Working Paper Series

WORKING PAPER NO. 577

STRUCTURAL ADJUSTMENT AND THE PEASANTRY IN MOROCCO: A COMPUTABLE HOUSEHOLD MODEL APPROACH

by

A. de Janvry, M. Fafchamps, M. Raki, and E. Sadoulet

DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS

BERKELEY

CALIFORNIA AGRICULTURAL EXPERIMENT STATION

University of California

DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS
DIVISION OF AGRICULTURE AND NATURAL RESOURCES
UNIVERSITY OF CALIFORNIA AT BERKELEY

WORKING PAPER NO. 577

STRUCTURAL ADJUSTMENT AND THE PEASANTRY IN MOROCCO: A COMPUTABLE HOUSEHOLD MODEL APPROACH

by

A. de Janvry, M. Fafchamps, M. Raki, and E. Sadoulet

California Agricultural Experiment Station
Giannini Foundation of Agricultural Economics
January 9, 1991

STRUCTURAL ADJUSTMENT AND THE PEASANTRY IN MOROCCO: A COMPUTABLE HOUSEHOLD MODEL APPROACH

by

A. de Janvry*, M. Fafchamps#, M. Raki^, and E. Sadoulet*
*University of California at Berkeley
#Stanford University
^Institut Agronomique et Vétérinaire Hassan II, Rabat

I. STRUCTURAL ADJUSTMENT AND MOROCCAN AGRICULTURE

Moroccan agriculture has been deeply affected in the last decade by implementation of a set of macroeconomic and sectoral policy reforms. These reforms were triggered by the foreign sector crises that followed the end of the phosphate export boom in the mid-1970s and a decline in the capacity to borrow on the international financial markets starting in the early 1980s. Initiated in 1983, they included a depreciation of the real exchange rate with the consequent potential of benefiting agriculture as a producer of mostly tradable goods (Morrisson). They also included fiscal austerity leading to a reduction in consumer and producer subsidies and in public expenditures in health and education. Additional components of the package of reforms were trade liberalization for agriculture and industry and the privatization or abandonment of a number of activities in which the public sector had been directly involved in agriculture such as the provision of tractor services, seeds, fertilizers, and irrigation water. Starting in 1989, and as part of the negotiations of an agricultural structural adjustment program (ASAP) loan with the World Bank, a new set of rules was introduced for the pricing of grains (soft and hard wheats, barley, and maize). The purpose of these rules is to move from a system where the government fixed domestic prices and controlled all imports to a situation where transactions are liberalized and the government only affects import prices through variable levies, thus insuring a closer relation between domestic and international prices (Aloui, Dethier, and Houmy). Together with depreciation of the real exchange rate, these price reforms have the potential of reversing the historical discrimination against the cereals sector and of creating significant benefits for cereals producers.

The objective of this paper is to analyze what these new rules for cereals price formation may imply for the weaker segments of Moroccan society, namely the small and medium farmers in nonirrigated areas who account for the majority of the poor. Changes in cereals prices by a significant magnitude as proposed in ASAP will affect all other prices particularly through the exchange rate for tradables and through shifts in supply and demand for nontradables. We trace out these price effects at the macroeconomic and aggregate sectoral levels by using a computable general equilibrium (CGE) model (based on Mateus) and, at a greater level of disaggregation within agriculture, a multimarket model (Aloui et al.). At the household level, changing prices imply complex reallocations in production and consumption as well as in the distribution of the burden of work across household members. Because a certain number of markets for products (milk in some regions) and factors (child labor which is very important in animal production in a context

of property rights without enclosures and of access to commons) are missing, and because of eventual credit constraints, decisions regarding production and consumption are not separable and the reallocations are traced out in a household model that solves simultaneously for these decisions.

We start, in Part II, by explaining the new rules of price determination for cereals and we use the CGE and multimarket models to predict the expected changes in the price vector to which farm households will be confronted when the new rules apply. In Part III, we use data from a farm household survey to characterize the structure of small and medium farms in the Haute Chaouia, a region of dryland agriculture and extensive poverty in spite of its proximity to Casablanca. We then proceed, in Part IV, to construct a computable model of household behavior with missing markets and credit constraint. This model is used, in Part V, to simulate the changes in resource allocation and welfare that the predicted price changes may have. The results allow us to derive, in Part VI, a set of policy implications with the potential of enhancing the positive effects of the price reforms on the welfare of Moroccan peasants.

II. NEW PRICING RULES FOR CEREALS

2.1. Predicted cereals prices

Price formation for cereals has traditionally been highly intervened by government. For soft wheat and corn, which are both imported, this was done by price fixing by the government parastatal, ONICL, and quantity adjustment through monopolistic control over imports. Prices were also set for hard wheat and barley, but the fact that these two cereals were nontradables did not allow government to control quantities and made the price controls ineffective. As a result of rent seeking competition, this system of price determination has led to severe price distortions against cereals in favor of industrial and export crops produced in the irrigated areas. In addition, financial weakness of ONICL periodically led to food shortages. The bias against cereals has resulted in both an efficiency cost, since Morocco has comparative advantages in cereals, and a welfare cost since the peasantry is the main producer of cereals (74% of cereals is produced on farms of less than 20 hectares (Raki)) and this principally in the nonirrigated areas where rural poverty is concentrated.

The new pricing rules have the objective of tying domestic prices to world market prices and of eliminating the price bias against cereals, thus providing incentives to cereals production and improving the incomes of peasant households in the less favored areas. The rules consist in the determination of an import reference price that is based on the calculation of two base level prices:

1. An international "threshold" level equal to the average world price over the last five years, plus freight and insurance and a protective tariff of 25%.

2. A minimum guaranteed price. For soft wheat, barley, and corn, this minimum price is equal to the 1986 official producer price updated for inflation. For hard wheat, the minimum price is set by multiplying the soft wheat minimum price by the ratio of the two

cereals threshold prices, considered to provide a fair margin determined by the international market.

The import reference price that actually applies is the maximum of these two base level prices, augmented by 10% to take into account domestic transportation and storage costs. This import reference price is then used to determine the levy applied to imports. With liberalized international transactions, the domestic producer price should settle at the import reference price, provided the country is in deficit. A particular clause applies to the case of a surplus. It establishes an export subsidy scheme to insure a minimum producer price equal to the average world price over the last five years. This eventuality, which should only occur with barley during good years, is not considered here. While the new price system should, in theory, create a link between world market prices and domestic prices, the minimum guaranteed price has in fact prevailed over the international threshold price for the first year of implementation in 1989.

In Appendix Table I, we apply this new price mechanism to compute what would have been the reference import price for 1988 had the ASAP been implemented in that year. According to these calculations, the resulting post-reform producer prices should be, in Dirhams per ton:

Hard wheat	2784,
Soft wheat (mills)	2313,
Barley	1909,
Corn	2082.

To characterize the pre-reform situation that actually prevailed, we compute the average real official price in 1986-1988 for the two controlled cereals (soft wheat and corn) and the average 1985-1987 market price for the two other cereals (hard wheat and barley) that have been completely nontraded over the last seven years and for which the price controls have been ineffective. The resulting pre-reform producer prices, in 1988 Dirhams, are:

Hard wheat	2363,
Soft wheat (mills)	2050,
Barley	1471,
Corn	1845.

An adjustment needs to be made to the calculation of the price of soft wheat as it includes both wheat processed by mills (60% of total) and artesanal wheat. From the study of Aloui et al., we know that the change in the price of soft wheat is 1.12% greater than the price of wheat going through the mills. The expected price changes due to the reform are consequently:

Hard wheat	17.8%,
Soft wheat	14.4%,
Barley	29.7%,
Corn	12.9%.

Using the shares of these different cereals in production, this corresponds to an overall price increase of 20.1% for cereals (Table I).

2.2. Transmission to other prices: CGE predictions

These changes in the prices of cereals are sufficiently large that they can be expected to have significant macroeconomic effects and hence affect all the other prices in the economy. This can be simulated using the Mateus-Sadoulet CGE model for Morocco. This model integrates all the sectors of the economy and the balance-of-payments constraint. It is homogenous in all prices and consequently solves only for relative prices and needs a numéraire. To keep closer to the information on nominal prices which is given by the previous analysis, we use the exchange rate as the numéraire and leave the macroeconomic adjustment (i.e., equilibrium in the balance of payments) to occur through the overall level of domestic prices. To capture a medium run response, we allow for the reallocation of agricultural land and capital across activities in response to changes in relative profitabilities with a partial adjustment coefficient of 0.6. On the labor market, there is full employment and an equilibrium wage for unskilled labor and unemployment at an institutional wage for skilled labor.

