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THE IMPLICATIONS OF PARTIAL MARKET PRICING
ON AGRICULTURAL CROP PRODUCTION
IN EGYPT

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I. INTRODUCTION

Recent indicators show that the agricultural sector in Egypt is moving in a direction where it will increasingly fail to meet future domestic (food) and export (foreign currency) demands.

Development and administration of natural resources in Egypt since 1952 has been largely the responsibility of the government, through the Ministry of Agriculture.

The current agricultural problems have reached such levels of magnitude, that public intervention is still justifiable, particularly in light of the fragmentation of holdings by the private sector. Conflicting objectives within the public and private sectors have led to several problems. Examples are urban sprawl, natural and man-made (brick manufacturing) erosion, avoiding the centrally administered cropping pattern, declining production of export-revenue earning crops such as cotton, rice and onions, and possible misallocation of scarce land and water resources.

If agriculture is to continue as a major contributing sector to the economy, immediate attention is required on the various problems. In the context of development planning and, in light of the current trends, it seems rational to first tackle issues of policy and pricing as these are central to a solution to the other problem areas.

The general goal of the research project could be broadly categorized as being empirically oriented, in that it investigates the effects on the cropping pattern and other parameters of agricultural production of a relaxation of the tight restrictions imposed by the administered price system. The last few years have already witnessed a gradual move towards allowing relatively larger margins of profit to the farmers.

This report opens with a description of the design, construction, and estimation of the model. Then, the results of the analysis are examined; and, finally, a discussion of the findings and their implications is made.

The objectives of this paper are to: (1) demonstrate the construction of a recursive linear programming model to be used as a vehicle for investigating land and water allocation; (2) measure the potential gains due to a higher degree of regional specialization; and (3) investigate the effects of an alternative pricing policy for the four main controlled crops.

II. MODELLING THE AGRICULTURAL SECTOR

The principle of including a time lag (or time delay) mechanism in models has led to the evolution of dynamic analysis. That in turn led to the increased complexity of models. Computational procedures have attempted to meet the challenge by breaking down inter-temporal optimization problems to smaller problems of suboptimization with feedback. The feedback mechanism is incorporated in the values of both x(t) and the constant a in

$$x(t) = a^2\ x(t-2) = a^h\ x(t-n) = a^t\ x(0) \qquad (1)$$

where x(t) is the variable of interest at time t.

During the actual process of solution, new observations always occur and it thus becomes inevitable that a^t should be allowed to vary, thus (1) becomes:

$$x(t) = a^t\ x(t-1) = a^t\ a^{t-1}\ x(t-2) = \ldots \prod_{j=0}^{n-1} a^{t-j}\ x(t-h) \qquad (2)$$

Furthermore, since a^t is affected by the values of x(t) prior to period t we get

$$a^t = f_t\ (x(t-j)) \qquad (3)$$

which on substitution in the first-order homogenous linear difference equation [$x(t) = ax(t-1)$] gives

$$x(t) = h_t\ (x(t-1),\ x(t-j)) \tag{4}$$

This implies that the value of $x(t)$ is partially determined by the initial condition $x(0)$ and implicitly by the value of each allocation between $x(0)$ and $x(t-1)$. It should also be stressed that (1) and (2) above, are dissimilar since the former is analogous to the principal of optimality of dynamic programming in that no allowance is made for revision and renewal of parameters and data after an optimal decision has been made, whereas the latter is

> "a sequence of optimizations with feedback ... which ... may converge to a path that is intertemporally optimal in some sense; just as a sequence of atonement like adjustments may lead to a general equilibrium that is efficient or Pareto optimal." (Day, 1977, p. 83)

Cournot (1838) utilized the feedback principle in his duopolies study, but it was not until Wood (1951) that restrictions were placed on the levels of a solution's activities. These restrictions were in the form of a statement that an activity in any time period shall not exceed $(1 + \alpha)$ of its value in the previous period. It was Day, however, who in 1963 explictly incorporated this restriction in a mathematical program which he also called recursive programming. This was done in Day's adaptation of Henderson's 1959 national model, to the Mississippi Delta area. The latter was the first though, to mention that his "... analysis is both descriptive and <u>recursive</u>" (p. 242).

About the same time as Henderson's endeavors were completed, Nerlove (1958, 1959) was discussing the lags in price response. This work contributed to the philosophical foundations of this class of models. The idea of adjustments of production in response to exogenous variables had been studied earlier (as early as Marshall) by Hicks (1953) whose "responses" were due to price expectations.

Henderson integrated several ideas to develop his analysis. He used a combination of lag models, production response, restrictions on activities, and linear programming. The farmer's decision making process was recognized as dependent on two forces. The first is profit maximization. The second could be stated as a restriction on maximizing net returns in that a multitude of factors, economic, sociological, personal, technical, and institutional are combined to limit the decision to deviations from preceding ones and not just emerging as fresh "unrooted" decisions. Thus the relation

$$(1 - \beta_{ij,min})\, x^*_{ij} \leq x_{ij} \leq (1 + \beta_{ij,max}) x^*_{ij} (j=1, \ldots m) \qquad (5)$$

in which x^*_{ij} is the acreage which the i^{th} farmer devoted to the j^{th} crop in the preceding crop year. The β coefficients are "constants for the determination of the farmer's current land utilization pattern" (Henderson 1959, p. 243). Estimates of the constants were made by separately averaging the positive and negative historical crop acreage movements.

An important question still has to be answered, why use flexibility restraints? Before attempting to tackle the question, perhaps it is helpful to reiterate that these bounds barely allow for aggregate measurement of disaggregate activities. This fact was highlighted in Cigno's (1971) study of the effects of the Common Agricultural Policy of the EEC on Italian Agriculture. A policy maker has to recognize that:

(1) Only a subset of farmers adapt quickly to changing market conditions because they anticipated them, while the others wait until price changes reduce them to adopt a new system.

(2) Only a subset of farmers foresee a more profitable mode of production and thus have a fast adoption rate, while others only change when it is apparent that profit is manifest in the proposed price changes.

(3) Certain products will only increase in production up to a certain level to which we add a fourth point.

(4) In the presence of ministerial targets and acreage quotas, it is only realistic to limit changes in production to these levels which will be allowed in reality.

Going back to the question, flexibility restraints merely translate all these considerations into a model component. Thus, once incorporated into the model, these restraints will effectively limit our solution. These limitations lead to inevitable residuals because it is impossible to simultaneously satisfy all the upper and lower bounds. For this model the crops were stratified as follows:

(1) Crops which do not directly compete with other crops for area (within the rotation) such as sugar cane.

(2) Crops which are in direct competition for area with other crops. Usually these fall into the same subdivision within the crop rotation program such as rice and maize.

(3) Crops which are indirectly competing for area with other crops, such as cotton and berseem. Even though these crops do not follow the same seasonal category, berseem could be extended into cotton planting time and it thus affects cotton yields and production.

The actual process of measurement of the flexibility coefficients is therefore a function of the previous points, farmers' response, crop categories, and estimation considerations and techniques. The sought relation is in the form of:

(1) Upper bounds $X_{it} \leq (1 + \overline{\beta}_{it})\, X_{it-1}$

(2) Lower bounds $X_{it} \geq (1 - \underline{\beta}_{it})\, X_{it-1}$

A programming model was selected as most suitable because of the spatial nature of production and its implications for interregional specialization; in addition, the homogeneity of Egyptian agriculture allows such an approach. Programming models are normative, and it is usually the case that models of agriculture purport to change regional production patterns. In the agricultural decision making process, a recursive element is inherent because decisions for a particular period are influenced in part by previous ones. Also, decisions are continuously being amended due to updated information, a feature which could be easily incorporated in an RP. Furthermore, in an RP the parameters of a multi-period model can be adjusted in response to the previous solutions. That feature is particularly useful for accommodating technological change in the models. But the fourth and (probably) foremost advantage of RP over LP is due to Henderson's identification of the factors affecting farmers decisions as including some nonpecuniary elements. However, by relying on measurement of previous reaction to similar conditions (similar in principle but not necessarily in magnitude), one can specify the range within which the response is likely to happen. This is the spirit of RP as represented by the flexibility restraints. RP's are dynamic in a Frisch-Samuelson sense because the parameters are time subscripted in an irremovable way.

The model could be written as:[1]

$$\max\ Z = c^T X \tag{6}$$

$$\text{subject to } Ax \leq b \tag{7}$$

$$x \geq 0 \tag{8}$$

where A = an m x n matrix

x = an n-element column vector

b = an m-element column vector

c = an n-element column vector.

In the above system if time is introduced in an irremovable way, i.e., the solution for time t is only possible after that for t-1 is reached, RP, the model, has the formulation as follows:

$$\max\ Z(t) = C^T(t-1)\ x(t) \qquad t=1,\ldots,n \tag{9}$$

$$\text{subject to } A\ x(t) \leq \theta\ Ax(t-1) + k \tag{10}$$

$$x(t) \geq 0$$

where θ = an m x s diagonal matrix such that

$$\begin{bmatrix} 0 & & & & & & \\ & (1+\overline{\beta}_i) & & & & & \\ & & \ddots & & & & \\ & & & (1+\overline{\beta}_n) & & & \\ & & & & (1-\underline{\beta}_i) & & \\ & & & & & \ddots & \\ & & & & & & (1-\underline{\beta}_n) \end{bmatrix} = \theta_{(m \cdot s)} \tag{11}$$

---

[1] The superscript T indicates the transpose of a matrix. The vectors are column vectors.

and k = an m x 1 vector of fixed resources such that

$$k^T = [\bar{x}\ 0\ 0\ \ldots\ 0]$$

and c(t-1) is composed of n net returns. The matrix A is structured as follows:

$$\begin{bmatrix} 1 & 1 & \cdots & \cdots & 1 \\ 1 & \ddots & & & \\ & & \ddots & & \\ -1 & & & \ddots & \\ & \ddots & & & 1 \\ & & \ddots & & \\ & & & \ddots & -1 \end{bmatrix} = A_{(m \cdot n)} \qquad (12)$$

and x(t-1) is of dimensions (n·1) and is composed as follows:

$$x(t-1)^T = [x_1 x_2 \cdots x_n]$$

The right hand side vector in (7) is thus a function of lagged endogenous and current exogenous variables, which fall into any of these categories: (i) resource supply, such as land, water, labor, fertilizer ..., etc., (ii) ceilings on activities such as the upper and lower flexibility restraints, and (iii) managerial constraints which take the form of budget constraints, minimum production levels, investment requirements ..., etc. Thus, essentially the system

$$Ax \leq b \qquad (13)$$

is a production transformation set. That is clear from the solution to the model since the matrix A transforms inputs into outputs via the yields (or a_{ij}'s) which in time are transformed into activity levels at the optimum (x^*):

$$Ax^* \leq b \qquad (14)$$

where x^* is the vector of optimal solution process levels. Additionally, the matrix A also transforms the input requirements into an input demand relationship. Thus, at the solution stage, the system becomes:

$$Ax^*_t = \begin{bmatrix} Y_t \\ V_t \end{bmatrix} \tag{15}$$

where Y_t is a vector of output supply and V_t is a vector of input demand.

