between large and small farmers. (see Table 4).

On the plains of Abida and Lorbeus, where all large farms could be surveyed, we calculate that 28% of the land operated by the large farmers is rented (see Table 5). This only partially indicates the significance of the rental market in transferring land from small to large farmers. Much of the land now owned by large farmers was rented in the past from small farmers and subsequently purchased.

Table 2

Land Use in the Delegation of Ebba-Ksour, in Hectares

Total land area	Crop land area	(2)/(1)x100	Cereals area	(4)/(2)x100
(1)	(2)	(3)	(4)	(5)
72,900	61,620	84.53	49,000	79.52

Source: L'Agriculture dans le governorat du Kef, unpublished document, Tunisian Ministry of Agriculture, 1972.

Table 3

No. of Hectares of Mechanizable Land by Plain, 1973

Zouarines	11,486
Abida	7,000
Lorbeus	2,818

Source: Estimation made by Fraenkel based on field observation and topographical maps.

Table 4

Distribution of Land by Farm Size Class in the Delegation of Ebba-Ksour 1/

Farm size class (in has)	Percent of all farmers	Percent of land
0 - 20	84.4	23.0
20 - 50	7.5	18.0
50 - 100	5.1	15.0
> 100	3.0	44.0

Source: *L'Agriculture dans le gouvernorat du Kef*, unpublished document, Tunisian Ministry of Agriculture, 1972.

Table 5

Hectares of Land Operated by Large Farmers

Plain	Has operated	Has owned	Has rented
Abida	6,134	5,283	851
Lorbeus	2,818	1,876	942

Source: Estimation made by Fraenkel.

Partial budgets derived from survey data are presented to show the differences in resource use and net returns between the traditional and modern technologies (see Table 6). Farm survey data further indicate that almost all of the small farmers in the locality use the traditional technology, and that large farmers use the modern technology according to these partial budgets. Large farmers own machinery, whereas small farmers operate by purchasing custom machinery services. No small farmer used any chemical fertilizers, while most the large farmers used them as budgeted. These data suggest the pattern of market exclusion such as we are hypothesizing, rather than a lack of demand by small farmers for the modern inputs.

The structures of resource markets have a crucial role in restraining the outcome of the small farmer maximization problem. Government policy and public institutions have played crucial roles in resource markets. Between 1963 and 1969, the aim of government policy was to collectivize all of the resources of private cereals farmers and to place them in large-scale production cooperatives. It was observed that the outcomes of small farmer maximization decisions have been influenced by the differential impact of this collectivization program on the small and large farmer classes.

The collectivization policy in the locality of Ebba-Ksour did not affect most of the large farmers directly until 1968. The mechanizable land owned by small farmers, on the other hand, was collectivized in 1963, and at this time small farmers sold their draft animals, at first from fear of expropriation and later due to restrictions on grazing imposed once the cooperatives were created. With the restoration of private

Table 6

Partial Budgets for Durum Wheat Production/ha. Using the Traditional and Modern Technologies:

A. Traditional Technology	
Costs:	
1. Custom Tractor services: 2 disc cultivations1/ @ 1.500 each Unimproved	3.000 2/
2. Seed @ 5.000/ql 3/	5.000
3. Harvest 4/	5.000
TOTAL	13.000
Gross Return @ 8 qxx5.000	40.000
Net Return	27.000
B. Modern Technology	
Costs:	
1. Variable tractor costs 5/	
a. Labor (@ .100/hr. x 6.75 hrs.)	.675
b. Fuel (@ 8.51ts/hr x .039 x 6.75 hrs.)	2.238
c. Servicing (@ .350/hr x 6.75 hrs.)	2.363
d. Insurance (A .030/hr x 6.75 hrs.)	.203
	5.479
2. Weeding	1.500
3. Chemical Fertilizers	
a. Nitrogen	3.165
b. Phosphate	3.510
c. Labor at .050/hr.	.050
	6.725
4. Selected seed	7.000
5. Transport	1.500
6. Harvest	5.000
TOTAL	27.204
Gross Return @ 15 qxx5.000	75.000
Net Return	47.736
Net Return to Traditional Technology	27.000
Net Return to Modern Technology	47.736
Technology Dividend	20.736

1/ The 1.500 disc cultivation price was observed on the 'competitive' plain of Zouarines.

2/ One dinar (1.000) is about two U.S. dollars.