The simulation experiment consists in an increase in the import tariff on cereals to raise the domestic price by the same amount which the new pricing rules predict (i.e., 20.1%). The main macroeconomic result, which is to be expected in an economy which produces the same cereals that it also imports (Sadoulet and de Janvry), is a sharp reduction in cereal imports coming from both an increase in domestic production by import substitution and a decrease in consumption. The relief on the balance of payments which this creates is shown by the resulting appreciation of the real exchange rate, reflected here in an overall domestic price increase of 5.7% relative to the exchange rate.

In terms of sectoral price changes, the other agricultural sector (which includes the very large livestock sector) and the food processing sector get substantial price increases (14.3% and 9.1%, respectively), while the other industrial and services sectors have only moderate price changes. To infer the increase in the livestock price, we assumed that the other components of this large sector (forestry and fishing) have not been affected and attribute all the price increase to livestock, resulting in a 14.3% increase. Agricultural wages increase by 6.7%.

2.3. Disaggregation of the agricultural prices: multimarket predictions

The agricultural sector is more aggregated in the CGE than in the household model. We therefore use the Aloui-Dethier-Houmy multimarket model, which has nearly the same disaggregation as the household model, to predict the price changes for the more disaggregated products and factors that appear in the household model. To preserve consistency with the CGE, we keep the aggregate livestock price level predicted by the CGE (14.3%) and use the multimarket to distribute this price increase across components of the livestock sector (milk, meat, and forage). The resulting vector of price increases that will be used to simulate household responses is reported in the last column of Table I. Before constructing a model of household behavior, we characterize the features of peasant households in the region analyzed.

III. FARM HOUSEHOLD CHARACTERISTICS IN THE HAUTE CHAOUIA

The Haute Chaouia region, located in the Settat Province, is an area of dry land and highly uncertain rainfall where the main economic activities are cereals production and livestock. The data we use to characterize the structural characteristics of small (0 to 10 hectares) and medium (10 to 50 hectares) farms in Table II derive from a survey of 88 households conducted in 1986-87 (Mohamed) and from a number of in depth case studies of households conducted by students of the Institut Agronomique et Vétérinaire Hassan II in Rabat. These farms have sharply contrasted cropping patterns, schemes of labor use, sources of income, and degrees of reliance on the market for food consumption.

Land in the region is highly unequally distributed. Census data indicate that small farms account for 82% of the total number of farms and only occupy 34% of the land area. Medium size farms represent 15% of farms and 34% of the land area. Resources per hectare decline with farm size reflecting the scarcity of land on the small farms: Labor declines from 0.96 adult equivalent to 0.31 and livestock units from 1.02 to 0.41. Collective grazing lands are however important in this Province, as in most areas of dry land in Morocco, and they provide a complementary resource which is fundamental to small farmers. Because of this, the economy of small farms tends to be importantly vested in livestock activities while that of medium farms is mainly oriented at the production of crops.

Cereals account for 72.5% of the value of crop output on the small farms and 83.7% on the medium. Among cereals, hard wheat, a food crop used importantly for home consumption, represents 37.1% of cereals production on small farms compared to 31.3% on the medium. By contrast, soft wheat, a cash crop, represents 8.1% of cereals on the small farms and 31.3% on the medium. Coarse grains production, principally barley used for animal feed, is more important on the small (54.8% of cereals production) than on the medium (44.1%) farms, reflecting the fundamental role of animal production on the former.

Animal production accounts for 55.5% of total gross agricultural output on the small farms and 32.4% on the medium. While the production of milk and meat increases with farm size, it declines sharply on a per hectare basis from 1,819Dh to 656Dh due to access to collective grazing lands. The availability of child labor is crucial for livestock production both on private and collective lands since neither is enclosed.

Integration between crops and livestock is a condition for success on all farms. Crops benefit from animal manure and fallows that serve for grazing. An important part of animal feed is a recycling of by-products from crops such as straw, stalks, fallows, and residues from leguminous crops. Most farms do not have access to a market for milk due to large price bands associated with perishability and poor transportation facilities. As a result, milk production is mainly for home consumption, and milk will be treated in the household model as a product for which the market fails.

Family size is larger on the medium (7.1 adult equivalent units) than on the small (4.9 units) farms, reflecting the facts that demography may still be bound by income among small farmers and the greater levels of outmigration on the smaller farms. In spite of this, the small farms have a surplus of labor and sell labor on the wage market. Thus male labor time is distributed as follows: 40.2% on-farm labor, 26.6% wage labor, and

33.2% (also refered to as "leisure"). Female labor is distributed between 57.3% on-farm labor, 6.7% wage labor, and 36% home time. The medium farms, by contrast, have a labor deficit which they make up by hiring-in wage labor. Male labor time is distributed 38.5% on-farm work and 61.5% home time while female labor is 12.6% farm labor and 87.4% home time.

Labor allocation in the household is quite clearly defined by age and sex. Adult males principally concentrate in work on crops, services (commerce particularly), and off-farm wage labor, including migration to Casablanca. Married women are in principle classified as unemployed. They in fact participate actively to field labor at peak times of labor needs; they help watch animals, particularly if these are kept on the farm; and they generate side revenues in activities such as butter, weaving, and the raising of minor animals like poultry. Children are fundamentally occupied in the herding of animals on fallows, stalks, and collective grazing lands. It is a very low productivity activity but essential to the net income of the household. Young girls are also involved in herding but usually only in the immediate proximity of the home.

Rural households in the Chaouia are in general reticent to let women work for a wage in other households' lands. However, only the richer households can afford this luxury. On small farms, many women participate to the seasonal labor market. Because of intense male migrations to the cities and foreign countries, wages for seasonal labor are highly attractive. In the household's choice, the substitution effect between male and female labor partially counteracts the income effect on the demand for female home time. Small farms are thus observed to have a small surplus of female labor while the medium farms have a large deficit.

There is practically no market for child labor, even though a few transactions are reported for herding. This is due to three reasons. First, there is a problem of moral hazard in the supervision of child labor since children can be easily abused and parents little inclined to take this chance. Second, children are fundamentally used for herding, an activity with relatively little seasonality and hence thin seasonal labor markets. Finally, even though lack of proper care can be highly detrimental to the animals, it is virtually impossible to supervise herding labor. As a result, it is difficult to motivate children to take proper care of the animals, unless this is done within the family. This market failure for child labor explains the emergence of a variety of institutional arrangements which are used to secure child labor for herding such as the practice of adoption by childless households and share contracts with herders who have children of their own. But, by far, most child labor is from the family itself and we will assume that there is market failure for child labor.

Off-farm incomes are important for all farms as they represent 28.5% of total net income on the small farms and 10.5% on the medium. The types of off-farm incomes vary with farm size, with salaried agricultural labor important for the small farms and remittances from migrants, handicrafts, and services (commerce and the rental of machinery) for the medium. This difference is due to the fact that higher savings rates on medium farms and better access to credit allow them to invest in these productive activities.

Both the small and the medium farms have marketed surpluses of hard wheat and meat. For soft wheat and coarse grains, the small farms are net buyers while the medium farms have marketed surpluses. All three types of cereals are thus important cash crops for the medium farms. The small farms have a large deficit in coarse grains due to their use as animal feed and the great importance of animals in their economies. Both types of farms also produce forage for animals and are deficitary, buying forage that is shipped from irrigated areas. Grazing on the commons offers a substitute to purchased forage for as long as child labor can be sufficiently mustered for this purpose.

The cash balances for small farms are thus composed, on the income side, of the sale of a marketed surplus of hard wheat and meat, the sale of male and female labor, and the sale of handicrafts and services; on the expenditure side, of the purchase of food (soft wheat, coarse grains, and leguminous crops) and other consumption goods, the purchase of inputs (fertilizers, machinery, and forage), the depreciation of fixed factors, and savings. For the medium farms, the income side is composed of the sale of a marketed surplus of hard wheat, soft wheat, coarse grains, and meat and of handicrafts and services; the expenditure side includes leguminous crops, other consumption goods, inputs (fertilizers, machinery, and forage), depreciation, and savings.

We now proceed to construct a household model that captures the structural features identified above, including the existence of market failures for milk (which is of marginal importance as this production is fairly secondary) and child labor (which is quite important as livestock is a fundamental source of income, for the poorer households especially) and eventual credit constraints in responding to price signals.