If the third component of the constraints set is expanded, i.e., the budget constraints, it results in:

$$\sum_{j=1}^{m} a_{ij} x_{jt} \leq b_{it} \tag{16}$$

where b_{it} is the budgetary allowance defined as operating surplus which is the difference between revenue and cost, and thus:

$$\sum_{j=1}^{m} a_{ij} x_{jt} \leq \sum_{j=1}^{m} P_{jt-1} X^*_{jt-1} - S_t \tag{17}$$

where P_{jt-1} is used as a proxy for expected price and the revenue is formulated in terms of t-1, while the cost S is assumed to be estimable for t. By substituting (9) into (15) we obtain:

$$\sum_{j=1}^{m} a_{ij} x_{jt} \leq (a + B X_{t-1})^T X^0_{jt-1} - S_t \tag{18}$$

which in conjunction with (12) defines the new system that is now "closed"

$$\text{Max } z = a^T x_t + (x^0_{t-1})^T B^T X_t - K^T_t X_t \tag{19}$$

subject to

$$\sum_{j=1}^{m} a_{ij} X_{jt} \leq a^T X^0_{t-1} + X^{0T}_{t-1} B^T X^0_{t-1} - S_t \tag{20}$$

$$\sum_{j=1}^{m} a_{ij} X_{jt} \leq b_{it} \quad (i=2, \ldots, n) \tag{21}$$

$$X_{jt} \geq 0 \quad j=1, \ldots, m \tag{22}$$

The system is closed since the solution for period t is a direct function of that for t-1, hence it is recursive. The corresponding dual is

$$\min \Psi = [a^T X^0_{t-1} + X^{0T}_{t-1} B^T X^0_{t-1} - S_t] \lambda_{it} + \sum_{i=2}^{n} b_{it} \gamma_{it} \qquad (23)$$

subject to

$$A^T \lambda_t \geq a + BX^0_{t-1} - K_i \qquad (24)$$

$$\lambda_t \geq 0 \qquad (25)$$

The model presented above is outlined in tableau form by Table 1. The upper and lower bounds were specified on a regional basis rather than a governorate basis to allow a greater degree of regional specialization. If the constraints were specified on a governorate basis the fell ramifications of alternative specification are restricted because only small changes in acreage within governorates would be permitted. The model thus specifies an upper and lower bound for every crop for each of the three regions (or groups of governorates) which are traditionally pooled as:

I. North
1. Alexandria
2. Behera
3. Gharbiya
4. Kafr El Sheikh
5. Dakahliya
6. Damietta
7. Sharkiya
8. Ismailiya
9. Suez
10. Minufiya
11. Kalyubiya

ACTIVITIES				CROPS: CROP PRODUCTION BY GOVERNORATE	PRODUCTION SCHEME: ROTATION	PRODUCTION SCHEME: CROPPING PATTERN	REVENUE: CROP PRICE BY GOVERNORATE	INPUTS: WATER	INPUTS: LABOR	INPUTS: LAND	INPUTS: FERTILIZER	INPUTS: MACHINES	INPUTS: ANIMALS
MAXIMIZE Z=				- COST OF PRODUCTION PER FEDDAN	0	0	+ PRICE PER UNIT OF PRODUCTION	- COST PER UNIT OF INPUT					
	ROW NAME	TYPE	RHS	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
CROPPING	(1) CROP YIELD BY GOVERNORATE	≤	0	Y			-1						
FLEXIBILITY	(2) CROP UPPER BOUND BY GOVERNORATE	≤	$\hat{\text{FED-DAN}}$	1									
FLEXIBILITY	(3) CROP LOWER BOUND BY GOVERNORATE	≥	$\hat{\text{FED-DAN}}$	1									
PRODUCTION SCHEME	(4) ROTATION BY GOVERNORATE	≥	0	1	-1								
		≥	0	1	-.33								
PRODUCTION SCHEME	(5) CROPPING PATTERN BY GOVERNORATE	≥	0	1		-1							
		≥	0	1		-P							
PRODUCTION SCHEME	(6) NATIONAL LIMITS	≤	FED-DAN	1									
INPUTS	(7) WATER	≤	Cu.M	w				-1					
INPUTS	(8) LABOR	≤	MAN-DAYS	m					-1				
INPUTS	(9) LAND	≤	FED-DAN	l						-1			
INPUTS	(10) FERTILIZER	≤	kgs	f							-1		
INPUTS	(11) MACHINES	≤	hours	l								-1	
INPUTS	(12) ANIMALS	≤	days	a									-1

Figure 1

II. Middle 12. Giza

13. Beni Suef

14. Faymu

15. Minya

III. South 16. Assyut

17. Sohag

18. Quena

19. Aswan

The yield entries (Y_{ij}) were obtained from Ministry of Agriculture (MOA) estimates of average yields and may contain a sampling error or departure from "time" yields. Water coefficients (w) were generated by aggregating several sources reporting water wages and water requirements. This data, reported per crop, per season, or per area, had to be processed into a per feddan basis.

The regional recursive linear programming model measures several parameters both at the national and regional levels. These are agricultural net revenue, crop production, demand for inputs, and resource valuations. The formulation of the model makes it possible to assess the two main goals of the exercise. First, net revenue is maximized subject to water supply by region, land productivity by governorate, the availability of purchased and nonpurchased inputs, crop rotations, regional governmental and public policy, behavioral constraints, and the current technology. The second objective was to gauge the system's reaction to several proposed changes over time, such as price and nonprice intervention, regional specialization, resource policies, and deteriorating land quality because of rising water tables. For the 30 crops included in the model, production activities are specified by governorate. The data in the model is on an annual basis, thus we have yield per feddan, price per unit of product, variable and fixed costs, water supply, labor supply, fertilizer input, machinery input, animal input and the various behavioral constraints (flexibility constraints). The matrix of technical coefficients is of size 845 x 1777, and its 9251 elements are basically of two types, yransfer (pivot) elements and input coefficients for the various resource requirements.

The objective function could be expressed algebraically as follows:

$$\text{Max} \quad Z = \sum_{j=1}^{k+m+n} \sum_{i=1}^{q+r+s} [(P_{iy}Y_{ij}) - C_{ij}] X_{ij} \qquad (26)$$

$$\text{where } C_{ij} = \sum_{y=1}^{b} (m_y L_y + t_y M_y + a_y A_y + V) + d_{ij}F_{ij} + l_{ij} \qquad (27)$$

and

Z = agricultural aggregate net revenue from plant production

P_{ij} = price per unit of output of crop i in governorate j

Y_{ij} = yield per feddan of crop i in governorate j

C_{ij} = total cost per feddan in LE for producing one feddan of i in j

X_{ij} = number of feddans of crop i in j

m_y = wage rate per man hour in month y for labor L_y hired for growing i in j

t_y = machine cost per hour in month y for machine time M_y employed in producing i in j

a_y = cost of feed per draft animal in month y for animals A_y working in producing i in j

d_{ij} = cost per kilogram of fertilizer F employed in producing i in j

l_i = rent per season i per feddan

V = is other additional cash outlays

θ = k,m,n are north, middle and south, respectively

α = q,r,s are winter, summer and nili, respectively

b = 1, ..., 12 is the months of the year.

Regional crop production and net revenue are maximized subject to several constraints:

$$\sum_{i} X_{ij} \leq \overline{X}_j \tag{28}$$

$$\sum_{i} X_{ij} \leq \overline{X}^{w}{}_{j}{}^{w} \tag{29}$$

$$\sum_{i} X_{ij} \leq \overline{X}_j{}^{s} \tag{30}$$

$$\sum_{i}^{\alpha} \sum_{j}^{\theta} X_{ij} \leq \overline{X} \tag{31}$$

where

$\overline{X}_j$ = the total number of feddans in governorate j

$\overline{X}^{w}{}_{j}$ = the maximum number of feddans available for winter crop production (including land for permanent crops in the winter months)

$\overline{X}^{s}{}_{j}$ = the maximum number of feddans available for summer and nili crop production (including land for permanent crops in the summer months)

$\overline{X}$ = the total national cropped acreage available in all regions.

The set of constraints specified by (28)-(31) relate to the land constraints within which optimization is to take place. The winter and summer acreages were formulated from data on the base period. The water supply is specified through

$$\sum_{i}^{\alpha} \sum_{j}^{\theta} \gamma_{igy} X_{ij} \leq \overline{W}^{0}{}_{y} \tag{32}$$

where γ_{ijy} = the quantity in cubic meters required to produce crop i in Governorate j in month y.

$\overline{W}$ = the total amount of irrigation water available in cubic meters in region θ for month y.

The human labor requirements are estimated and expressed as:

$$\sum_{i}^{\alpha} \sum_{j}^{\theta} b_{ij} X_{ij} \leq \overline{L}_j \qquad (33)$$

where $\overline{L}_j$ is the available labor in governorate j expressed in man hours.

b_{ij} is the requirement per feddan of crop i in governorate j of labor.

The final set of constraints on physical inputs is the one which covers fertilizers, machinery, and animal input.

$$\sum_{i}^{\alpha} \sum_{j}^{\theta} f_{ij} X_{ij} \leq \overline{F}_\theta \qquad (34)$$

where $\overline{F}_\theta$ is the total available supply of nitrogen fertilizer in region θ.

$$\sum_{i}^{\alpha} \sum_{j}^{\theta} \varepsilon_{ij} X_{ij} \leq \overline{M}_\theta \qquad (35)$$

where $\overline{M}_\theta$ is the total available machine hours in region θ.

$$\sum_{i}^{\alpha} \sum_{j}^{\theta} v_{ij} x_{ij} \leq \overline{A}_j \qquad (36)$$

where $\overline{A}_j$ is the available draft animal expressed in animal days for governorate j, and f_{ij}, ε_{ij}, v_{ij} represent the technical requirement per feddan of nitrogen fertilizer, machine hours, and animal days, respectively. The above constraints are in addition to the flexibility constraints discussed earlier.

$$\sum_{i} \sum_{j=1}^{N} X_{ij} \leq (1 + \overline{\beta}_{id}) X_{ij(d-1)} \qquad (37)$$

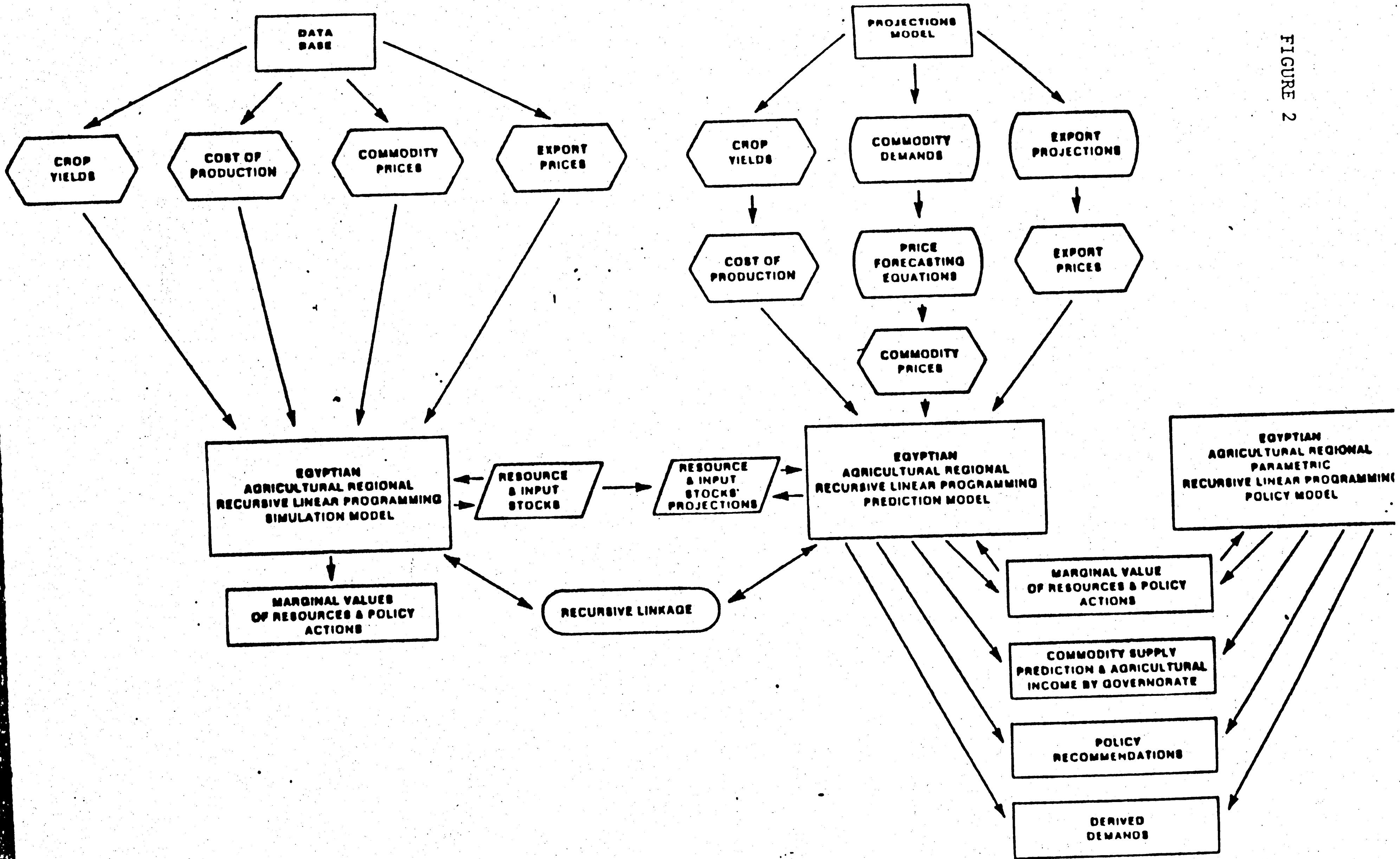
$$\sum_{i} \sum_{j=1}^{N} X_{ij} \geq (1 + \underline{\beta}_{id}) X_{ij(d-1)} \qquad (38)$$

where $\overline{\beta}_{id}$ is the upper flexibility coefficient for crop i in region N or M or S for year d.