3/ 5.000 was the average price paid for durum wheat by the marketing board after quality adjustments and is also the approximate free market price.

4/ The 5.000 custom harvesting price was observed to be about the same throughout the locality.

5/ The difference between tractor use time in the partial budget and the peak period tractor requirements of Table 7 is due to tractor use outside of the peak period.

agriculture in 1969, small farmers had their land returned, but they no longer owned a source of traction to start-up plowing for cereals production. One representative small farmer is quoted in a study done elsewhere in 1969: "When the cooperatives were being created, I sold a draft animal for fifteen dinars. Now the same animal costs between 60 and 110 dinars, and it's impossible for me to get it back." [Zamiti, 15, p. 50]. Most large farmers, whose resources remained in the production cooperatives for only a short period, had their machinery returned to them in working order. As a consequence of collectivization, many small farmers became dependent for the first time upon tractor services purchased, usually, from a large farmer. This assumption is presented in equation R.1 of the model.

The inputs of the modern technology, including a flow of machinery services, and their financing are, of course, fully divisible; _ceteris paribus_, they may be used with equal efficiency on small and large farming units. But, a comparison of data showing the inputs used for durum wheat production by small farmers using tractors and draft animals for tillage collected within and outside of the formerly collectivized zones indicates that the use of tractor services on small farms has simply substituted mechanical for animal traction; it has not been accompanied by adoption of the yield-increasing, biological-chemical inputs (selected seed and chemical fertilizer) of the modern technology.

Small farmers have not directly adopted the modern technology due to their exclusion from the bureaucratic and participatory, public institutions servicing the cereals sector. Large farmers have greater access to the research, extension, marketing, and credit services of such bureaucratic institutions as the Accelerated Cereals Production Project, the Office of Cereals, and the tractor station as the result of minimum-size criteria for their services and of favoritism by local officials. Through elective office large farmers enjoy greater power in such participatory institutions as the local mutual credit union.

Another restraint on small farmer access to the services of public institutions is the requirement that all applications for their services must be approved by the local officials of the Ministry of Interior.[18/] The Ministry of Interior is the most important organization determining the distribution of purchased resources for cereals production. In the rural localities, the technical ministries operate only with the approval of its officials. The shaykh (or omdah), the lowest official of the Ministry of Interior, is responsible for a territorial sub-unit of a delegation. The shaykh's approval is needed for applications made by farmers to be sent to the appropriate branch of a technical ministry.

The shaykhs were recruited from among the local population. All of the shaykhs in the locality studied were large farmers who rented a high percentage of the land they operated from small farmers. Small farmers complained frequently of refusals by the shaykhs to accept their applications for instutional services.

After the reversal of the collectivization program, the government recognized the need of helping the private cereals producers to start-up production. Two policies were decided which appear to have been intended

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18/ Thus, the pattern of political control in this locality is not dissimilar to that found in Morocco. For a discussion of the predominant role of the Ministry of Interior in rural Morocco, see Waterbury [17], pp. 280-286. There are also strong continuities between the excercise of political control in Tunisia by the Protectorate and by the nationalist government, as Ashford documents, [2,pp. 60-93]. For a more complete discussion of agricultural resource allocation within the context of the Tunisian political system, see the thesis by Fraenkel (forthcoming).

to permit the small farmer, who had sold his draft animals and lacked the capacity to self-finance cereals production, to begin operation once again. The first was to make loans available to small farmers from the mutual credit union system. The second was to liberalize machinery credit policy. But, as we shall see, these policies did not permit the small farmer to adopt the modern technology, and probably had little effect in maintaining the small farmer as an operator.

There are a number of reasons why the mutual credit union at Ebba-Ksour did not function as intended. An examination of the amounts of loans made by the credit union after 1969 to small farmers showed that these were in fact consumption subsidies and not production credits; it would not have been possible to start-up cereals production even using the traditional technology with loans which were as small as 9 dinars.[19/]

A second problem is the relative power of large and small farmers in the credit union of Ebba-Ksour.[20/] Lending decisions are made by the union's board, all of whose eight members are large farmers in the locality. According to the rules, none of them is even eligible for loans from the union on whose board they sit. This is not in itself evidence that small farmers do not get loans from the credit union, but examination of a list of loan recipients from 1970 to 1973 showed it to be generally true. Significantly, this examination showed that most of the loans were approved by the board

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19/ The tradition of smallholder credit in northern Tunisia since the colonial period has been to provide for the subsistence requirements of the small farm population at times of natural disaster in the guise of production credit in kind (seed which, of course, may be either consumed or planted). This tradition was simply perpetuated in 1970 when the credit union system was used to extend credit to small farmers following the man-made catastrophe of the production cooperatives.