IV. A HOUSEHOLD MODEL WITH MARKET FAILURES AND CREDIT CONSTRAINT

4.1. The Model

The household model developed here aims at capturing the decisions of two types of households representative of small and medium farms in the Haute Chaouia. The household produces ($q \geq 0$) hard wheat, soft wheat, coarse grains, other crops (leguminous, fruits, and vegetables), forage, milk, and meat. Non-agricultural sources of income include handicrafts and services and the sale of labor. The factors ($q \leq 0$) it uses in production are machinery and fertilizers; coarse grains and forage; male, female, and child labor; and the depreciation of fixed factors. Products and factors are related through the production technology $G(q, Z)$, where Z is a vector of structural characteristics of the farm household and fixed factors (land, livstock, and capital). The household consumes ($c \geq 0$) hard wheat, soft wheat, coarse grains, other crops, milk, meat, nonagricultural goods and services, home time (male, female, and child), and they also save.

The household has initial endowments ($T \geq 0$) in total time (male, female, and child) and receives net transfers S. Expenditures on machinery, fertilizers, forage, and hired labor have to be incurred ahead of harvest and this requires financial liquidity at that time of the year. For this, the household has access to credit in an exogenous amount K (including transfers received ahead of harvest) and to cash income from wage earnings if it is a net seller of labor. Since all farms have a surplus of coarse rains, they carry over

stocks of these grains with the result that they do not enter in the liquidity constraint. According to the net of these entries and outlays that occur before harvest, the credit constraint may be binding or not.

The household may be a net seller or a net buyer of any product and factor. It is a price taker ($\bar{p}$) for all products and factors for which markets exist (or more exactly for which the subjective equilibrium price falls outside a price band between risk equivalent sale and purchase prices). For milk and child labor, market failure (or a subjective equilibrium within the effective price band) implies that an internal equilibrium must obtain between the supply (q + T) and demand (c) of these nontradable commodities.

The household maximizes a utility function, U(c, z) where z denote exogenous household characteristics, with respect to production and consumption decisions subject to a cash constraint, a credit constraint, a technology constraint, and equilibrium conditions for tradables and nontradables. Goods are decomposed into three subsets:

Tradables which are not subject to a credit constraint, TNC;
Tradables subject to a credit constraint, TC;
Jointly, these two subsets of tradables are also indexed as T.
Nontradables, NT.

The household's problem is thus to:

(1.a) $\underset{c,q}{\text{Max}}\ U(c, z)$ subject to:

(1.b) $\sum_{i\in T} p_i(q_i + T_i - c_i) + S \geq 0,$ cash constraint,

(1.c) $\sum_{i\in TC} p_i(q_i + T_i - c_i) + K \geq 0,$ credit constraint,

(1.d) $G(q, Z) = 0,$ production technology,

(1.e) $p_i = \bar{p}_i, \quad i \in T,$ exogenous market price for tradables,

(1.f) $q_i + T_i = c_i, \quad i \in NT,$ equilibrium for nontradables.

The Lagrangean associated with the constrained maximization problem is written as:

$$L = U(c, z) + \lambda\left[\sum_{i\in T} \bar{p}_i(q_i + T_i - c_i) + S\right] + \eta\left[\sum_{i\in TC} \bar{p}_i(q_i + T_i - c_i) + K\right]$$
$$+\phi\, G(q, Z) + \sum_{i\in NT} \mu_i(q_i + T_i - c_i).$$

The three types of goods can be treated symmetrically in the first order conditions by defining endogenous decision prices as follows:

(2.a) $p_i^* = \bar{p}_i, \quad i \in TNC,$

(2.b) $p_i^* = \bar{p}_i(1+\lambda_c), \quad \lambda_c = \eta/\lambda, \quad i \in TC,$

(2.c) $p_i^* = p_i = \mu_i/\lambda, \quad i \in NT.$

Since the credit constraint may not be effective, we use the Kuhn-Tucker conditions for this constraint, and the first-order conditions can be written as:

(3.a) $U_i' = \lambda p_i^*,$ $\quad i \in$ all consumer goods,

(3.b) $\sum p_i c_i = \sum p_i (q_i + T_i) + S,$ $\quad$ all i, full income constraint,

(3.c)
$$\begin{cases} \eta\left[\sum_{i\in TC} p_i(q_i + T_i - c_i) + K\right] = 0 \\ \eta \geq 0 \\ \sum_{i\in TC} p_i(q_i + T_i - c_i) + K \geq 0 \end{cases}, \quad \text{credit constraint,}$$

(3.d) $\phi\, G_i' = -\lambda p_i^*,$ $\quad i \in$ all producer goods,

(3.e) $G(q, Z) = 0,$ $\quad$ technology,

(3.f) $q_i + T_i = c_i,$ $\quad i \in$ NT, equilibrium nontradables,

(3.g) $p_i = \bar{p}_i,$ $\quad i \in$ T, equilibrium tradables.

where U_i' and G_i' are the partial derivatives of U and G with respect to c_i and q_i, respectively.

These first-order conditions fall into four blocks of equations:

(1) Consumption decisions are taken in equations (3.a) and (3.b),
(2) The credit constraint is imposed by equations (3.c),
(3) Production decisions are taken in equations (3.d) and (3.e),
(4) Equilibrium conditions for price formation are given by equations (3.f) and (3.g).

At the level of the reduced form, these four blocks of equations can be written as follows. Production decisions that satisfy equations (3.d) and (3.e) are represented by a system of supply and factor demand functions in the endogenous decision prices p^* that derive from maximizing a generalized profit function Π^* for all tradables and nontradables:

(4.a) $\Pi^* = \Sigma p_i^* q_i,$

(4.b) $q = q(p_i^*, Z).$

On the demand side, decisions are also made in terms of the p* prices in equation (3.a). The income constraint in p* prices is derived as follows from the full income and the credit constraints (3.b) and (3.c):

$$Y^* = \sum_i p_i^* c_i = \sum_i p_i c_i + \lambda_c \sum_{i \in TC} p_i c_i,$$

$$= \sum_i p_i (q_i + T_i) + S + \lambda_c \left[\sum_{i \in TC} p_i (q_i + T_i) + K \right],$$

$$= \sum_i p_i^* (q_i + T_i) + S + \lambda_c K,$$

(4.c) $$= \Pi^* + \sum_i p_i^* T_i + S + \lambda_c K,$$

which is equivalent to an extended full income constraint.

Equations (3.a) and (4.c) define a demand system

(4.d) $c = c(p^*, Y^*)$,

that maximizes the utility function (1.a) under the extended full income constraint (4.c).

The Kuhn-Tucker condition (3.c) on the credit constraint can also be rewritten using a slack variable K_{net} in the credit constraint as:

(4.e) $K_{net} \lambda_c = 0$,

(4.f) $K_{net} = K + \sum_{i \in TC} \bar{p}_i (q_i + T_i - c_i) \geq 0$,

(4.g) $\lambda_c \geq 0$.

In these equations,

- either the credit constraint is effective in which case $K_{net} = 0$ and $\lambda_c > 0$;
- or it is ineffective in which case $K_{net} \geq 0$ and $\lambda_c = 0$.

The household model with nontradables and credit-constrained tradables thus contains three sets of prices: Decision prices, prices of tradables, and prices of nontradables. Decision prices p* affect how production and consumption decisions are taken to accommodate the credit constraint. The endogenous markup λ_c on the price of the credit constrained tradables serves to raise the decision price of the credit constrained tradable products and factors with a positive marketed surplus (in particular labor on the small farms). Even though these goods are transacted at the market price $\bar{p}$, their supply increases and their home use falls, since $p^* > \bar{p}$, reflecting the fact that higher exports of these goods and factors help ease the credit constraint. Similarly, the endogenous

markup λ_c raises the decision price of the credit-constrained tradables of which the household is a net buyer, such as forage on all farms and labor on the medium farms, inducing it to produce more of them for import substitution and to use less of them in production. Even though the transaction occurs at the market price $\overline{p} < p^*$, imports of these goods and factors are reduced to accommodate the credit constraint.

The model to be solved is thus composed of the four blocks of equations:

production decisions (4.a and 4.b),
consumption decisions (4.c and 4.d),
credit constraint (4.e, 4.f, and 4.g), and
equilibrium conditions for price formation (3.f and 3.g).

Because of the existence of both a credit constraint that transforms the prices of credit-constrained tradables into endogenous prices and of endogenous nontradables prices, production and consumption decisions are not separable. This system of equations consequently needs to be solved simultaneously. Since this is analytically intractable, we proceed by setting up a computable version of this model as follows.

V. A COMPUTABLE VERSION OF THE HOUSEHOLD MODEL

Functional forms need to be specified for the profit function and the indirect utility function. Because we start from an equilibrium point where the credit constraint is postulated to be exactly satisfied, $K_{net} = 0$ and the two systems can be written in terms of market prices for all tradables. For the nontradables, measurement units are chosen for their prices to be equal to one.