$\underline{\beta}_{id}$ is the lower flexibility coefficient for crop in region N or M or S for year d.

FIGURE 2

FIGURE 4.1 INTEGRATED AGRONOMIC ECONOMIC POLICY ANALYTICAL SYSTEM



III. ESTIMATION OF THE MODEL

The model passed through several stages of building and testing before it arrived at its current form. The first stage in model building was the design of the structure in such a way that future augmentation would be possible. The overall system was to be put together to achieve the end objective of creating an experimental vehicle which would aid in analyzing the agricultural sector, and then, investigating the effects of any postulated changes. An integrated system presented in Figure 1 is still incomplete, mainly because of the lack of reliable elasticity measures which are needed for the price forecasting equations. Thus the prediction model (the second in the figure) has not been formulated. The first use of the model, the Regional Recursive Linear Programming Simulation Model (RSM) provides estimates of the values of resources, the cost of some policy actions, and identifies resource and input use under current conditions. The third model, which is the Regional Parametric Recursive Linear Programming Policy Model (PPM), can estimate derived demand relationships for inputs, investigate policies affecting resource use and stocks, and gives an alternative assessment of the marginal value of resources under altered output values.

The basic model uses the type of flexibility coefficients proposed by Day on crop acreages on a regional basis. Within the three regions, crops are allocated to governorates according to their cooperative advantage. The bounds serve as the effective limits on the optimization process and thus ensure that we are "close" to reality.

In making any comparisons between the model results and the actual cropping pattern, the model will give some indication of comparative advantage in crops among governorates through the dual values on the bounds and crop activity rows. Although the model does in principle reflect the influence of administered prices and production plans and targets, it will not necessarily reflect every aspect of public policy at governorate level.

One should also note that allocations not only reflect margins of net returns, but also the pattern of resource use and marginal productivity differences. So an estimate of productive efficiency vis-a-vis national requirements can be estimated for input use. The salient inputs are land, water, labor, fertilizer, animal power, and machinery.

The Price System was run recursively for the years 1975-79, using prices which are higher than the actual prices for the period. Table 2 lists the objective function values for the sequence of Price models, and for the historical (henceforth referred to as Original) equivalent. The figures are aggregate values added resulting from crop production in current Egyptian pounds (L.E.).

Table 2

Value Added Estimates in LE[1]

Year	Original	Price System
1974	569,847,870	NA
1975	585,404,350	1,204,509,879.98
1976	619,620,230	1,195,245,297.67
1977	705,843,400	1,539,412,085.38
1978	745,976,690	1,969,818,151.48
1979	1,167,382,600	2,315,067,399.36

[1]Nominal Prices

The 1975 and 1979 years are the only ones to be discussed in detail for several reasons: (i) they are the opening and closing years of the sequence (although most of the results for the other years will be presented, but not discussed in the same detail); (ii) 1975 is the first year, so no recursive error build-up is included; (iii) 1979 is the last year, so it should include the effect of any accumulated error, and the effect of successive optimizations; (iv) 1979 is also the most recent year to be analyzed and as such is important to our discussions; (v) As far as model validation is concerned, these two years should be sufficient; and (vi) it allows us to determine the various characteristics of the 1975 solution (such as allocational inefficiencies) and then by studying 1979 we could determine the pattern of change.

Running the price system consisted of changing the prices of the four major crops: cotton, wheat, rice and sugar cane.

Table 3 shows the international and local prices for these crops, together with the tax implied by the price differentials. The table shows that the tax has been declining, but a detailed look will show that a large part of the decline is due to the drop in international prices, and thus the typical farmer is still faced with the problem of insufficient incentives. In the face of that reality, the margin between both prices was halved (i.e., reduce the inputed tax by half). Table 4 gives the new prices and the percentage change over existing prices.

The net return estimates listed in Table 2 are in nominal prices and include the effects of various factors such as inflation, the effect of the optimization process, and the price effect on the various model parameters. To be able to separate these effects, we ran a sequence of models called Day system which is identical to Price system except that it uses the actual prices in the objective function. Computing the objective function value (aggregate net returns) for all three systems (Original or historical, Day system, and Price system), using 1979 average crop prices would remove the

Table 3

International and Local Prices
for Major Crops 1975-1979

Crop	1975	1976	1977	1978	1979
Cotton					
International price	84	70	96	73	73
Local price	28	34	36	37	47
Tax percent	200	106	166.6	97.3	55.3
Rice					
International price	259	154	107	143	135
Local price	40	50	57	65	67
Tax percent	547	208	87.72	120	101.5
Wheat					
International price	28.2	17.5	14	15.1	12.1
Local price	6.9	6.5	7.0	8.9	8.9
Tax percent	300	170	100	70	36
Sugar Cane					
International price	22.07	16.4	11.17	11.6	10.0
Local price	7.53	8.4	8.03	9.0	10.0
Tax percent	194	96	40	28	0

Notes

1. International prices are adjusted for transportation, processing, etc.

2. All prices are in Egyptian pounds per unit of net product (i.e., sugar cane prices are for the sugar equivalent) based on the appropriate conversion factors.

3. The tax figure is the difference between both prices represented as a percentage of local prices.

Source: computed from MOA and FAO statistics.

Table 4

New Prices Used in Policy Years

Crop	1975	1976	1977	1978	1979
Cotton					
Price	56	52	66	55	60
Change percent	100	33	83	49	28
Rice					
Price	113	102	82	104	101
Change percent	183	105	44	60	51
Wheat					
Price	14	12	10.5	12	10.5
Change percent	103	85	58	35	18
Sugar Cane					
Price	14.8	12.4	9.6	10.3	10.0
Change percent	97	48	20	14	0

Notes

1. All margins were halved except for rice and wheat in 1975 where the new price is based on 33 percent of the difference plus the old price.

2. These prices are only averages for the whole country but the actual price scenario figures vary between governorates.

effect of inflation. We would then be left with the other two factors. The difference between the Day and Original systems represents the effects of optimization within the flexibility constraints, and the difference between the Price and Day systems represents the effects of the higher prices. The aggregate crop net returns have been recalculated using the 1979 national average price for each crop, and the new values are presented in Table 5.

Comparison of the totals in the table reveals that the Day system's aggregate net returns in real terms for 1975 was only an improvement of .02 percent over the Original figure, compared with 12.82 percent when measured in current prices. For 1979, the Day system's[1] estimate in current prices was 43.46 percent higher than the original estimate, whereas when evaluated in real terms, the difference became 13.93 percent. The difference is not all due to deflation or the actual effect of optimization, but is also due to the fact that for every crop, the weight used is an average for that crop, whereas in the model the net return valuations are computed for each crop/governorate combination and thus have a wider variance. Nevertheless, we can still say that these results show that in aggregate terms, restructuring the production process within the flexibility constraints did not show large efficiency gains in real terms. The inputed costs of some of the constraints will be examined later. However, if we view the situation from a dynamic context (over several years), we find that the agricultural system will take a few years to adjust. For example, the improvement due to higher prices in 1975 is marginal (.9 percent)[2] when measured in real terms, compared to a

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[1]We have to point out that for 1979, the net return figures for recalculation are still the national average estimates, which differ from the figures used in all three versions.

[2]This is a comparison of Price system to Original.

Table 5

Adjusted Net Returns, Using 1979 NR Figures

(L.E. x 10^4)

Crop	1975			1979		
	Original	Day	Price	Original	Day	Price
Cotton	24040	23455	24868	21353	16351	15993
Rice	6032	5260	6850	5970	5191	7263
Wheat	1562	1341	1366	1552	1051	1054
Peanuts	467	540	451	455	586	891
Lentils	155	155	131	59	59	42
Beans	1616	1823	1318	1642	1896	1175
Barley	130	93	93	139	106	74
Garlic	662	842	834	721	639	1290
Sugar Cane	3905	4121	4121	4435	3718	4115
Flax	231	161	161	290	181	177
Sesame	274	249	236	312	213	232
S. Sorghum	1383	1601	1528	1162	1459	1488
N. Sorghum	52	66	66	33	78	60
Maize	4950	6429	5337	5197	5582	3692
W. Onions	1938	366	289	168	387	318
S. Potatoes	1898	2820	2863	2973	7663	10615
N. Potatoes	1999	2108	2108	2691	4206	4206
W. Tomatoes	3133	3361	3361	3840	5610	10642
S. Tomatoes	985	1148	933	1087	1799	1676
N. Tomatoes	3314	3271	3271	2461	6247	6247
W. Vegetables	2820	3259	3131	3801	10917	20413
S. Vegetables	3122	4145	4145	3940	8791	9862
N. Vegetables	2884	3086	3086	2875	4700	4700
Long Berseem	25995	20213	20213	25995	27464	19498
Short Berseem	1461	1422	1422	1461	1212	1274
Fruits	6155	5967	5967	7331	6861	6688
Oranges	3130	2985	2967	3743	3386	3341
Melons	11099	13462	13462	11784	13947	33801
S. Onions	117	247	247	201	637	257
Total	113777	114010		117684	134087	171102

Notes: N = Nili, W = Winter, S = Summer

striking 105.6 percent using current prices, which even when adjusted for the effect of optimization (to give us the effect of higher prices) yields differences of .87 percent and 92.78 percent, respectively. Or in other words, on the surface the picture looks really rosy with a doubling of agricultural returns by changing some prices (not dramatically), but in real terms the initial benefits are substantially lower than some other unconstrained studies have estimated. One should only expect a real shift in returns to the tune of 10-13 percent in response to higher prices in the first year of change. At the end of several years, when the prices have been brought closer to the equilibrium values, we can expect the real change to be about 30 percent[1] (compared to 95.67 percent). Again, the price effect alone is 31 percent and 52.21 percent (real and current, respectively). The situation could be summed up as follows: If a reorganization is made such that we can reallocate production within regions to achieve a more efficient pattern and also to reorganize such that the more optimal crops are emphasized, then we can expect an improvement in aggregate net returns of about .02 percent in the first year, but over time the change becomes 14 percent at the end of the fifth year of pursuing such a policy. Additionally, if we use higher prices for the four major crops, we can expect an increase of about .9 percent in the first year, which rises to 30 percent at the end of the fifth year. More dramatic gains in reallocation of production may result if interregional shifts in key crops is permitted. This substantial institutional shift is not examined in this set of results.

So far, only total figures have been discussed, but examination of the net returns when disaggregated by crop will show what the effects would be in a

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[1]This is a comparison of Price system and Original.

more detailed fashion. These effects could be broken down further into acreage effects (i.e., the change in area and production) and price effects (i.e., the nominal[1] effect of higher prices). First, we can look at the price effect before and after deflation by the 1979 weights. We already examined the deflated net returns in Table 5, and the undeflated results are presented in Table 6.