20/ This has not gone unnoticed by Tunisian and American officials. Johnson, for instance, notes the problem of "local political influence on boards of directors" of the mutual credit unions [8, p. 35].

only for small farmers operating non-mechanizable land (and presumably of no interest to the large farmers).

A third problem is the requirement, already discussed, that all loan applications be first approved by the shaykh before they could be even considered by the credit union board. Small farmers complained that the shaykhs would not accept their applications for credit for cereals production from the local union.

Following the collectivization program, many small farmers could afford neither an animal nor mechanical capital resource. There was an increased demand for a flow of capital services. In 1969, the government made it possible for import houses to give suppliers credits for machinery purchase. Prior to this, machinery for cereals production was available only from the national agricultural bank. Bank credit was given only to farmers who operated in excess of one hundred hectares, and usually to those who could use the machinery to capacity on their (owned + rented) land. It may be assumed that on farms of over 250 hectares (of which one-half are cultivated annually), a tractor of the capacity generally purchased is utilized fully (see Table 7). Farmers of this size would have little interest in providing a flow of custom services to small farmers.

The import houses after 1969 gave credit to cereals producers on an ability-to-pay basis. As Table 8 indicates, a farmer operating as few as 50 hectares of dryland for cereals production with the modern technology could afford a tractor such as the type sold most widely since 1970, the STEYR 870. On the basis of the calculations presented in Table 7, we may assume that the tractor owners eligible for suppliers credits, cultivating as few as 25 hectares per year, have excess capacity allowing them to provide custom services.

Table 7:

Tractor Requirements for Cultivated Land Areas of Different Sizes During Peak Use Period of August to Mid-November

	Number of Hectares							
	50	100	125	150	175	200	225	250
Hours per season 4 3/4 hr/hectare	237	475	594	713	831	950	1,069	1,188
Hours per week 15 wk/season	15.8	31.7	39.6	47.5	55.2	63.3	71.3	79.2

Table 8:

Financing of a STEYR 870 Tractor on an Ability-to-Pay Basis

Basic Tractor Cost	3800.000
Implements	1000.000
Average yearly payment[1]	1036.800
Annual rural family[2] subsistence expenditure	166.950
Min number of hectares cultivated[3]	25.168
Min number of hectares operated (2 x 25.168)[4]	50.336

1 Based on a repayment period of five years and an interest rate of 7 1/2%, the terms given by the import house.

2 See page 31.

3 This is derived by adding the subsistence expenditure of an average rural family to the annual tractor payments and dividing the sum by the net return per hectare to using the modern technology for durum production.

4 Assuming a biennial, durum - fallow rotation.

But, despite the increase since 1969 in the number of tractors in the locality due to the suppliers credits, the availability of a flow of custom services to small farmers varies according to the plain. Each of the three plains around Ebba-Ksour constitutes a separate market for tractor services. There are different degrees of competition among tractor owners on the plains of Zouarines, Abida, and Lorbeus, of which the competitive, oligopolistic, and collusive oligopolistic market structures of the model are the empirical counterparts.

On the 'competitive' plain of Zouarines, there are 40 owners of tractors with the capacity of the STEYR 870 who operate an average of 66 hectares of owned and rented land in cereals production. This is 59 hectares less than our estimate of full utilization of a tractor of this size, and many of them perform custom services. On this plain, at the prevailing prices for custom services, a farmer would have to cultivate 188 hectares of cereal land using the modern technology to justify purchase of a tractor.[21/] Since this exceeds by 63 the number of hectares which we assume can be cultivated by a tractor given the peak season requirements of the modern technology, we may conclude that prices on this plain are even below the long-run, competitive equilibrium.

On the 'oligoplistic' plain of Abida, there are only six tractor owners who provide custom services. They have colluded to fix prices at approximately 35% above those on the competitive plain. Finally, in

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21/ 188 hectares is derived by dividing the payments for the suppliers credit for a STEYR 870 tractor (1036.800/year) by the difference between the cost of custom tractor sercices on the competitive plain (11.000/ha.) and the variable cost of operating the tractor (5.479/ha). that is $\frac{1036.800}{5.521}$.