The profit function used is a Generalized Leontief,

$$\Pi = \sum_{i,j} b_{ij}\sqrt{p_i p_j} + \sum_{i,m} b_{im} p_i Z_m$$

with a derived system of output supply and factor demand,

$$(5) \qquad q_i = \sum_{j} b_{ij}\sqrt{p_j / p_i} + \sum_{m} b_{im} Z_m, \text{ with } b_{ij} = b_{ji}.$$

To determine the values of the b_{ij} and b_{im} parameters of this system, we start from a set of "best guess" price and fixed factor elasticities derived from the literature. For the medium farm, these elasticities are taken principally from the multimarket model for Moroccan agriculture by Aloui et al., complemented with values derived from the compilation of elasticities for the Middle East and North Africa by Sullivan et al. These elasticities are then calibrated to satisfy the constraints that a Generalized Leontief profit function implies. We do this by using an algorithm that minimizes, with respect to b_{ij} and b_{im}, the sum of the squares of the discrepancies between this initial set of elasticities and

a set of new elasticities that derive from the Generalized Leontief, keeping untouched the diagonal values on which we have the greatest confidence.

For the small farm, the elasticities are equal to the medium farm elasticities calibrated to their corresponding level of fixed factors. The reason why it is necessary to do this is because the unit of measurement of the parameter b_{ij} in equation (5) is in the dimension of $b_{im}\, Z_m$. In addition, we want the supply and demand system to show constant returns to scale in the fixed factors, whatever the price system. That is, if all the Z_m are multiplied by k, q_i should also be multiplied by k. For this, b_{ij} must be multiplied by k and also $\Pi = \Sigma pq$.

If we take $k = \frac{\Pi^{small}}{\Pi^{medium}}$, then $b^s_{ij} = \frac{\Pi^s}{\Pi^m} b^m_{ij}$. The generalized Leontief elasticities are $E_{ij} = \frac{1}{2} b_{ij} \frac{1}{q_i}$. The elasticities for the small farms are thus obtained from those for the medium farms as:

$$E^s_{ij} \frac{q^s_i}{\Pi^s} = E^m_{ij} \frac{q^m_i}{\Pi^m} \quad \text{or} \quad E^s_{ij} = \frac{w^m_i}{w^s_i} E^m_{ij} \quad \text{where} \quad w_i = \frac{p_i q_i}{\Pi} \text{ are the profit shares.}$$

These elasticities satisfy exactly the constraints on elasticities that derive from a Generalized Leontief profit function as the E_{ij}^{medium} already do. These two sets of elasticities are given in Appendix Table II.

The price and income elasticities in consumption are derived from AIDS systems estimated for rural areas by Laraki and by Stryker et al. and from point estimates of elasticities for the Chaouia calculated from the household survey. These first guess elasticities are calibrated using the same algorithm as above to satisfy all the additivity and symmetry constraints that they must meet to derive from a Translog indirect utility function,

$$V = \sum_k \alpha_k \ln(p_k / Y) + \frac{1}{2} \sum_{k,l} \beta_{kl} \ln(p_k / Y) \ln(p_l / Y)$$

where $Y = \Pi + \sum_i p_i T_i + S$, full income, which gives the expenditure system,

$$\frac{p_i c_i}{Y} = \frac{\left[\alpha_i + \sum_j \beta_{ij} \ln p_j / Y \right]}{\left[\alpha_Y + \sum_j \beta_{Yj} \ln p_j / Y \right]},$$

where

$$\alpha_Y = \sum_i \alpha_i, \beta_{Yj} = \sum_i \beta_{ij}, \text{ and } \beta_{ij} = \beta_{ji}.$$

These elasticities are reported in Appendix Table III.

VI. SIMULATION RESULTS

6.1. Simulations of single price changes

We have seen that the new pricing rules for cereals imply a sharp increase not only in the prices of hard wheat (17.8%), soft wheat (14.4%), and coarse grains (27.8%), but also, indirectly through general equilibrium effects, in the prices of forage (24%) and meat (12.8%) and in the agricultural wage (6.7%). Before analyzing the joint effect of these direct and indirect price effects, we simulate the separate effects of a 10% increase in these prices to understand how they each affect the two types of rural households. Partial results are given in Table III.

Both farm types are net sellers of hard wheat and consequently benefit from a higher price. The marketed surplus of hard wheat increases in both farms. Since cereals production is demanding principally in men labor time, male labor required for production increases. The income effects induce the consumption of more home time. Higher on-farm labor needs and more home time thus lead to a fall in the sale of male wage labor by the small farmers (-1.1%) and to a sharp increase in the hiring of wage labor by the medium farmers (7.7%). Because there is a high marginal utility of income for home time among women, the impact is much greater on female labor: The sale of wage labor by women on small farms falls by 10.2% while the hiring of female labor on the medium farms increases by 12.2%, allowing an increase in their consumption of home time, particularly on the medium farms. The impact on animal production and consequently on child labor is small, indicating that cereals and animal production do not compete importantly.

When it is the price of soft wheat that increases, the contrasted effect on small versus medium farms comes from the fact that the medium are net sellers of soft wheat, and thus receive an income gain from the price change, while the small are net buyers, and consequently face a rising consumption cost. The sale of a marketed surplus of soft wheat thus increases by 11.3% on medium farms while the purchase of soft wheat falls by 23.4% on the small. The negative income effect on the small farms is reflected by more on-farm work for men, more sale of wage labor, and a fall in home time. These effects are all reversed on medium farms where utility increases. All family members enjoy more home time and the farm makes up for the labor deficit by greater hiring-in of outside wage labor (5.5% male and 7.9% female). Improving the welfare of the small farmers would consequently require lowering the price of soft wheat or using technological change in soft wheat to compensate for rising prices. A rising price of coarse grains would have the same unequal welfare effects as a rising price of soft wheat since small farmers are net buyers while medium farmers are net sellers.

A rising price of forage creates a sharply negative income effect on both types of farms as they are net buyers, particularly the small ones whose economy is heavily vested in animals. More interestingly, it also creates a perverse effect on the labor of

children in spite of the fact that they are not particularly involved in the production of forage and that the production of livestock declines due to higher production costs. This is due to the fact that rising forage prices lead to a substitution in the use of animal feed toward coarse grains and grazing in the commons. Since the latter requires child labor, we see that the substitution effect is greater than the effect of declining meat production on the demand for child labor. Their workload increases and their home time declines correspondingly, particularly on the small farms. Children and the commons thus bear the burden of adjusting to higher forage prices.

We have seen that all farms are important producers of meat, but particularly the small for whom it accounts for a very large share of total income. A rising price of meat thus allows to sharply increase the home time of men (4.8%) and especially of women (10.7%) on the small farms, and to a lesser extent also on the medium farms (3 and 7.6%, respectively). Greater adult home time leads to less sale of wage labor by the small farmers, particularly female labor (-60%), and more purchase by the medium, particularly of female labor (29.5%). In production, male labor is replaced by female labor as women are more important than men in animal husbandry. Because the consumption of meat, in spite of a high income elasticity, does not increase due to the price effect, it is the consumption of the other goods, mainly purchased manufactured goods, that increases sharply (4.7% on small and 3% on medium farms (not reported in Table III)), indicating the importance of an elastic supply of manufactured consumption goods in inducing peasant households to respond to higher prices.

The more interesting part of the story of rising meat prices is, however, on children who are very important for animal production and for whom there is no labor market. The use of child labor in production increases (0.6% on small and 4.5% on medium farms) and their home time decreases correspondingly. The shadow price of child labor, which indicates its scarcity value, increases sharply (by 3.4 and 3.5%, respectively), indicating the pressure that exists for the provision of child work. The rising price of a tradable factor thus rejects adjustment on the nontradable factor. Were this nontradable a tradable, the elasticity of price response would be even higher as there would be no price effect. Market failures on the factor side thus reduce the elasticity of supply response of tradables. The cost of this demand on child time has to be less school attendance and more pressure on the commons which are used proportionately to child labor. Higher illiteracy and more ecological destruction are thus the long run costs of higher meat prices. This is not the case when price increases occur in cereals which are intensive in adult labor, men principally. We thus conclude that higher meat prices create strong welfare gains for the adult population, particularly on the small farms and for women, and much higher than an equal percentage increase in the price of cereals, but that this happens at a high cost in terms of child labor and overgrazing in the commons.

The fifth experiment in Table III consists in raising the wage of male labor by 10%. Since the small farms are net sellers of labor while the medium are net buyers, this has opposite effects on their welfare, with the small gaining and the medium losing. The small farms respond by selling more male wage labor (1.9%), using less male labor in home production (-1.5%), and increasing the home time of all labor categories as a result of a positive income effect. Crops production falls as the opportunity cost of adult labor has increased. Medium farms, by contrast, hire less male labor (-18.6%), use less labor in production (-2.8%), and substitute family male and female labor for previously hired labor,

with the result that male and female home time decline due to both income and substitution effects. Like on small farms, crops production also falls but not for the same reason and not to the same extent: It falls because labor costs have risen, but the impact on production is mitigated by reduced family home time. On both farms, male labor is principally used in cereals production and the production of these crops decline.