These results are really quite interesting, since for example one could be easily misled into thinking (indeed as several analysts have done) that by doubling cotton price (for example), its aggregate net return would rise from L.E. 82,509,187 (original 1975 NR) to L.E. 238,546,690 (Price 1975 NR); but if we reevaluate these figures using the 1979 NR as weights, the change is only from L.E. 240,407,270 to L.E. 248,688,530, that is, a change of only 3.4 percent compared to a nominal increase of 189.11 percent. For rice, the nominal increase is from L.E. 39,383,857 to L.E. 236,845,585.9, while in real terms it is only from L.E. 60,322,242 to L.E. 68,501,174 in response to a price change of 183 percent. Doubling the price of wheat still doesn't seem to make any difference since the adjusted net revenue (NR) actually drops from the original adjusted L.E. 15,626,180 to L.E. 13,669,653, while in nominal terms the original is L.E. 45,415,099 and the Price 1975 NR is L.E. 130,591,360. Also, doubling the price of sugar cane caused the real NR to change from L.E. 39,059,000 to L.E. 41,219,011, whereas the nominal change was from L.E. 34,598,229 to L.E. 92,724,178.

For 1979, the effects of the Price change at the end of the five year phasing-in is also affected by the fact that the original NR valuations

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[1]By that we mean the effect of prices in an accounting sense.

Table 6

Price System Net Returns

(L.E. x 10^4)

Crop Code	Crop	1975	1979
1	Cotton	23854	21083
2	Rice	23684	13177
3	Wheat	13059	602
4	Peanuts	215	871
5	Lentils	500	172
6	Beans	1593	1446
7	Barley	396	204
8	Garlic	257	1465
9	Sugar Cane	9272	3228
10	Flax	226	338
11	Sesame	161	370
12	Summer Sorghum	1292	412
13	Nili Sorghum	58	14
14	Maize	3942	3114
16	W. Onions	527	893
17	Summer Potatoes	2455	13841
18	Nili Potatoes	1703	6360
19	Winter Tomatoes	3616	12688
20	Summer Tomatoes	3076	8354
21	Nili Tomatoes	2902	9701
22	Winter Vegetables	1618	24530
23	Summer Vegetables	3089	15305
24	Nili Vegetables	1355	5644
25	Long Berseem	6037	19498
26	Short Berseem	678	3352
30	Fruits	4934	10079
31	Oranges	2437	5514
32	Melons	7238	49000
35	Summer Onions	263	236
	TOTAL	120450	231506

include the effects of several actual price increases. Thus for the four major crops under investigation, their Price 1979 prices are the last stage in narrowing the gap between local and international prices, while for Original 1979, this is also true, although to a lesser extent, since Original 1975 does not include any higher prices while in 1979 the actual prices were higher in real terms.

For cotton in 1979 we find that at first glance the net returns of the Price model are L.E. 210,837,290 which are approximately equal to the original L.E. 213,533,430, while after deflation the Price estimate becomes L.E. 159,938,650. Rice also drops from the L.E. 131,770,498 estimated by Price 1979 to the adjusted figure of L.E. 72,637,346 while the original estimate is L.E. 59,702,574. The original figure for wheat is L.E. 15,529,135 which when compared to the adjusted figure of L.E. 6,026,659.5 while in nominal terms the reduction is only to L.E. 10,549,753. Sugar cane also dropped from the original L.E. 44,356,107 to the adjusted L.E. 32,289,908 while the unadjusted is L.E. 41,154,875. Note, however, that the totals for 1979 showed an increase in both nominal and real terms from L.E. 1,176,842,600 to L.E. 2,315,067,000 and L.E. 1,711,022,900, respectively, which is largely the effect of the acreage increase in the crops with unaltered prices, such as peanuts, garlic, summer sorghum, nili sorghum, summer potatoes, nili potatoes, winter tomatoes, summer tomatoes, nili tomatoes, winter vegetables, summer vegetables, nili vegetables, melons, and summer onions. For 1975, in addition to the real increase in net revenue brought about by increasing the prices of the major crops (except cotton which marginally dropped), the following crops also increased: lentils, barley, flax, nili sorghum, winter onions, summer potatoes, winter tomatoes, summer tomatoes, oranges, and summer onions.

The changes in these crops for 1975-79 are not due to the cross price effect since when no price changes are made (as in the Day models), the list of crops for which net returns have actually increased is mainly due to the effect of optimization. Thus for 1975 the list is: peanuts, lentils, beans, garlic, sesame, summer sorghum, nili sorghum, maize, winter onions, summer potatoes, nili potatoes, winter tomatoes, summer tomatoes, winter vegetables, summer vegetables, nili vegetables, melons, and summer onions. Thus we can say that the cross price effect is due to the difference in both lists, i.e., the decrease in net return due to the change in the following crops: peanuts, beans, garlic, sesame, summer sorghum, maize, nili potatoes, winter vegetables, summer vegetables, nili vegetables, and melons. For 1979, the price effect is attributed to: lentils, beans, winter onions, maize, long berseem, melons and summer onions.

This analysis leads us into examining the acreage effect (both non- and cross-) due to the price changes. This could be achieved by examining Table 7 and comparing it to Tables 10 and 11. The comparison confirms that the Day system shows a drop in acreage for cotton in all three regions; that is, on optimality grounds the areas we actually measured in the original time series are not the time equilibrium values. Then, when the Price system is operated, the areas actually approximate (marginally higher than the original) true areas, indicating that these prices are closer to the prices that would lead to such acreage. The question is then which method is more acceptable, the price incentives or the employed quota system? The answer is implied in the original acreage tables where we can see that the general trend for the acreage of several crops has been dropping, which indicates the desire of farmers to change their production pattern (where the crops are administered,

Table 7

Price Scenario Area

Crops	Region	1974	1975	1976	1977	1978	1979
1	N	946764	871023	801341	737234	678255	623995
	M	307317	322068	256640	205647	163392	129741
	S	198646	199264	188973	183015	161053	141727
2	N	1030715	1153027	1242187	1266688	1269299	1227259
	M	19738	36436	67261	53895	42821	34025
	S	0	0	0	0	0	0
3	N	771969	689387	810168	745355	685727	630869
	M	249337	202314	145666	104880	75514	54370
	S	348633	327715	308052	289569	272195	255863
4	N	20257	18434	16775	20283	24524	29652
	M	5740	8721	13251	20134	16732	25423
	S	3070	3578	4170	4860	5664	5607
5	N	491	368	276	207	155	116
	M	471	353	652	1204	903	677
	S	64595	48446	36335	27251	20438	15329
6	N	73842	56625	57100	45109	35636	28152
	M	113217	104160	165799	152535	140332	129105
	S	56576	39603	62375	43663	30564	21395
7	N	59066	55040	52838	50724	48695	45747
	M	8540	7686	6917	6225	5603	5043
	S	9540	8586	7727	6954	6259	5633
8	N	5542	4932	5629	6424	7332	8368
	M	6922	9928	8439	7173	10288	14755
	S	587	481	510	541	574	609
9	N	9899	9701	11641	13969	13690	13416
	M	27012	40518	60777	54858	49097	43945
	S	171297	179862	188855	183189	177693	172362
10	N	43533	36340	44760	55131	47413	40775
	M	2399	1679	2718	1903	1332	932
	S	108	81	61	46	35	26
11	N	4196	3273	2553	2943	2296	2646
	M	1893	2742	2034	2946	2179	3156
	S	21032	22085	21643	21210	22272	21827

Table 7 (cont.)

Crops	Region	1974	1975	1976	1977	1978	1979
12	N	0	0	0	0	0	0
	M	88451	131880	117168	104679	92730	118189
	S	385697	386037	386038	386039	386040	386041
13	N	0	0	0	0	0	0
	M	25103	26107	27151	28237	28200	23406
	S	41	62	31	47	71	107
14	N	962564	885559	814714	49537	689574	634408
	M	314044	426915	359739	361630	294706	268966
	S	109994	138592	127505	117305	109342	100595
15	N	96718	0	0	0	0	0
	M	203833	0	0	0	0	0
	S	67409	0	0	0	0	0
16	N	3009	2949	4999	8473	8304	14075
	M	10114	17234	13787	11030	8824	7059
	S	26091	19568	22601	26104	19578	22613
17	N	38184	47463	58997	73333	91153	113303
	M	7831	17792	40423	73355	155783	132323
	S	5	8	13	20	32	50
18	N	33826	40253	47901	57002	67832	80720
	M	14251	16389	18847	21674	24925	28664
	S	537	848	1340	2117	3345	5285
19	N	49884	43585	54176	67341	83705	104045
	M	30631	49585	80268	129938	152098	135367
	S	11802	18588	29276	46110	72623	114381
20	N	69791	68395	67027	87102	113189	147089
	M	13750	23430	20816	18597	16474	14595
	S	3433	5407	5299	8346	13145	12882
21	N	61201	73441	88129	105755	126906	152287
	M	30642	32174	33783	35472	37246	39108
	S	8387	10903	14174	18426	23954	31140
22	N	61166	56997	96610	163754	277563	470469
	M	21734	46293	98604	94660	201626	205027
	S	6527	5808	9149	14410	22696	35346

Table 7 (cont.)

Crops	Region	1974	1975	1976	1977	1978	1979
23	N	66035	81335	100180	123392	151982	187196
	M	22316	42146	78453	66477	55853	46932
	S	11577	18234	28719	45232	71240	103068
24	N	55386	60925	67018	73720	81092	89201
	M	23655	26021	28623	31485	34634	38097
	S	7727	9272	11126	13351	16021	19225
25	N	1203335	934442	856275	918904	946424	870641
	M	298588	268729	241856	217670	195903	176313
	S	116254	109395	141313	164655	212068	219178
26	N	833149	776372	745317	715504	686884	659409
	M	210595	202171	201730	279560	268378	257643
	S	134680	115825	99610	85665	73672	63358
30	N	90477	89572	92259	95027	97878	100814
	M	37949	39846	41838	43930	39316	41282
	S	14480	15494	16579	17740	18982	20311
31	N	106799	105731	104674	109908	115403	121173
	M	13309	13176	13835	14527	13134	13791
	S	9940	9841	9743	9646	10128	10027
32	N	1000789	120725	144604	173207	207467	248504
	M	46038	69296	104304	156998	236313	240725
	S	9809	10608	11473	12408	13419	14513
35	N	4739	8033	7872	7715	7561	12816
	M	3453	5884	4311	3176	2320	1695
	S	0	0	0	0	0	0

Table 8

Price System
Absolute Differences in Area

Crops	Region	74-75	75-76	76-77	77-78	78-79
1	N	75741.00	69682.00	64107.00	58979.00	54260.00
	M	-14751.00	65428.00	50993.00	42255.00	33651.00
	S	-618.00	10291.00	5958.00	21962.00	19326.00
2	N	-122312.00	-89160.00	-24501.00	-2611.00	42040.00
	M	-16698.00	-30825.00	13366.00	11074.00	8796.00
	S	0.00	0.00	0.00	0.00	0.00
3	N	82582.00	-120781.00	64813.00	59628.00	54858.00
	M	47023.00	56648.00	40786.00	29366.00	21144.00
	S	20918.00	19663.00	18483.00	17374.00	16332.00
4	N	1823.00	1659.00	-3508.00	-4241.00	-5128.00
	M	-2981.00	-4530.00	-6883.00	3402.00	-8691.00
	S	-508.00	-592.00	-690.00	-804.00	57.00
5	N	123.00	92.00	69.00	52.00	39.00
	M	118.00	-299.00	-552.00	301.00	226.00
	S	16149.00	12111.00	9084.00	6813.00	5109.00
6	N	17217.00	-475.00	11991.00	9473.00	7484.00
	M	9057.00	-61639.00	13264.00	12203.00	11227.00
	S	16973.00	-22772.00	18712.00	13099.00	9169.00
7	N	4026.00	2202.00	2114.00	2029.00	1948.00
	M	854.00	769.00	692.00	622.00	560.00
	S	954.00	859.00	773.00	695.00	626.00
8	N	610.00	-697.00	-795.00	-908.00	-1036.00
	M	-3006.00	1489.00	1266.00	-3115.00	-4467.00
	S	106.00	-29.00	-31.00	-33.00	-35.00
9	N	198.00	-1940.00	-2328.00	279.00	274.00
	M	-13506.00	-20259.00	5919.00	5761.00	5152.00
	S	-8565.00	-8993.00	5666.00	5496.00	5331.00
10	N	7193.00	-8420.00	-10371.00	7718.00	6638.00
	M	720.00	-1039.00	815.00	571.00	400.00
	S	27.00	20.00	15.00	11.00	9.00
11	N	923.00	720.00	-390.00	647.00	-350.00
	M	-849.00	708.00	-912.00	767.00	-977.00
	S	-1053.00	442.00	433.00	-1062.00	445.00

Table 8 (cont.)