Table 9:

Rural Per Capita Expenditure Pattern, 1965-1968
in Dinars Per Year

Item		Yearly Expenditure
Food		27,000
Clothing		4,800
Housing		7,900
Medical		2,500
Amusement and Other		5,500
	Total Consumption Expenditures	47.700

Source: Republique Tunisienne, Institut National de la Statistique, La Consommation et les Depenses des Menages en Tunisie 1965-1968. Tunis, 1968.

Lorbeus, the collusive oligopolistic plain, the eight owners of tractors have agreed to provide no custom services, using them only on land which they operate (own and rent) themselves.

We have further hypothesized that the rental decisions may also be determined by the magnitude of the investible surplus of the small farmer. In the model, we distinguish among three income classes of small farmers. We now estimate the boundary (in number of hectares operated) between the Class I and Class II small farmers.

In a study of Tunisian consumption patterns conducted between 1965 and 1968, the following rural per capita consumption pattern was reported (see Table 9). Since the 47.700 dinar figure represents average consumption, a downward adjustment must be made to obtain a subsistence income. This is taken to be ½ of the average figure, or 23.850. The average family size of the small farmer sample was seven, and consequently Ma* is 166.950 per year. Based on a net return to the traditional technology of 27.000 it is possible to estimate the boundary of Class I and Class II to be 12.5 hectares, of which one half is planted annually ($27.000 \times 6.25 \approxeq 166.950$).

VI. Hypotheses

To the extent that the actual conditions of the different markets within the locality and on the three plains correspond to the assumptions specified in the model, the observations of the small farmer maximization decision should be consistent with the following hypotheses:

Hypothesis I: No rental will occur except at terms mutually beneficial to both small and large farmers. In other words, at the very least, neither party will be made worse off by the arrangement.

R will fall between the net return to the traditional technology (πX_{11}) and the net return to the modern technology (πX_{12}), the gross return minus variable costs.

The net return to the traditional technology is 27.000, or 36% of the total return of the modern technology; the net return to the modern technology is 47.736, or 64% of the gross return (see Table 6).

In fact, all observations of rental terms fell between 25% and 50%. Of 31 observations of rental in the locality, the average rental term was 35.4%. This is slightly less than the net return to the traditional technology, or 27.000. Aside from errors in estimating the partial budgets, there are several reasons why we might expect the rental term to be discounted.

1) the assymmetry of risks of rental arrangements; since the large farmer assumes all of the risk of losses from using the modern technology under dry land conditions, the small land owner may be willing to accept discounted rental terms;

2) collusion in the land rental market; it was observed that rental terms on the plain where there was a collusive oligopoly in the custom services market tended to be the lowest (generally, 30%) of the three plains. It is possible that the same farmers who have agreed not to provide custom services here have also colluded to maintain rental terms at a level below those of the other plains.

3) an interest payment for consumption advances; most small farmers take advances on their share of the harvest to meet the immediate consumption requirements of their households. The discounted rental terms reflect an interest payment for these time advances.

Hypothesis II: No small farmer of any class will be operating on the plain where there is a collusive oligopoly in the custom services market.

If custom services, following the impact of collectivization, are indispensible to operation by small farmers, and if none are available, all small farmers will be forced to rent. As Tables 3 and 5 demonstrate, all mechanizable land on the 'collusive oligopolistic' plain is now operated by large farmers. The transfer of land through the rental market from small to large farmers is completed here. This is consistent with the hypothesis.

Hypothesis III. No Class I farmer will be operating on any plain. The upper bound of the Class I small farmer, which represents the minimum size of a viable dryland cereals farm, was estimated to be 12.5 hectares. For 68 observations on the three plains of the locality, the average size of rented plots was 10.74 hectares. This is consistent with the hypothesis.

VII. Conclusion

With respect to the questions posed initially, we may conclude as follows: In the face of market conditions characteristics of a "dualistic" agricultural sector, small farmers have chosen to rent to large farm operators who used the modern technology for cereals production. The potential of profits from using the modern technology explains rental arrangements between large and small farmers. The restraints of dualistic market institutions have not prevented the diffusion of the modern technology.

Rental terms are generally such that neither party is made worse off by the arrangement. But, the small farmer is less well off that he would be if there were different institutions and market structures permitting him to adopt directly the modern technology. This would allow him, rather than the large farmer, to internalize the dividend gained from diffusion of the modern technology.

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