Finally, when it is the wage of women that increases by 10%, the resulting readjustments, that occur for very different reasons on the small and medium farms, are devastating on their home time. Small farmers are net sellers of female labor and consequently gain from a higher wage. With rising wages, female labor in farm production decreases (-0.7%), their off-farm wage labor increases sharply (90.1%), and their home time declines (-16.2%). Farm production declines correspondingly to their lower participation to farm work, but the net effect of higher family income and greater demands for farm work leave male home time unchanged. The medium farmers are net buyers of female labor. Higher wages lead them to reduce the hiring of female workers (-53.9%) and to substitute family female labor for previously hired workers. The net is to leave production and the welfare of the other members virtually unchanged, while the work load of women increases sharply and their home time falls by 15.8%.

These experiments thus show that the output and welfare effects of changes in different product and factor prices are sharply contrasted across farm types and across household members. Global statements about the effects of rising product prices or rising wages are consequently much more meaningless than could have been thought at first sight, calling upon a great degree of caution in assessing the effects of structural adjustment on the welfare of different members of the peasantry.

5.2. Impact of the Agricultural Structural Adjustment Program

The new pricing rules for cereals introduced by the ASAP, together with the secondary effects they induce in other prices and wages, result in a complex set of readjustments that are given in Table IV. Since the changes are very large, the possibility of a credit constraint on the ability to respond to price incentives arises and we consequently simulate the effects of ASAP when this constraint is alternatively present and relaxed.

While it is no longer possible to see what exactly comes from which price change, the net effect is clearly contrasted between small and medium farms, with the medium farmers deriving significant welfare gains from ASAP while the gains are much more modest for the small farmers as they are caught, on the consumption side, by rising food prices of which they are important buyers. Rising cereals prices distort the farm economy towards crops and away from livestock. In this response, it is the medium farms that are more constrained by credit needs as the shadow price of credit rises by 2.9% on these farms as opposed to 0.4 on the small. This is due to the fact that the small farms are importantly engaged on the labor market as net sellers and consequently find in wage incomes an important source of credit. While all labor income is not available at the time when credit is needed, it nevertheless provides important liquidity. The effect of the credit constraint on the medium farmers is to sharply reduce their ability to hire labor and to expend on machinery and fertilizers. As a result, even though cereals prices rise, the

hiring of female labor and the use of machinery and fertilizers fall to accommodate the hiring of more male labor. Relaxing this constraint, by contrast, allows them to hire more labor and use purchased inputs, significantly increasing their aggregate elasticity of supply response. As pointed out by Mundlak, the aggregate elasticity of supply response is thus highly dependent on the elasticity of effective factor supply to the farm, determined by credit in this particular case.

On the small farms, the credit constraint prevents these households from reducing the sale of labor in spite of rising farm prices and the incentive to import substitute. This is because the labor market is their source of access to credit. When this constraint is relaxed, the sale of labor falls sharply (-4.7% for men and -59.1% for women) and the elasticity of supply response increases. Eliminating the credit market failure thus increases the elasticity of supply response of the traded goods that make use of credit in production.

The paradoxical result of ASAP is that, in spite of displacing the farm economy from livestock to crops, resulting in a falling production of milk and meat, rising forage prices induce a substitution in meat production from the use of forage to the use of grazing in the commons and hence intensified need for child labor. As a result, the use of children in production increases, their shadow price rises sharply, and their home time falls. Market failure for child labor and access to commons reduce the negative effect of ASAP on the livestock economy. But, as mentioned before, the long run consequence in increased school absenteeism and increased overgrazing in the commons, two of the curses of Moroccan underdevelopment.

We thus conclude by observing that the price adjustments brought about by ASAP, which are typical of the effects of foreign sector crises on agriculture, are highly positive on the welfare of medium farmers who have important marketed surpluses, particularly if the ASAP is accompanied by credit availability that allows them to incur the higher cash expenditures necessary for the hiring of labor and the use of modern inputs. For small farmers, rising prices are a mixed blessing as they are important buyers of cereals for consumption and feed. And relaxation of the credit constraint only brings small relief as they, in any case, can use the labor market as a source of cash at a small efficiency cost. As such, the effects of ASAP are regressive on the distribution of income on agriculture. As we will argue in the conclusion, ASAP needs to be complemented by vigorous programs of rural development targeted at small farmers if this unequalizing effect is to be avoided. In all types of farms, however, the effects are negative on the welfare of children, and thus indirectly on literacy and the environment, unless the productivity of forage production is enhanced, suggesting as well complementary types of interventions to the price effects of ASAP if these negative consequences are to be avoided.

5.3. Structural changes: animals and children

We finish by simulating in Table V the effects of two structural changes on the welfare of farm households. One is an increase in the number of animals and the other in the number of children.

When the number of animals increases, there is a shift in production from cereals to livestock and the welfare of particularly small farmers rises as livestock is so important to them. Labor in farm production increases, but mainly that of women and children since they are essential in animal husbandry. The result is that improved welfare allows to reduce the sale of family labor on the wage market in the small farms and to increase the hiring of labor on the medium. The consumption of adult home time increases, although the income effect on women home time is reduced by their role in animal husbandry. Children, however, pay the cost of improved household welfare. The shadow price of their work rises, their work load increases, and their home time falls. Shifting the farm economy toward animal production thus has strong negative effects on schooling and on overgrazing in the commons.

Finally, a rising number of children is a Pareto optimal change for all household members on both farm sizes. It allows to increase livestock production, reduce the production of cereals, sell less labor on the small farms and hire more labor on the medium farms, and increase the consumption of home time by all household labor categories. The shadow price of child labor in farm production declines. This result suggests that continued demographic growth in Moroccan peasant households is indeed a rational initiative. Children and animals are fundamental sources of wealth for these households, creating the contradiction of increased pressure on the commons.

VI. CONCLUSION

This paper made, we believe, the significant contribution of opening the field of computable non-separable household (CNH) modeling as a microlevel instrument of policy analysis. This can be thought of by analogy with the computable general equilibrium (Johansen; Adelman and Robinson; Taylor), the multimarket (MM) (Quizon and Binswanger; Braverman and Hammer), and the integrated multimarket-CGE (Sadoulet and de Janvry) approaches which offer macro and sectoral instruments of policy analysis that are now widely used. The household and macro-sectoral modeling approaches indeed have much in common, from use of the concepts of tradables and nontradables, to the choices of numéraire, and to the use of identical computational algorithms. A clear advantage of the CNH approach is that survey data are available for the whole model as opposed to the CGE and MM situations, making estimation of the model possible, clearly the next step in developing this approach. Also part of the next step is to add behavior toward risk which must be introduced in the computable form of the model at the level of the indirect utility function.

CGE, MM, and CNH models all find their policy usefulness in the systematic lack of comparable data over time that would allow to separate ex-post the impact of policy instruments. For this reason, recourse is made to simulation of policy impacts in such models, either to retrace historical effects in duly calibrated models or to explore alternative policy scenarios. As exemplified here, CNH models allow to explore the effects of stabilization and adjustment policies at the household level, an important policy question at the moment, in a considerable degree of detail that could not be achieved with available historical data.

The results we have obtained in this paper fall in two categories: Those that are based on the structural features of the model and those which derive from the interplay of the particular values of the elasticities used in the model. Among the first, the main results are:

(1) The elasticity of supply response of tradables is reduced by presence of nontradables among either products which are home consumed or factors of production (see also de Janvry, Fafchamps, and Sadoulet). The lower the substitutions between these goods and tradable alternatives, and the larger the shares of these goods in production or consumption, the lower the elasticity of supply response of tradables. To increase the elasticity of supply response of tradables, technological change needs to be directed at the nontradable products and factors to ease the constraint which their production or availability imposes on the production of tradables.

(2) Accommodating a credit constraint imposes an endogenous markup on credit dependent tradables. This distorts the household's allocation of resources toward import substitution and greater exports of the credit constrained products and factors. Small farmers were thus seen to remain heavily on the labor market, in spite of rising cereals prices, because wages give them an escape to the credit constraint at a relatively low efficiency cost. Such low-cost escape is not available to the medium farmers. Their elasticity of supply response and their ability to benefit from the higher prices offered by ASAP depend on relaxation of this credit constraint, confirming the fundamental importance of credit components in ASAP loans.

(3) For the small farmers, vigorous programs of rural development must be put into place to allow them to become net sellers of the commodities whose prices have increased. The productivity of their land must consequently be raised and the new ASAP pricing rules should be seen as a historical opportunity to mount a massive complementary program of rural development.