Crops	Region	74-75	75-76	76-77	77-78	78-79
12	N	0.00	0.00	0.00	0.00	0.00
	M	-43429.00	14712.00	12489.00	11949.00	-25459.00
	S	-340.00	-1.00	-1.00	-1.00	-1.00
13	N	0.00	0.00	0.00	0.00	0.00
	M	-1004.00	-1044.00	-1086.00	37.00	4794.00
	S	-21.00	31.00	-16.00	-24.00	-36.00
14	N	77005.00	70845.00	65177.00	59963.00	55166.00
	M	-112871.00	67176.00	-1891.00	66924.00	25740.00
	S	-28598.00	11087.00	10200.00	7963.00	8747.00
15	N	96718.00	0.00	0.00	0.00	0.00
	M	203833.00	0.00	0.00	0.00	0.00
	S	67409.00	0.00	0.00	0.00	0.00
16	N	60.00	-2050.00	-3474.00	169.00	-5771.00
	M	-7120.00	3447.00	2757.00	2206.00	1765.00
	S	6523.00	-3033.00	-3503.00	6526.00	-3035.00
17	N	-9279.00	-11534.00	-14336.00	-17820.00	-22150.00
	M	-9961.00	-22631.00	-32932.00	-82428.00	23460.00
	S	-3.00	-5.00	-7.00	-12.00	-18.00
18	N	-6427.00	-7648.00	-9101.00	-10830.00	-12888.00
	M	-2138.00	-2458.00	-2827.00	-3251.00	-3739.00
	S	-311.00	-492.00	-777.00	-1228.00	-1940.00
19	N	6299.00	-10591.00	-13165.00	-16364.00	-20340.00
	M	-18954.00	-30683.00	-49670.00	-22160.00	16731.00
	S	-6786.00	-10688.00	-16834.00	-26513.00	-41758.00
20	N	1396.00	1368.00	-20075.00	-26087.00	-33900.00
	M	-9680.00	2614.00	2219.00	2123.00	1879.00
	S	-1974.00	108.00	-3047.00	-4799.00	263.00
21	N	-12240.00	-14688.00	-17626.00	-21151.00	-25381.00
	M	-1532.00	-1609.00	-1689.00	-1774.00	-1862.00
	S	-2516.00	-3271.00	-4252.00	-5528.00	-7186.00
22	N	4169.00	-39613.00	-67144.00	-113809.00	-192906.00
	M	-24559.00	-52311.00	3944.00	-106966.00	-3401.00
	S	718.00	-3340.00	-5261.00	-8286.00	-13050.00

Table 8 (cont.)

Crops	Region	74-75	75-76	76-77	77-78	78-79
23	N	-15300.00	-18845.00	-23212.00	-28590.00	-35214.00
	M	-19830.00	-36307.00	11976.00	10624.00	8921.00
	S	-6657.00	-10485.00	-16513.00	-26008.00	-31828.00
24	N	-5539.00	-6093.00	-6702.00	-7372.00	-8109.00
	M	-2366.00	-2602.00	-2862.00	-3149.00	-3463.00
	S	-1545.00	-1854.00	-2225.00	-2670.00	-3204.00
25	N	268893.00	78167.00	-62629.00	-27520.00	75783.00
	M	29859.00	26873.00	24186.00	21767.00	19590.00
	S	6859.00	-31918.00	-23342.00	-47413.00	-7110.00
26	N	56777.00	31055.00	29813.00	28620.00	27475.00
	M	8424.00	441.00	-77830.00	11182.00	10735.00
	S	18855.00	16215.00	13945.00	11993.00	10314.00
30	N	905.00	-2687.00	-2768.00	-2851.00	-2936.00
	M	-1897.00	-1992.00	-2092.00	4614.00	-1966.00
	S	-1014.00	-1085.00	-1161.00	-1242.00	-1329.00
31	N	1068.00	1057.00	-5234.00	-5495.00	-5770.00
	M	133.00	-659.00	-692.00	1393.00	-657.00
	S	99.00	98.00	97.00	-482.00	101.00
32	N	-19936.00	-23879.00	-28603.00	-34260.00	-41037.00
	M	-23258.00	-35008.00	-52694.00	-79315.00	-4412.00
	S	-799.00	-865.00	-935.00	-1011.00	-1094.00
35	N	-3294.00	161.00	157.00	154.00	-5255.00
	M	-2431.00	1573.00	1135.00	856.00	625.00
	S	0.00	0.00	0.00	0.00	0.00

Table 9

Price System
Percentage Differences in Area

Crops	Region	74-75	75-76	76-77	77-78	78-79
1	N	8.00	8.00	8.00	8.00	8.00
	M	-4.80	20.31	19.87	20.55	20.60
	S	-0.31	5.16	3.15	12.00	12.00
2	N	-11.87	-7.73	-1.97	-0.21	3.31
	M	-84.60	-84.60	19.87	20.55	20.54
	S	0.00	0.00	0.00	0.00	0.00
3	N	10.70	-17.52	8.00	8.00	8.00
	M	18.86	28.00	28.00	28.00	28.00
	S	6.00	6.00	6.00	6.00	6.00
4	N	9.00	9.00	-20.91	-20.91	-20.91
	M	-51.93	-51.94	-51.94	16.90	-51.94
	S	-16.55	-16.55	-16.55	-16.54	1.01
5	N	25.05	25.00	25.00	25.12	25.16
	M	25.05	-84.70	-84.66	25.00	25.03
	S	25.00	25.00	25.00	25.00	25.00
6	N	23.32	-0.84	21.00	21.00	21.00
	M	8.00	-59.18	8.00	8.00	8.00
	S	30.00	-57.50	30.00	30.00	30.00
7	N	6.82	4.00	4.00	4.00	4.00
	M	10.00	10.01	10.00	9.99	9.99
	S	10.00	10.00	10.00	9.99	10.00
8	N	11.01	-14.13	-14.12	-14.13	-14.13
	M	-43.43	15.00	15.00	-43.43	-43.42
	S	18.06	-6.03	-6.08	-6.10	-6.10
9	N	2.00	-20.00	-20.00	2.00	2.00
	M	-50.00	-50.00	9.74	10.50	10.49
	S	-5.00	-5.00	3.00	3.00	3.00
10	N	16.52	-23.17	-23.17	14.00	14.00
	M	30.01	-61.88	29.99	30.01	30.03
	S	25.00	24.69	24.59	23.91	25.71
11	N	22.00	22.00	-15.28	21.98	-15.24
	M	-44.85	25.82	-44.84	26.04	-44.84
	S	-5.01	2.00	2.00	-5.01	2.00

Table 9 (cont.)

Crops	Region	74-75	75-76	76-77	77-78	78-79
12	N	0.00	0.00	0.00	0.00	0.00
	M	-49.10	11.16	10.66	11.41	-27.45
	S	-0.09	-0.00	-0.00	-0.00	-0.00
13	N	0.00	0.00	0.00	0.00	0.00
	M	-4.00	-4.00	-4.00	0.13	17.00
	S	-51.22	50.00	-51.61	-51.06	-50.70
14	N	8.00	8.00	8.00	8.00	8.00
	M	-35.94	15.74	-0.53	18.51	8.73
	S	-26.00	8.00	8.00	6.79	8.00
15	N	100.00	0.00	0.00	0.00	0.00
	M	100.00	0.00	0.00	0.00	0.00
	S	100.00	0.00	0.00	0.00	0.00
16	N	1.99	-69.52	-69.49	1.99	-69.50
	M	-70.40	20.00	20.00	20.00	20.00
	S	25.00	-15.50	-15.50	25.00	-15.50
17	N	-24.30	-24.30	-24.30	-24.30	-24.30
	M	-127.20	-127.20	-81.47	-112.37	15.06
	S	-60.00	-62.50	-53.85	-60.00	-56.25
18	N	-19.00	-19.00	-19.00	-19.00	-19.00
	M	-15.00	-15.00	-15.00	-15.00	-15.00
	S	-57.91	-58.02	-57.99	-58.01	-58.00
19	N	12.63	-24.30	-24.30	-24.30	-24.30
	M	-61.88	-61.88	-61.88	-17.05	11.00
	S	-57.50	-57.50	-57.50	-57.50	-57.50
20	N	2.00	2.00	-29.95	-29.95	-29.95
	M	-70.40	11.16	10.66	11.42	11.41
	S	-57.50	2.00	-57.50	-57.50	2.00
21	N	-20.00	-20.00	-20.00	-20.00	-20.00
	M	-5.00	-5.00	-5.00	-5.00	-5.00
	S	-30.00	-30.00	-30.00	-30.00	-30.00
22	N	6.82	-69.50	-69.50	-69.50	-69.50
	M	-113.00	-113.00	4.00	-113.00	-1.69
	S	11.00	-57.50	-57.50	-57.50	-57.50

Table 9 (cont.)

Crops	Region	74-75	75-76	76-77	77-78	78-79
23	N	-23.17	-23.17	-23.17	-23.17	-23.17
	M	-88.86	-86.15	15.27	15.98	15.97
	S	-57.50	-57.50	-57.50	-57.50	-44.68
24	N	-10.00	-10.00	-10.00	-10.00	-10.00
	M	-10.00	-10.00	-10.00	-10.00	-10.00
	S	-19.99	-20.00	-20.00	-20.00	-20.00
25	N	22.35	8.37	-7.31	-2.99	8.01
	M	10.00	10.00	10.00	10.00	10.00
	S	5.90	-29.18	-16.52	-28.80	-3.35
26	N	6.81	4.00	4.00	4.00	4.00
	M	4.00	0.22	-38.58	4.00	4.00
	S	14.00	14.00	14.00	14.00	14.00
30	N	1.00	-3.00	-3.00	-3.00	-3.00
	M	-5.00	-5.00	-5.00	10.50	-5.00
	S	-7.00	-7.00	-7.00	-7.00	-7.00
31	N	1.00	1.00	-5.00	-5.00	-5.00
	M	1.00	-5.00	-5.00	9.59	-5.00
	S	1.00	1.00	1.00	-5.00	1.00
32	N	-19.78	-19.78	-19.78	-19.78	-19.78
	M	-50.52	-50.52	-50.52	-50.52	-1.87
	S	-8.15	-8.15	-8.15	-8.15	-8.15
35	N	-69.51	2.00	1.99	2.00	-69.50
	M	-70.40	26.73	26.33	26.95	26.94
	S	0.00	0.00	0.00	0.00	0.00

Table 10

Original Area

Crops	Region	1974	1975	1976	1977	1978	1979
1	N	946764	880928	829341	969982	821177	826566
	M	307317	283220	256872	288418	225461	222083
	S	198646	181842	161415	172965	141965	146880
2	N	1030715	1030818	1056580	1021100	1011109	1019316
	M	19738	16625	17228	16390	13959	17367
	S	0	0	0	0	0	0
3	N	771969	786734	812275	685916	783176	796804
	M	249337	252798	239531	197411	241362	227359
	S	348633	354418	343782	323824	355520	361130
4	N	20257	21801	21709	25296	20650	20434
	M	5740	5758	6608	7003	5910	6214
	S	3070	4231	3766	4107	4355	4357
5	N	491	396	1236	707	961	455
	M	471	570	666	436	275	135
	S	64595	57401	61682	47166	34268	21687
6	N	73842	78443	89570	96663	72082	74925
	M	113217	11463	108279	123229	99409	109546
	S	56576	52496	61789	71898	67463	65038
7	N	59066	77363	75320	70897	84890	79529
	M	8540	11210	14186	10883	15000	15030
	S	9540	11003	14268	13428	13933	12196
8	N	5542	5284	2700	4535	5082	4756
	M	6922	6366	10453	9981	7074	8033
	S	587	531	377	829	630	480
9	N	9899	11426	12076	9008	8699	0
	M	27012	33137	37559	38260	38007	0
	S	171297	173461	192845	202037	200886	0
10	N	43533	51718	44436	55599	57432	64972
	M	2399	2604	2818	2823	2333	3439
	S	108	142	236	151	153	114
11	N	4196	3496	2919	2726	2219	3064
	M	1893	1615	1435	1440	1204	2220
	S	21032	27539	26445	35845	19925	31836

Table 10 (cont.)