The conclusions which are dependent on the particularly set of elasticiy values used, and which are consequently to this point not as robust as the above, are the following. While ASAP displaces the farm economy from livestock to crops, pressures on the use of children for herding and overgrazing in the commons will not be relaxed if the price of forage increases with that of cereals due to competition in production. Avoiding this secondary effect thus requires focusing on the technology of forage production to lower its production costs. While the price adjustment occurs in cereals, technological change is needed in the forage-livestock economy. It also stresses the need to seek infrastructure investments and institutional arrangements that can reduce and ultimately eliminate the need for child labor in animal production. They include the enclosure of fields and innovations in contracts for herding that achieve economies of scale (and thus raise the productivity of labor in herding, making it a remunerative activity for adults) while avoiding the problems of moral hazards which, to this day, have kept economically rational this ancestral practice of child use.

Structural adjustment and the new pricing rules for cereals, by eliminating a historical bias in agricultural price formation, have the potential of benefiting the Moroccan peasantry in dry land areas, the poorest segment of Moroccan society, but only if accompanied by these complementary structural and policy interventions.

REFERENCES

Adelman, I. and S. Robinson. *Income Distribution Policy in Developing Countries: A Case Study of Korea.* Stanford: Stanford University Press, 1978.

Aloui, Omar, Jean-Jacques Dethier, and Abderrahim Houmy. "L'impact de la politique d'ajustement sur les secteurs des céréales et de l'élevage au Maroc." Agriculture and Rural Development Department, Washington D.C.: The World Bank, November, 1989.

Braverman, A. and J. Hammer. "Multimarket Analysis of Agricultural Pricing Policies in Senegal." *Agricultural Household Models*, ed. I. Singh, L. Squire, and J. Strauss. Baltimore: The Johns Hopkins University Press, 1986.

de Janvry, Alain, Marcel Fafchamps, and Elisabeth Sadoulet. "Peasant Household Behavior with Missing Markets: Some Paradoxes Explained." *Economic Journal*, Forthcoming.

Johansen, L. *A Multi-Sectoral Study of Economic Growth.* Amsterdam: North-Holland Publishing Company, 1964.

Laraki, Karim. "Ending Food Subsidies: Nutritional, Welfare, and Budgetary Effects." *The World Bank Economic Review*, Vol. 3, No. 3 (September, 1989), pp. 395-408.

Mateus, Abel. "A Multisector Framework for Analysis of Stabilization and Structural Adjustment Policies: The Case of Morocco." World Bank Discussion Paper No. 29, The World Bank, Washington, D. C., 1988.

Morrisson, Christian, "Ajustement, revenus et pauvreté au Maroc", unpublished paper, OECD Development Centre, Paris, 1990

Mohamed, Salouhi. "Analyse des Revenus des Agriculteurs de la Haute Chaouia et des Beni Meskine." Institut Agronomique et Vétérinaire Hassan II, Rabat, Morocco, April, 1989.

Mundlak, Yair, "The Aggregate Agricultural Supply", *World Development Report 1986* background paper, The World Bank, Washington DC, 1985.

Quizon, J. and H. Binswanger. "Modeling the Impact of Agricultural Growth and Government Policy on Income Distribution in India." *The World Bank Economic Review* 1(1986):103-148.

Raki, Mohammed. "The Cereal Sector in Morocco: Focus of the 'New Agricultural Policy.'" Staff Papers Series, Department of Agricultural and Applied Economics, University of Minnesota, St. Paul, Minnesota, August, 1987.

Sadoulet, Elisabeth and Alain de Janvry. "Implications of GATT for the Poor African and Asian Countries: A General Equilibrium-Multimarket Approach", Department of Agricultural and Resource Economics, University of California at Berkeley, September 1990.

Striker, Dirck, unpublished report on the pricing of cereals in Morocco, Somerville, MA: Associates for Interational Resources and Development, 1990.

Sullivan, John, John Wainio, and Vernon Roningen, *A Data Base for Trade Liberalization Studies*, Washington DC: USDA, Economic Research Service, Agriculture and Trade Division, March 1898.

Taylor, L., *Structuralist Macroeconomics: Applicable Models for the Third World.* New York: Basic Books, 1982.

Table I. Determination of Price Changes for the Household Model

	ASAP prices	CGE prices	Multimarket prices	Consumption shares		Household prices
				Small farms	Medium farms	
				%	%	
Hard Wheat	17.8					17.8
Soft wheat	14.4					14.4
Mills	12.9					
Artesanal	16.7					
Coarse grains	27.8					27.8
Barley	29.7					
Corn	12.9					
All cereals	20.1	20.1^				
Leguminous, fruits, & veget.		8.7				8.7
Other agriculture		14.3	14.3*			
Forage			24.0			24.0
Milk			8.3			8.3
Meat			12.8			12.8
Handicrafts(textiles,leather)		6.1		20.0	22.9	6.1
Food processing		9.1		8.2	11.5	
Oil		1.0		0.3	1.5	
Production goods		1.5		6.8	8.6	
Machinery						1.5
Fertilizers						1.5
Consumption goods		3.3		9.4	10.2	
Services		3.8		14.3	16.6	
Other consumption						
Small farms						4.96#
Medium farms						4.99#
Agricultural wage		6.7	--			6.7

^ Exogenous from ASAP
* Exogenous from CGE
# Using the consumption shares by farm size

Table III

Table II. Structural Characteristics of Small and Medium Farms, Haute Chaoula

Data in 1000 Dirham unless otherwise indicated

Farm types	Small farms	Medium farms	Small farms	Medium farms	Small farms	Medium farms	Small farms	Medium farms	Small farms	Medium farms
Structural characteristics	Total resources		Resources per hectare							
Average farm size (ha)	5.1	22.8								
Labor (adult units)	4.9	7.1	0.96	0.31						
Animals (livestock units)	5.2	9.3	1.02	0.41						
Production	Gross value of output		% gross value of crops		% gross value of ag. output		Gross output per hectare		Animal prod. technology	
Hard wheat	2.00	8.56	26.9	26.2	12.0	17.7	Crops		Coarse grains per animal	
Soft wheat	0.44	6.73	5.9	20.6	2.6	13.9	1.46	1.43	0.54	0.58
Coarse grains	2.95	12.07	39.7	36.9	17.7	25.0	Animal products		Forage per animal	
Leguminous, fruits & vegetables	1.64	4.40	22.0	13.5	9.8	9.1	1.82	0.69	0.27	0.30
Forage	0.41	0.92	5.5	2.8	2.4	1.9	Total crops and animals		Child labor per animal	
Milk	0.74	1.54			4.4	3.2	3.27	2.12	0.35	0.21
Meat	8.54	14.09			51.1	29.2			Value product per animal	
Handicrafts & services	1.20	2.92							1.78	1.68
Total	17.91	51.23	100	100	100	100				
Product and factor use	Production or availability		On-farm use		Consumption and leisure		Net sale		Family labor used on farm	
Hard wheat	2.00	8.56			0.85	2.38	1.15	6.17		
Soft wheat	0.44	6.73			1.43	1.72	-0.99	5.01		
Coarse grains	2.95	12.07	2.78	5.40	1.61	1.55	-1.44	5.13		
Leguminous, fruits & vegetables	1.64	4.40			2.18	4.48	-0.54	-0.08		
Forage	0.41	0.92	1.39	2.74			-0.99	-1.83		
Milk	0.74	1.54			0.74	1.54				
Meat	8.54	14.09			1.71	4.04	6.83	10.05		
Handicrafts & services	1.20	2.92					1.20	2.92		
Machinery			0.04	3.42			-0.04	-3.42		
Fertilizers			0.85	5.02			-0.85	-5.02		
Male labor	8.86	12.84	3.56	6.60	2.94	7.90	2.36	-1.66	3.56	4.94
Female labor (at male wage)**	4.43	6.42	2.54	2.55	1.60	5.61	0.30	-1.74	2.54	0.81
Child labor	3.73	5.24	1.82	1.95	1.91	3.28			1.82	1.95
Depreciation of fixed factors			-1.94	-3.53			-1.94	-3.53		
Other consumption					3.72	7.72	-3.72	-7.72		
Savings					1.33	4.29	-1.33	-4.29		
Distribution of labor use	Total availability		Total used on farm		Leisure		Net sale		Family labor used on farm	
Male labor	100	100	40.2	51.4	33.2	61.5	26.6	-12.9	40.2	38.5
Female labor	100	100	57.3	39.7	36.0	87.4	6.7	-27.2	57.3	12.6
Child labor	100	100	48.7	37.3	51.3	62.7	0	0	48.7	37.3
Income	Total		Income shares							
Total net income	13.55	27.71								
Net crops income*	5.93	19.74	43.8	71.2						
Net animal income	3.76	5.05	27.8	18.2						
Off-farm income	3.86	2.92	28.5	10.5						

* Hired labor costs are imputed to crops income. Depreciation costs are allocated between crops and animals proportionately to their shares of gross income.

** Female labor must be multiplied by a price equal to 0.5 when calculating net sale by small farms

Table III. Simulation of Household Behavior: Price Responses
Results in percentage changes over base run unless otherwise indicated

Experiment	Base run in 1000 Dirham		10% increase in price of hard wheat		10% increase in price of soft wheat		10% increase in price of forage		10% increase in price of meat		10% increase in wage of men		10% increase in wage of women	
Farm size	Small	Medium	Small	Medium	Small	Medium	Small	Medium	Small	Medium	Small	Medium	Small	Medium
Utility														
per 1000 change	26.28	42.98	3.8	7.2	-2.8	5.9	-3.1	-2.0	21.2	11.8	7.3	-1.7	1.4	-1.4
Consumption														
Total consumption	12.25	23.47	0.4	0.8	-0.6	0.9	-0.4	-0.3	2.3	1.2	1.2	0.1	2.3	2.7
Leisure men	2.95	7.90	0.6	1.5	-0.7	1.0	-0.6	-0.4	4.8	3.0	0.3	-1.6	0.0	0.1
Leisure women	1.60	5.61	2.0	3.8	0.7	2.6	-1.0	-0.7	10.7	7.6	2.1	-0.1	-16.2	-15.8
Leisure children	1.78	3.22	0.4	1.0	0.4	1.0	-0.2	-0.6	-0.6	-2.7	0.1	0.2	-0.3	-0.5
Savings	1.33	4.28	0.9	2.5	-0.8	1.7	-0.9	-0.6	7.8	5.1	3.2	0.2	3.0	3.4
Production														
Hard wheat	1.99	8.56	4.5	4.9	-1.1	-1.2	0.2	0.2	-1.6	-2.3	-0.3	-0.1	0.1	0.1
Soft wheat	0.42	6.73	-5.2	-1.5	19.0	5.6	0.7	0.2	-2.5	-1.3	-1.1	-0.1	0.7	0.3
Coarse grains*	0.17	6.67	-9.3	-1.1	-4.9	-0.6	2.8	0.3	-13.1	-2.0	-14.1	-1.3	-1.4	-0.2
Forage*	-0.98	-1.83	-0.4	-0.9	-0.3	-0.7	-1.1	-2.8	2.8	6.9	-0.4	-1.1	0.5	1.6
Total crops	3.24	24.54	1.2	0.8	1.3	0.8	0.8	0.5	-3.2	-2.6	-1.5	-0.6	-0.1	-0.1
Total livestock	9.31	15.67	-0.4	-1.4	-0.2	-0.7	-0.3	-0.8	0.9	4.9	0.2	0.3	-0.1	-0.6
Mach & fertilizer	-0.90	-8.44	1.0	1.8	4.0	0.5	-0.3	-0.1	-2.6	0.1	-0.3	-1.2	-0.8	-0.9
Labor men	-3.55	-6.60	0.2	0.2	0.2	0.2	-0.1	-0.4	-0.7	-0.9	-1.5	-2.8	0.0	0.0
Labor women	-2.53	-2.55	0.0	-0.1	-0.1	-0.4	0.2	0.9	0.5	3.4	0.1	0.2	-0.7	-2.1
Labor children	-1.76	-1.91	-0.4	-1.6	-0.4	-1.7	0.2	1.0	0.6	4.5	-0.1	-0.4	0.3	0.9
Shadow prices														
Labor children	1.06	1.02	0.5	1.0	0.4	0.5	-0.2	0.0	3.4	3.5	2.3	1.4	0.2	0.9
Wage labor														
Men	2.36	-1.66	-1.1	7.7	0.6	5.5	0.9	-3.1	-5.0	10.7	1.9	-18.6	0.1	0.1
Women	0.31	-1.74	-10.2	12.2	-2.4	7.9	3.9	-0.8	-60.0	29.5	-11.8	-0.1	90.1	-53.9
Marketed surplus														
Hard wheat	1.14	6.17	12.4	8.8	-5.8	-3.2	0.9	0.5	-6.1	-4.5	-1.8	-0.1	-1.1	-0.8
Soft wheat	-1.00	5.01	7.3	-3.1	-23.4	11.3	-0.3	0.3	1.0	-1.4	0.2	-0.2	2.4	-0.1
Meat	6.85	10.05	-0.6	-2.9	0.0	-1.5	-0.2	-1.0	1.7	9.3	-0.4	0.2	-1.0	-2.4

* Net of intermediate use.

Table IV. Simulation of Household Behavior: ASAP Responses
Results in percentage changes over base run unless otherwise indicated

Experiment	Base run in 1000 Dirham		ASAP Credit constraint		ASAP No credit constraint	
Farm size	Small	Medium	Small	Medium	Small	Medium
Utility						
per 1000 change	26.28	42.98	9.8	35.4	10.3	37.9
Credit						
Credit deficit (10^3 Dh)			0.0	0.0	0.4	2.9
Shadow price (%)			8.4	16.6	0.0	0.0
Consumption						
Total consumption	12.25	23.47	1.8	9.8	-0.1	5.4
Leisure men	2.95	7.90	1.4	6.1	2.6	8.4
Leisure women	1.60	5.61	-5.4	-9.7	10.3	14.4
Leisure children	1.78	3.22	-0.9	-1.9	-0.9	-2.8
Savings	1.33	4.28	13.7	27.8	10.7	20.0
Production						
Hard wheat	1.99	8.56	1.6	1.8	2.0	1.8
Soft wheat	0.42	6.73	2.1	-0.7	8.5	2.3
Coarse grains*	0.17	6.67	82.5	8.1	98.6	11.5
Forage*	-0.98	-1.83	-2.6	-8.3	-1.5	-3.3
Total crops	3.24	24.54	4.4	1.8	6.5	3.8
Total livestock	9.31	15.67	-1.0	-4.1	-1.0	-1.8
Mach & fertilizer	-0.90	-8.44	3.1	-2.0	7.1	4.0
Labor men	-3.55	-6.60	-0.5	-5.0	1.0	2.2
Labor women	-2.53	-2.55	0.1	-0.4	0.7	5.5
Labor children	-1.76	-1.91	0.9	3.1	0.9	4.7
Shadow prices						
Labor children	1.06	1.02	12.7	17.1	11.2	13.2
Wage labor						
Men	2.36	-1.66	-1.0	9.1	-4.7	48.7
Women	0.31	-1.74	27.5	-31.8	-59.1	54.4
Marketed surplus						
Hard wheat	1.14	6.17	3.6	-0.5	4.9	1.4
Soft wheat	-1.00	5.01	2.7	-1.2	-2.1	0.5
Meat	6.85	10.05	-1.4	-11.2	-0.6	-4.4

* Net of intermediate use.

Table V. Simulation of Household Behavior: Structural Characteristics
Results in percentage over base run unless otherwise indicated

Experiment	Base run in 1000 Dirham		10% increase in number of animals		10% increase in number of children	
Farm size	Small	Medium	Small	Medium	Small	Medium
Utility						
per 1000 change	26.28	42.98	15.4	8.4	11.4	5.8
Consumption						
Total consumption	12.25	23.47	2.8	1.7	-0.6	-0.2
Leisure men	2.95	7.90	3.3	1.7	0.2	1.7
Leisure women	1.60	5.61	4.7	2.8	3.8	1.4
Leisure children	1.78	3.22	-4.5	-2.2	19.3	14.7
Production						
Hard wheat	1.99	8.56	0.1	0.0	-0.1	-0.1
Soft wheat	0.42	6.73	0.4	0.0	-0.8	-0.2
Coarse grains*	0.17	6.67	-0.4	0.0	2.5	0.3
Forage*	-0.98	-1.83	19.9	19.8	-0.2	-0.5
Total crops	3.24	24.54	-5.9	-1.4	-0.1	0.0
Total livestock	9.31	15.67	9.9	9.7	0.1	0.4
Mach & fertilizer	-0.90	-8.44	2.2	2.4	0.4	0.3
Labor men	-3.55	-6.60	1.0	1.1	0.0	0.0
Labor women	-2.53	-2.55	3.3	2.8	-0.1	-0.4
Labor children	-1.76	-1.91	4.5	3.7	0.6	2.1
Shadow prices						
Labor children	1.06	1.02	2.6	1.4	-4.8	-4.2
Wage labor						
Men	2.36	-1.66	-5.7	12.6	-0.2	0.5
Women	0.31	-1.74	-52.0	13.0	-19.1	3.9
Marketed surplus						
Hard wheat	1.14	6.17	-3.1	-0.9	-1.3	-0.3
Soft wheat	-1.00	5.01	1.0	0.0	-2.1	0.0
Meat	6.85	10.05	11.7	13.5	0.1	0.6

* Net of intermediate use.