Crops	Region	1974	1975	1976	1977	1978	1979
12	N	0	0	0	0	0	0
	M	88451	86487	71337	52766	56342	43899
	S	385697	382269	373726	340368	356798	345439
13	N	0	0	0	0	0	0
	M	25103	19985	27229	12783	20328	12740
	S	41	420	1059	2608	128	449
14	N	962564	947764	977478	884843	937396	943817
	M	314044	341826	380172	309687	325513	326172
	S	109994	136163	132663	128173	141642	143010
15	N	96718	137107	135651	151541	170937	150111
	M	203833	196053	207605	223304	261273	269965
	S	67409	70534	57358	67397	61342	51577
16	N	3009	4228	6038	8139	5954	6711
	M	10114	7568	8503	14314	9508	9765
	S	26091	14838	16122	14474	13720	6704
17	N	58189	35664	45092	82137	53365	56210
	M	7851	8235	8875	11826	11196	12535
	S	5	36	99	184	189	87
18	N	33826	38087	54499	56181	41846	47070
	M	14251	15740	18805	21004	20764	25474
	S	537	666	866	1147	608	813
19	N	49884	54782	56221	55680	59422	63842
	M	30631	35002	35761	35240	38987	48787
	S	11802	14391	17005	14723	14677	15000
20	N	69791	83223	82469	81897	86701	94410
	M	13750	15299	14411	15278	15774	14750
	S	3433	4033	4106	5137	4924	4059
21	N	61201	76730	63062	50982	54668	48895
	M	30642	32372	28996	28281	33324	33551
	S	8387	8950	5917	6167	2164	5217
22	N	61166	66518	74873	76397	81473	99927
	M		36250	24755	25846	25187	26625
	S						

Table 10 (cont.)

Crops	Region	1974	1975	1976	1977	1978	1979
23	N	66035	73482	79414	77073	81879	94298
	M	22316	23849	24283	25222	23725	31920
	S	11577	9425	8662	9929	8124	8486
24	N	55386	60779	59367	58207	70732	65316
	M	23655	23409	23376	19614	20102	19390
	S	7727	5738	5199	6550	6351	4925
25	N	1203335	1238740	1255712	1235240	1312217	1245681
	M	298588	306713	319936	322420	337185	348083
	S	116254	142578	135102	139100	139749	152189
26	N	833149	820632	757393	839983	748299	774827
	M	210595	187172	187074	196204	142630	166551
	S	134680	116144	101337	121418	102379	89748
30	N	90477	94276	102946	105541	107855	109427
	M	37949	40082	42817	43927	46214	47773
	S	14480	15106	18052	18922	20118	20830
31	N	106799	112572	126853	130383	133063	135798
	M	13309	13224	12978	12970	13857	14163
	S	9940	10011	12078	12217	11992	12469
32	N	100789	107488	112127	110004	108295	0
	M	46038	48501	53590	44477	57137	0
	S	9809	9429	9439	10179	10192	0
35	N	4739	4728	7837	13125	7600	0
	M	3453	1868	4137	6465	3743	0
	S	0	0	0	0	0	0

Table 11

Day System Area

Crops	Region	1974	1975	1976	1977	1978	1979
1	N	946764	871023	769839	708252	680580	626134
	M	307317	267366	239653	198688	212083	184512
	S	198646	174808	153831	135371	119126	104831
2	N	1030715	896341	940642	771326	870795	879503
	M	19738	17172	14257	11820	25249	21967
	S	0	0	0	0	0	0
3	N	771969	689387	669437	615882	665891	612620
	M	249337	179523	171300	123336	96787	69687
	S	348633	327715	308052	289569	272195	255863
4	N	20257	24493	26298	31797	26552	28411
	M	5740	8721	13700	20816	7524	6847
	S	3070	3578	4030	4697	4661	4614
5	N	491	368	239	179	233	175
	M	471	353	230	425	672	874
	S	64595	57722	42743	32057	28341	21256
6	N	73842	56625	20817	16445	38956	30775
	M	113217	180855	195049	179445	239515	234246
	S	56576	39603	62375	43663	32990	23093
7	N	59066	55040	50883	48848	67935	65218
	M	8540	7686	6242	5618	11691	10522
	S	9540	8586	7981	7183	6259	5633
8	N	5542	4932	5320	6072	5081	5132
	M	6922	9928	5170	7415	6061	6122
	S	587	623	519	550	496	501
9	N	9899	9701	11641	11408	11180	10956
	M	27012	40518	39708	37083	38136	37373
	S	171297	179862	188631	182972	164155	159230
10	N	43533	36340	36772	45292	48484	41696
	M	2399	1679	907	635	1310	917
	S	108	81	44	33	27	20
11	N	4196	4836	4933	5686	3473	3542
	M	1893	2742	2797	4051	2049	1660
	S	21032	22085	22086	21644	20605	20193

Table 11 (cont.)

Crops	Region	1974	1975	1976	1977	1978	1979
12	N	0	0	0	0	0	0
	M	88451	131880	85759	79269	99322	96342
	S	385697	410493	387820	387821	398140	398141
13	N	0	0	0	0	0	0
	M	25103	26107	27307	28399	29366	30541
	S	41	62	31	47	71	107
14	N	962564	1109450	1117150	1235413	897628	915580
	M	314044	500083	540604	511298	500485	460446
	S	109994	138592	149639	145051	154037	141714
15	N	96718	0	0	0	0	0
	M	203833	0	0	0	0	0
	S	67409	0	0	0	0	0
16	N	3009	2949	7629	12931	11280	16920
	M	10114	17234	13188	10550	13982	16778
	S	26091	30135	27511	31775	17759	19535
17	N	38184	47463	52208	64895	55904	61494
	M	7831	17792	33805	76805	72371	115794
	S	5	8	17	27	36	54
18	N	33826	40253	47901	57002	67832	80720
	M	14251	16389	18847	21674	24925	28664
	S	537	848	1340	2117	3345	5285
19	N	49884	43585	55806	69367	59875	65863
	M	30631	49585	43635	70636	51734	58977
	S	11802	18588	35318	55626	41108	61662
20	N	69791	90693	104298	135535	122066	140376
	M	13750	23430	28116	28158	28512	33608
	S	3433	5407	14599	22993	13625	13353
21	N	61201	73441	91177	109412	126906	152287
	M	30642	32174	33783	35472	37246	39108
	S	8387	10903	14174	18426	23954	31140
22	N	61166	56997	99529	168702	145565	218348
	M	21734	46293	44442	84848	84501	126752
	S	6527	10280	23644	37239	23529	35294

Table 11 (cont.)

Crops	Region	1974	1975	1976	1977	1978	1979
23	N	66035	81335	88655	109196	93214	101603
	M	22316	42146	56054	49143	69825	92867
	S	11577	18234	30998	48822	75281	106083
24	N	55386	60925	67018	73720	81092	89201
	M	23655	26021	28623	31485	34634	38097
	S	7727	9272	11126	13351	16021	19225
25	N	1203335	934442	1034045	1080973	1077090	1137913
	M	298588	268729	354187	318768	311087	326641
	S	116254	109395	123182	170477	290597	318856
26	N	833149	776372	767830	737117	707632	679327
	M	210595	202171	159143	232763	198171	190244
	S	134680	115825	98266	84509	73672	63358
30	N	90477	89572	92259	95027	97878	100814
	M	37949	39846	39050	41003	44758	46996
	S	14480	15494	16718	17888	17562	18791
31	N	106799	105731	111018	116569	115403	121173
	M	13309	13974	13835	14527	15252	15099
	S	9940	9841	9743	9646	10742	10635
32	N	100789	120725	126897	151997	127243	134878
	M	46038	69296	70197	105661	58122	61609
	S	9809	10608	11168	12078	11040	11371
35	N	4739	8033	13655	23145	20132	30198
	M	3453	5884	3315	2527	7162	5730
	S	0	0	0	0	0	0

but where they are not, it is an indication of the direction of the market forces). Tables 8 and 9 present the absolute and percentage difference (respectively) in the Price System areas for 1974-79.[1]

The breakdown of net returns by governorate is presented in Table 12 for 1975 and 1979. The effects of the higher prices on the per feddan net returns are presented in Table 12. The interesting feature of the change in net returns is that the higher prices seem to have caused a depression of agricultural income in some governorates, while the increase in the others more than offsets that drop as the aggregate net returns increase. This phenomenon highlights some of the features of the analysis, namely: (i) Optimization models of this nature assume a higher degree of resource mobility than can be achieved. In this model, resources are defined by governorate except for water which is defined by region, but still this does not seem to be the cause of the problem. (ii) The optimization models work on optimizing some friction without regard to distributional effects which were deliberately omitted to allow efficiency effects to dominate. To this end we have succeeded in identifying which crops would be affected by a price increase for the major crops and in which areas.

The change in acreage on a Governorate basis can be gauged by comparing the acreages[2] in Table 13 to those presented in Table 14 (for the Day system).

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[1]As previously mentioned, the signs are to be read in reverse, thus a t-ve is actually a-ve and vice versa.

[2]The tables list only a sample of 2 governorates from each region since the full set of governorates' allocation is presented later.

Table 12

Price System Net Returns
by Governorate (L.E. x 10^4)

Governorate	1975		1979	
	Aggregate	Per Feddan	Aggregate	Per Feddan
Alexandria	265	99.05		
Beheira	16063	108.00	19730	132.65
Gherbiya	8251	95.41	12098	139.88
Kafr El Sheikh	9273	106.38	5402	161.97
Dakahliya	11599	90.77	46268	362.09
Damietta	2113	105.11	6579	327.21
Sharkiya	19979	156.67	29855	234.11
Ismailiya	956	105.72	1805	199.53
Suez	60	37.44	69	43.61
Mimfiya	10375	154.34	20095	298.93
Kalyubiya	5651	137.24	10936	265.58
Giza	4369	109.75	17857	448.55
Beni Suef	5113	92.44	5035	91.01
Fayum	4529	67.76	5075	75.93
Miuya	6134	69.17	27696	312.30
Assyut	4968	76.78	7515	116.12
Sohey	4098	68.26	5169	86.09
Quena	9152	139.08	8461	128.59
Aswan	2091	114.98	565	31.06

Table 13

Price System Crop Area
$(x10^3)$

	1975						1979					
	DKH	SHR	FAM	MNY	SHG	ONA	DKH	SHR	FAM	MNY	SHG	ONA
1	92	534	120		114			31			141	
2			36				364	250	34			
3	158	76		202				610				
4	18				3.57			12		25	5.6	
5				.353	48		.116			.677	15	
6		48				39	28				21	
7					8.58				5.04		5.63	
8				9.92	.481			8.36		14		
9				40		179		7.94	43			42
10							40					
11			2.74			22			3.15			
12			131			71				118	19	256
13										23		
14	381		10	338	102	36			2.19		100	
16						7			7.05			
17								113		132		
18					.848			80				
19			49			18				135		114
20					5.4	10			14.5		12	31
21			32						39			
22						1.4	26			205		35
23		81		42	18.2			187		46		19
24		60	26			9.27		89		38		82
25	415			92	7	102	335		39		136	63
26				120	115				257			10
30					15					41		
31			13		9.84							
32	120				10		248			56		
35								12				