Appendix Table I. PASA Determination of Cereals Prices

	1982	1983	1984	1985	1986	1987	1988	1988 Reference Price	Base level prices: Threshold Price	Base level prices: Guaranteed Price	% increase Reference Price
Exchange Rate (Dh/$)	6.02	7.11	8.81	10.06	9.1	8.36	8.21	8.21			
CPI (base 1985)	77.8	82.6	92.8	100	108.7	111.7	114.3				
Hard Wheat											
Official Price^ (Dh/t)*	1400	1400	1500	1800	2000	2000	2000	2069		2784	
Market Price^ (Dh/t)	1510	1450	1800	2200	2190	2220		2363			17.8
World price# (Dh/t)	656	1330	1621	1660	1356	1354			2039		
Soft Wheat Mills											
Official Price^ (Dh/t)	1400	1400	1500	1800	2000	2000	2000	2050		2313	12.9
World price# (Dh/t)	969	1123	1348	1378	1065	953			1694		
Barley											
Official Price^ (Dh/t)*	1000	1000	1100	1500	1650	1650	1650	1713		1909	
Market Price^ (Dh/t)	1170	1040	1350	1430	1270	1410		1471			29.7
World price# (Dh/t)		584	929	1030	737	667			1226		
Corn											
Official Price^ (Dh/t)	1000	1000	1300	1600	1800	1800	1800	1845		2082	12.9
World price# (Dh/t)		910	1198	1127	774	635			1403		

Sources:

* Official price not effective. Price increase is calculated relative to the market price

^ Associates for International Resources and Development, unpublished statistics

USDA, Situation and Outlook Report

Reference world market price is the 1983/87 current dollar price average. Other reference prices are averages in 1988 Dh.

Appendix Table II. Production Elasticities

Medium Farm Household

	Hd wheat	Sft wheat	Coarse gr	Legumin	Forage	Milk	Meat	Handicft	Machine	Fertilizer	Male labr	Fem lbr	Child lbr
Hard wheat	.52	-.13	-.09	-.09	.02	-.01	-.18		-.03	-.02	-.04	.01	.03
Soft wheat	-.16	.60	-.06	-.08	.02	.00	-.09		-.04	-.21	-.04	.02	.05
Coarse grains	-.11	-.06	.78	-.16	.03	-.03	-.12		-.04	-.08	-.16	-.01	-.06
Leguminous	-.18	-.13	-.24	.90	.04	-.01	-.16		-.04	-.03	-.20	.00	.05
Forage	-.11	-.08	-.12	-.10	-.30	.09	.62		-.01	-.07	-.13	.11	.11
Milk	-.03	.01	-.12	-.02	-.10	.85	-.27		.22	.02	.08	-.36	-.27
Meat	-.11	-.04	-.06	-.05	-.08	-.03	.30		.04	.01	.08	-.01	-.05
Handicrafts & services								.70			-.50	-.10	-.10
Machinery	.07	.07	.07	.06	.00	-.10	-.17		-.20	-.02	.17	.04	.02
Fertilizers	.04	.29	.10	.03	-.03	-.01	-.03		-.02	-.10	-.13	-.08	-.07
Male labor	.05	.04	.16	.14	-.04	-.02	-.16	.22	.09	-.10	-.40	.00	.01
Female labor	-.02	-.05	.02	.00	.08	.22	.07	.11	.06	-.16	.01	-.40	.06
Child labor	-.12	-.15	.19	-.11	.09	.20	.30	.13	.03	-.16	.03	.07	-.50

Small Farm Household

	Hd wheat	Sft wheat	Coarse gr	Legumin	Forage	Milk	Meat	Handicft	Machine	Fertilizer	Male labr	Fem lbr	Child lbr
Hard wheat	.48	-.12	-.08	-.08	.02	.00	-.17		-.02	-.02	-.04	.01	.03
Soft wheat	-.55	2.05	-.20	-.29	.07	.01	-.32		-.12	-.74	-.15	.06	.16
Coarse grains	-.89	-.49	6.32	-1.28	.26	-.23	-.97		-.30	-.61	-1.26	-.07	-.48
Leguminous	-.10	-.07	-.14	.52	.02	.00	-.09		-.03	-.02	-.12	.00	.03
Forage	-.04	-.03	-.05	-.04	-.12	.03	.25		.00	-.03	-.05	.05	.04
Milk	-.01	.00	-.05	-.01	-.04	.38	-.12		.10	.01	.03	-.16	-.12
Meat	-.04	-.02	-.02	-.02	-.03	-.01	.11		.01	.00	.03	.00	-.02
Handicrafts & services								.36			-.26	-.05	-.05
Machinery	1.32	1.37	1.42	1.13	-.10	-1.97	-3.38		-3.97	-.45	3.42	.87	.34
Fertilizers	.05	.36	.13	.03	-.03	-.01	-.03		-.02	-.13	-.16	-.10	-.09
Male labor	.02	.02	.06	.05	-.01	-.01	-.07	.09	.04	-.04	-.16	.00	.00
Female labor	.00	-.01	.01	.00	.02	.05	.01	.02	.01	-.03	.00	-.09	.01
Child labor	-.03	-.04	.05	-.03	.02	.05	.08	.03	.01	-.04	.01	.02	-.13

Appendix Table III. Consumption Elasticities

Medium Farm Household

	Price elasticities											Income elasticities
	Hd wheat	Sft wheat	Coarse gr	Legumin	Milk	Meat	Others	Male leis	Fem leis	Child leis	Savings	
Hard wheat	-.84	.20	-.10	-.10	-.08	-.15	-.14	-.23	.12	.16	-.11	1.26
Soft wheat	.33	-1.21	.30	-.04	-.08	-.08	.55	-.04	.20	.18	-.03	-.08
Coarse grains	-.05	.34	-.71	.28	-.05	-.01	.05	.07	.26	.22	.03	-.44
Leguminous	-.03	-.05	.06	-1.50	-.02	-.02	.18	-.06	.33	.28	.02	.79
Milk	-.10	-.12	-.10	-.05	-1.23	.42	.09	-.09	.17	.18	-.03	.87
Meat	-.07	-.08	-.06	-.04	.17	-1.03	-.16	-.16	.24	.24	-.04	1.00
Others	-.02	.09	-.04	.10	.02	-.07	-.90	-.28	.19	.16	-.06	.80
Male leisure	-.05	-.05	-.04	-.04	-.02	-.07	-.29	-.30	-.10	.14	-.08	.89
Female leisure	.02	-.01	.00	.18	.02	.11	.10	-.30	-2.00	.00	.12	1.78
Child leisure	.11	.04	.04	.32	.07	.25	.27	.25	.05	-3.00	.26	1.33
Savings	-.07	-.08	-.06	-.04	-.03	-.08	-.23	-.25	.19	.20	-1.00	1.47

Small Farm Household

	Price elasticities											Income elasticities
	Hd wheat	Sft wheat	Coarse gr	Legumin	Milk	Meat	Others	Male leis	Fem leis	Child leis	Savings	
Hard wheat	-.84	.49	-.17	-.16	-.12	-.20	-.15	-.27	.03	.09	-.15	1.44
Soft wheat	.37	-1.21	.33	-.02	-.03	-.06	.25	-.07	.20	.34	-.02	-.09
Coarse grains	-.01	.33	-.71	.18	.00	.01	-.03	.02	.27	.43	.03	-.51
Leguminous	-.04	-.08	.02	-1.50	-.02	-.02	.14	-.06	.24	.41	.02	.90
Milk	-.12	-.13	-.12	-.06	-1.23	.38	.08	-.10	.14	.21	-.04	.99
Meat	-.09	-.13	-.12	-.05	.16	-1.03	-.19	-.16	.18	.32	-.04	1.15
Others	-.01	.03	-.12	.08	.02	-.07	-.90	-.26	.12	.24	-.03	.91
Male leisure	-.06	-.11	-.11	-.06	-.03	-.08	-.34	-.30	-.12	.25	-.06	1.01
Female leisure	-.01	.02	.05	.19	.03	.11	.06	-.35	-2.00	-.20	.08	2.03
Child leisure	.03	.11	.15	.34	.05	.22	.29	.26	-.11	-3.00	.15	1.52
Savings	-.10	-.14	-.13	-.06	-.05	-.09	-.23	-.23	.12	.23	-1.00	1.67