Table 14

Day System Crop Area
($x10^3$)

	1975						1979					
	DKH	SHR	FAM	MNY	SHG	QNA	DKH	SHR	FAM	MNY	SHG	QNA
1	336	534	267		107			119			104	
2			17				477	207	21			
3	111	124				54		523	69			23
4	24				3			13		6	4	
5				.353	57		.175			.874	21	
6							30			21	23	
7									10		5	
8				9	.623			5		6		
9				40				10	8	28		.752
10							41		.917			
11			2			22						
12			13	39		77				96	15	297
13										30		
14	131			298	109	29			284		141	
16									16			
17								61		115		
18					.848			80				
19			49			18				58		61
20					5					33	13	
21			32			10			39			31
22							8			126		35
23		81		42	18			101		92		
24		60	26			9		89		38		19
25	216			268	13	96	583		56	175	165	153
26			22	146	115				190			63
30					15					46		
31			13		9							10
32	120				10		134					
35								30				

Some very interesting deductions can be drawn from such a comparison. For example, in the case of cotton in 1975 (or alternatively the first year of a price increase) the Northern acreage is concentrated in Sharkiya (534,616 feddans) and Dakahliya (336,406). But when the price is revised, the acreages change to Sharkiya (534,617), Gharbiya (244,317), and Dakahliya (92,089) which is consistent with the Day system crop shadow prices. Table 14 shows that the next governorate to be expected to be used for expanding cotton acreage was Gharbiya. For example, in Suez the shadow prices show that the crops to be brought in next (if more land is to be used) are sesame and maize, which is exactly what happens since these crops are facing pressure from the now higher valued crops (the four major ones) in the most productive areas, which means that the displaced maize and sesame acreage is to be replaced elsewhere. This is why in Price 1975, Suez is producing those two crops in addition to its beans acreage. Examples of the shadow prices for the Price system crop rows and columns appear in Tables 15 and 16 for 1975. A shadow price of less than 20 percent of the price is specified as being the maximum acceptable level for deciding whether to introduce a crop, when it is not specified in the solution. Under the price scenario advocated in Price system 1975, production of cotton is favored in the following Northern Governorates: Gharbiya, Dakahliya, Sharkiya (already selected by the model), and Behera, Kalyubiya, and Minufiya (based on above argument). Production in Kafr El Sheikh is not recommended (given the available information), and cotton should be discouraged in Ismailiya, Damietta, and Alexandria. The argument could be easily extended to cover all crops in all the Governorates for each year 1975-79.

Table 15

Crop Row Dual Values
Price System 1975

	Cotton	Rice	Wheat	S. Cane	Maize	L. Berseem	Oranges
ALX	129.01	121.93	22.76	16.92	14.38	28.00	35.65
BHR	60.84	113.62	17.46	25.30	6.90	28.00	39.72
GMR	55.74	114.65	15.56	23.98	7.47	29.42	35.65
KFR	70.67	115.88	17.67	23.42	9.57	28.00	61.02
DKH	55.74	115.70	15.33	16.58	6.75	28.00	42.03
DAM	72.67	112.04	16.51	16.57	14.35	28.00	50.27
SMR	55.74	120.12	15.22	16.75	9.20	29.94	56.00
ISM	77.77	113.68	18.97	30.68	14.11	28.00	37.81
SUZ	NA	NA	17.62	NA	6.24	29.80	75.37
MNF	63.62	NA	14.33	18.47	6.24	29.99	44.60
KAL	53.32	NA	15.83	14.83	6.96	31.36	38.85
GZA	56.33	NA	17.25	17.69	7.77	28.00	45.75
BSF	48.94	NA	16.50	24.09	7.87	28.00	41.83
FAY	48.94	114.11	17.82	15.70	6.14	28.00	35.65
MNY	55.65	NA	15.49	14.83	7.50	28.00	54.81
ASY	54.81	NA	17.05	15.71	8.32	35.15	41.93
SMG	48.94	NA	18.04	16.25	6.92	28.00	35.65
QNA	67.67	NA	19.62	14.83	7.80	28.00	94.44
ASN	48.94	NA	25.26	17.59	14.59	31.74	91.75

Table 16

Crop Column Dual Values
Price System 1975

	Cotton	Rice	Wheat	S. Cane	Maize	L. Berseem	Oranges
ALX	73.27	8.31	8.85	2.09	7.48	0	0
BHR	5.1	0	3.55	10.47	0	0	4.07
GMR	0	.23	.44	9.15	0	1.42	0
KFR	14.93	0	2.45	8.59	3.07	0	25.37
DKH	0	2.44	0	1.75	0	0	6.38
DAM	26.01	0	1.39	1.74	7.49	0	14.62
SMR	0	6.47	0	1.92	2.11	1.94	20.35
ISM	22.03	0	4.60	15.85	7.11	0	2.16
SUZ	NA	NA	3.25	NA	0	1.80	39.72
MNF	7.88	NA	0	3.64	0	1.99	8.95
KAL	6.66	NA	0	0	0	3.36	3.20
GZA	7.39	NA	2.17	2.86	0	0	10.10
BSF	0	NA	1.42	9.26	.78	0	6.18
FAY	0	0	2.98	.87	0	0	0
MNY	6.71	NA	0	0	0	0	19.16
ASY	5.87	NA	0	.88	1.18	7.15	6.28
SMG	0	NA	.58	1.42	0	0	0
QNA	18.73	NA	1.76	0	0	0	58.79
ASN	0	NA	7.40	2.76	6.82	3.74	56.10

The dynamics of the solution also provides valuable information since it demonstrates how the relative positions of governorates could change between years. For example, rice in 1975 under the price scenario is shown by the model to be produced in Behera, Kafr El Sheikh, Damietta. Ismailiya, Faymu and Gharbiya, Dakahliya, Sharkiya, and Alexandria under the shadow price criterion[1]. For 1979 the list becomes: Kafr El Sheikh, Dakahliya, Sharkiya, Faymu (model selection) and Ismailiya, Alexandria and Beheira (shadow price criterion), while Damietta and Gharbiya have become marginally unfavorable. This then leads us to the conclusion that, once a governorate is proven acceptable for growing certain crops, it does not automatically follow that this advantage will remain indefinitely, even if the prices are raised relative to other prices.

The final aspects of the Price system to be discussed are the primal and dual values on the upper and lower flexibility restraints (bounds) since these values give us a marginal valuation of policy changes. For Day 1975, the crops at their upper bounds are the higher valued ones in general; thus the list includes: peanuts, garlic, sugar cane, sesame, nili sorghum, maize, winter onions, summer and nili potatoes, winter, summer and nili tomatoes, winter, summer and nili vegetables, fruits, oranges, melons, and summer onions, although not in all three regions in every case. By revising the price of the four major crops in the Price 1975 run, the list becomes: cotton, peanuts, garlic, sugar cane, sesame, nili sorghum, maize, winter onions, summer potatoes, nili potatoes, winter, summer and nili tomatoes, winter, summer, and nili vegetables, fruits, melons, and summer onions, and again not

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[1]This list for rice actually contains all governorates with the technical and climatic conditions favorable to rice, thus we see that ________ then is uneconomic for rice production.

all crops have hit the upper bounds in all three regions. These lists identify which crops would tend to be favored for expansion and which would not (the complement of these crops out of the total crop list). However, the change over time is also of great relevance, and this information (dynamic movement)[1] is included in the tables on regional cropping activity. Limiting the results to the 1975 and 1979 models for both regions, the dual values are presented in Tables 17, 18, 19 and 20.

Examination of the dual values reveals that the price changes here indeed affected both the upper and lower bound duals.

1. Upper bounds: For the purposes of this discussion we must classify crops according to their market structure, i.e., either administered or free. In general, one would expect the administered crops not to be at their upper bounds (they are administered so as to keep their profit margins deliberately low as a means of subsidizing the industry and/or consumers). Applying the higher prices should help free these crops and move them towards their upper bounds, and since this uses up acreage that could otherwise have been used by other crops, one would expect that some of the other crops would move down from their upper bounds.

As an example, Table 17 shows that revising the prices for cotton and rice has caused them to be at their upper bounds (Price model) in the middle region. Also, revising the price for sugar cane has caused more pressure on its upper bounds since the dual value changed from 31.62 to 309.11 in the middle region and from 8.48 to 224.89 in the southern region.

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[1]These are the primal values referred to earlier.

Table 17

Dual Values on Upper Bounds

Crop	North		Middle		South	
	Day	Price	Day	Price	Day	Price
Cotton				18.58		
Rice				132.35		
Wheat						
Peanuts	91.45		138.70	139.98	155.99	155.99
Lentils						
Beans						
Barley						
Garlic			99.33	85.83	12.93	
Sugar Cane			31.62	309.11	8.48	224.89
Flax						
Sesame	20.18		66.10	73.06	45.58	45.58
S. Sorghum			7.42	14.37		
N. Sorghum			22.2	22.2	39.67	39.67
Maize	10.32				6.79	6.79
W. Onions			49.47	35.97	22.42	
S. Potatoes	375.02	207.59	321.73	313.81	292.71	292.71
N. Potatoes	314.64	314.64	246.54	246.54	384.86	384.86
W. Tomatoes			171.85	158.35	221.99	167.35
S. Tomatoes	94.94		75.56	76.84	30.34	30.34
N. Tomatoes	330.40	330.40	119.25	119.25	84.37	84.37
W. Vegetables			39.34	25.84	32.69	
S. Vegetables	206.45	26.98	169.69	169.69	232.33	232.33
N. Vegetables	147.61	147.61	136.40	136.40	109.70	109.70
Long Berseem						
Short Berseem						
Fruits			117.67	96.25	170.95	116.31
Oranges			2.23			
Melons	391.61	224.17	265.64	266.92	210.76	210.76
S. Onions	200.06	44.45	117.74	119.02		

Table 18

1975 Dual Values on Lower Bounds

Crop	North		Middle		South	
	Day	Price	Day	Price	Day	Price
Cotton	368.48	396.57	76.18		82.63	
Rice			9.42			
Wheat	376.18	297.60	9.62		81.64	60.14
Peanuts		75.98				
Lentils	331.33	332.79	39.52	53.02		54.63
Beans	331.79	335.84		13.50	24.22	84.20
Barley	330.73	335.71	40.32	53.82	76.20	135.74
Garlic	263.50	275.27				41.70
Sugar Cane	287.70	178.46				
Flax	332.64	332.64	33.30	46.80	83.72	158.76
Sesame		139.55				
S. Sorghum						
N. Sorghum						
Maize		157.11				
W. Onions	166.79	178.55				39.86
S. Potatoes						
N. Potatoes						
W. Tomatoes						
S. Tomatoes		72.49				
N. Tomatoes						
W. Vegetables	227.81	232.79				42.33
S. Vegetables						
N. Vegetables						
Long Berseem	346.32	346.32	44.94	58.44	56.40	111.04
Short Berseem	386.12	386.12	84.74	98.24	96.20	150.84
Fruits	16.56	183.93				
Oranges	210.70	383.12		4.30	7.40	62.04
Melons						
S. Onions						

Table 19

1979 Dual Values on Upper Bounds

Crop	North		Middle		South	
	Day	Price	Day	Price	Day	Price
Cotton						
Rice	13.58					
Wheat						
Peanuts	118.67	28.14	22.25	66.20		
Lentils						
Beans						
Barley						
Garlic	443.26	440.42	586.50	580.27	196.55	196.14
Sugar Cane						
Flax						
Sesame	75.40	22.93		63.99		
S. Sorghum						
N. Sorghum			5.77		63.64	63.64
Maize	27.18					
W. Onions	121.64	120.56	25.60		12.13	14.26
S. Potatoes	595.30	504.76	137.45		373.31	373.31
N. Potatoes	621.80	621.80	370.22	370.22	529.45	529.45
W. Tomatoes	413.30	413.30	179.90		167.60	167.60
S. Tomatoes	462.88	349.60				
N. Tomatoes	469.50	469.50	383.76	383.76	337.40	337.40
W. Vegetables	194.96	194.96	245.50		186.0	186.0
S. Vegetables	539.28	448.74	24.20			
N. Vegetables	416.32	416.32	326.16	326.16	358.08	358.08
Long Berseem			104.30			
Short Berseem						
Fruits	415.43	313.88	86.0	281.60	25.71	25.30
Oranges	228.83	137.22		192.63		
Melons	1062.34	968.08	495.44		417.76	417.76
S. Onions	178.61	88.08				

Table 20

1979 Dual Values on Lower Bounds

Crop	North		Middle		South	
	Day	Price	Day	Price	Day	Price
Cotton	8.96	10.39	415.43	115.68	394.54	320.88
Rice			391.35	96.50		
Wheat	171.65	156.88	38.86	296.23	190.17	173.88
Peanuts			235.95		88.25	88.67
Lentils	94.30	94.30		242.22	45.21	45.21
Beans	95.31	95.31		137.00	84.58	84.58
Barley	125.65	118.35	50.93	139.58	164.69	164.69
Garlic						
Sugar Cane	125.72	219.09	415.91	680.49	372.13	372.54
Flax	72.09	72.09	2.30	113.79	54.89	55.31
Sesame			236.42		172.92	172.92
S. Sorghum			370.41		295.37	295.78
N. Sorghum				81.39		
Maize		59.52	373.13		282.69	283.11
W. Onions				575.00		
S. Potatoes				221.40		
N. Potatoes						
W. Tomatoes				65.60		
S. Tomatoes				350.52	12.49	12.90
N. Tomatoes						
W. Vegetables						
S. Vegetables				334.65		
N. Vegetables						
Long Berseem				409.44		
Short Berseem	142.17	142.17	5.71	304.71	137.93	137.93
Fruits						
Oranges			14.68		198.69	199.10
Melons						
S. Onions			358.72	854.17		

For the free crops group, one would expect that the effect of higher prices for the administered crops would cause that group's dual values on upper bounds to drop. The reason is that the higher prices (say) for wheat would cause its revenue to be relatively more attractive than before, compared to the free crops (but may be still less than for these crops); and, as such, wheat will be competing for land with these crops, which would cause their shadow prices to fall. This is true of all crops except for a few cases, namely sesame, summer sorghum, and summer onions in the middle region in 1975; and peanuts, sesame, fruits, oranges in the middle region in 1979. The reason seems to be due to the comparative advantage this region has for these crops. Looking at the cross-sectional change in these values by crop for each region indicates the most efficient crops. For example, in the south in 1975, the most efficient was nili potatoes at a value of 384.86, a situation which is also maintained under the price system.

2. Lower Bounds: These represent the cost of policy action, i.e., regional minimum acreage requirements, for the administered crops and the cost of demand for the free crops. One should expect the dual values to drop for the crops for which we raise prices, because there would be more incentive to produce them and less pressure to stop growing them. For the other crops, that price rise will cause their values to increase as the price incentive causes resources to start to be directed to the higher valued crops. This trend happened except in a few cases which for 1975 were northern cotton (increase in dual values instead of drop) and for 1979 northern cotton, barley, middle wheat, summer sorghum, maize, oranges, and southern cotton. The case for cotton is clear since by changing the price structure it seems that (even though its price has been raised) the other three major crops have

become more rewarding. So, for example, in the north in 1979, the dual value on cotton's lower bound changed from 8.96 to 10.39, which means that it is even more inefficient now (under the Price system) because the model would like to reallocate its land to sugar cane with the highest value at 219.01.

IV. APPLICATION OF RESULTS

The estimated results of our model, if they are to be useful (and usable), should now be examined in the context of actual policy. It is hoped that by now the reader has some appreciation of the overwhelming array of figures that the computer model has generated. There is no scope for presenting all the results here, let alone discussing and analyzing them; accordingly, only a subset of the results is presented.

A major problem that the results posed to analysis is due to the myopic optimization criterion of LP's, which resulted in only a subset of crops being grown in each governorate. This problem could have been tackled by adding more constraints to the model so that the number of allocated activities actually increases. Such a procedure would have posed enormous computational problems given the size of our model. The alternative was to improve our results *a posteriori*. This was done by using the shadow prices on crop activities to augment the list of crops grown in each governorate. If the shadow price was within 20 percent of the crop price, that crop was considered viable for production in that governorate. This 20 percent was considered to be a tolerance level representing nonpecuniary considerations or extra-model pecuniary variables. On that basis we modified the results through modifying the net return figures for each crop/governorate combination that did not get specified by the model but passed the 20 percent test. To achieve the required results, considerable post-model calculations had to be made, a process which is extremely time consuming and tedious. This is why we will only present the figures for 1979, which are contained in Table 21. The acreage figures resulting from the model which altered prices is the cropping pattern to be expected under the new policy. That is, this is the response which, if farmers are optimizing, one would expect to see in reality. We have to add that optimization in this case is purely based on the interests of the sector. So, for example, the cotton acreage of 46434 in Kalyubiya might be considered too high for transporting its product to textile factories. On the basis of such arguments, government officials could alter the suggested pattern in favor of such additional considerations. On this conditional basis, the cropping pattern is optimal given the specified price changes. The results are by no means definitive, since they should be modified in three ways:

(1) The effect of endogenous demand prices for crops.

(2) Modifications to incorporate information not explicitly used in the model, such as transportation costs or location of demand (whether it is industry or urban population centers).

(3) Improvements in the method for handling the regional cropping mix.

Thus, the way in which a decision maker could utilize this approach is as follows: First, the suggested cropping pattern is optimized from the agricutural sector's point of view, based on considerations of private benefit and on returns to natural resources. Second, the central authority then evaluates the optimality of demand and linkages, for example, the setting of some crop processing plant.

Table 21

Acreage Allocation Under Price Scenario

Crop	Alexandria		Behera		Gharbiya		Kafr El Sheikh		Dakahliya		Damietta		Sharkiya	
	Model	Original	Model	Original	Model	Original	Model	Original	Model	Original	Model	Original	Model	Original
Cotton			163019	159120	139502	126874	43284	121255	103344	186648			127900	136941
Rice	7654	4131	246434	183172	139562	96978	212393	222150	191128	293233			181791	159042
Wheat			174544	129982	67570	98325	33533	104724	125512	152866	52316	12094	154077	168971
Peanuts									5539	2			7021	5172
Lentils					34	56			208	9				
Beans					3335	7970			14736	3403			7621	17473
Barley					25288	934			26515	7145				
Garlic					4326	264							8964	1579
Sugar Cane	109	134							3051	1468			4343	742
Flax	243	771					4308	25778	17757	9735	1447	880	11455	7311
Sesame														
S. Sorghum														
N. Sorghum														
Maize			279505	162875			163398	72704	146018	57495			104240	205112
W. Onions														
S. Potatoes									33860	5131			46848	1852
N. Potatoes											34161	625	46558	214
W. Tomatoes	1062	4269	52071	11951										
S. Tomatoes					79090	3829			31866	7439				
N. Tomatoes			32886	6724							37651	2377		
W. Vegetables	4059	10702			66591	6075	31919	10763	154469	8530	16122	4611	125647	33331
S. Vegetables	4733	16647											85096	30807
N. Vegetables					21567	4968	19705	5270					25021	18649
Long Berseem	5423	27002	168942	212840	85047	140167	49398	171545	203082	222075	25296	56232	165516	216936
Short Berseem	566	20	81711	151416			290152	103023						
Fruits			25067	59827	19008	20900			16558	14208	9215	3962	21241	36883
Oranges	1435	1418	50583	33774	38480	10994							32509	21587
Melons			6806	45					77372	3018	87452	1625		
S. Onions									3890	653			4960	1056

Table 21 (cont.)

	Ismailiya		Suez		Minufiya		Kalyubiya		Giza		Beni Suef		Fayum	
	Model	Original	Model	Original	Model	Original	Model	Original	Model	Original	Model	Original	Model	Original
Cotton					91321	59742	46434	19420			56654	66401	27037	54049
Rice	33386	3353					74965	4826					33152	16917
Wheat	10571	10265			38312	80533	58103	37043	18766	19830	3050	49811	11936	68747
Peanuts	4132	11911	5822	140	8212	140								
Lentils														
Beans			272	217	2331	3257	3894	728	68105	243				
Barley					7490	705								
Garlic														
Sugar Cane					1720	1234	1968	1216					19150	326
Flax					4391	1760	3746	1660	380	436			348	2417
Sesame	262	2386	1888	289							617	94	1188	1032
S. Sorghum											6323	2920		
N. Sorghum														26824
Maize							28735	86508			54534	66717	148661	3988
W. Onions	1612	390			2458	105	2520	83	1354	225	3149	4430	2414	
S. Potatoes							9800	1853			41185	396		
N. Potatoes									9454	17548	9604	670		
W. Tomatoes	5997	9393	1240	1235	9817	2016			18690	18731	48411	5462	29420	20343
S. Tomatoes					56881	5227	9714	15569			2662	4468	5351	1264
N. Tomatoes					39082	1739	33920	4838	9162	7075	8938	4478	10906	20115
W. Vegetables			2861	1941			42872	29612	42137	39349	73218	9596	35028	21073
S. Vegetables							19050	32998					19046	3025
N. Vegetables							22906	24860	9847	19397	9446	6366	8677	23411
Long Berseem	21714	19425	3953	2561	47662	125592	46733	48296	34971	67611	64325	87939	33325	92708
Short Berseem					95337	67796							194794	50861
Fruits					8843	31458	7428	44072			16426	6704		
Oranges	6392	2657									14844	2903		
Melons					117412	860			182358	2614			61381	5084
S. Onions									3202	5258				

Table 21 (cont.)

Crop	Minya		Assyut		Somag		Qena		Aswan	
	Model	Original	Model	Original	Model	Original	Model	Original	Model	Original
Cotton	233551	101588	59910	90810	70893	55972				
Rice										
Wheat	8269	88971	85503	96198	61048	134745	45572	106609	43184	23578
Peanuts	11882	866	2133	604	2322	1853				
Lentils	436	135			17289	94				
Beans	27881	73643	12126	40892	10555	13399				
Barley	3249	2306	2461	1413	2314	5844	1319	1858		
Garlic	9508	6199	228	57	205	121			1103	72
Sugar Cane	11014	34777	54376	1882	36741	1938	66310	144231	18059	52835
Flax			26	114						
Sesame	482	459	10480	1572	7240	1013				
S. Sorghum	48591	1550	119376	125519	67257	152667	119174	48368	66616	18585
N. Sorghum										
Maize	18389	162130	18183	53269	57403	47687	3439	38153		
W. Onions			3704	1726	4856	4248	5915	53	5305	677
S. Potatoes	33613	3152	23	35	16	32				
N. Potatoes	9604	7256	1913	53	1817	754	1549	6		
W. Tomatoes	25599	4251	3476	3772	38726	2193	52889	7124		
S. Tomatoes	2416	2792	3603	2798	3638	755	9901	390		
N. Tomatoes	10100	1883	10315	808	10009	491	10814	3747		
W. Vegetables	35711	5392	17602	4351			21234	9182		
S. Vegetables	12152	5117	32950	5580	24306	2348	84185	3113		
N. Vegetables	10125	3767	6573	1385	5936	1202	6715	6195		
Long Berseem	28406	99825	54271	66820	63240	53675	65146	21205	29580	10489
Short Berseem					9049	50166	64291	5940		
Fruits	13480	18700	7185	18159	5345	6343	10571	6645		
Oranges							15609	1233		
Melons	36035	21672	6734	2314	5008	1120				
S. Onions										

Finally, examination of the agricultural cropping pattern provides a basis to decide whether to implement the suggestions. If the decision is to change the existing structure, then our results could be used as an indication of a conditionally optimal solution.

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