TURKEY AGRICULTURAL SECTOR MODEL

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I. INTRODUCTION

1. In recent years, "the inward-oriented development strategy followed by Turkey has discriminated against agriculture in favor of industry." 1/ Despite this policy, the agricultural sector grew at around 3% annually (calculated at constant 1968 US$) from 1972 to 1980. During this same period agricultural exports composed more than 55% of the country's export earnings. Although Turkey is classified as a middle-income country, agriculture still plays an important role in the country's development strategy. The agricultural sector contributes 24% to the GDP. It acts as: (i) a supplier of foodstuffs to domestic markets, (ii) a supplier of raw products to agro-industries, (iii) a foreign exchange earner, and (iv) a major source of employment (55% of civilian labor force in 1980).

2. Turkey's agriculture is highly diversified due to its variety of soils and agro-climatic conditions. It produces continental products (i.e., wheat, corn, barley, cotton, tobacco) as well as Mediterranean products (i.e., fruits, nuts and vegetables). All of which share vast resources of land (25 million ha of cultivated area) and labor (10.5 million people are counted as "agricultural population" in 1975). In addition, for the 1980s land is considered as a major resource constraint in the expansion of agricultural sector. Experts seem to agree that the lateral expansion starting from the late 1960s is reaching or about to reach its limits and that any further development in this sector will have to come from the use of higher technology in the cropping practices.

1/ Turkey: Industrialization and Trade Strategy, Report No. 3641-TU, The World Bank, February 18, 1982.

Particularly, the livestock sub-sector is running out of pasture (44% of agricultural land) to support its animal population. Due to this complex production structure, it would be misleading to try to analyze each product in isolation.

3. The Turkey Agricultural Sector Model (TASM) has been developed, on the basis of an earlier study [1], to:

(i) determine if Turkey has a comparative advantage in agriculture and if so, in which products?

(ii) identify changes in cropping patterns under alternative trade policies;

(iii) project production and trade patterns for 1990 under the assumptions that production techniques are using more inputs (labor, tractors, fertilizers) and consequently giving better yields and that demand structures are adjusted to reflect shifts in consumption pattern due to increase in income.

4. In this report, the alternative trade scenarios are presented with the assumptions that:

(i) sufficient time is allowed from the base year for production to adjust to alternative trade scenarios and technical assumptions, and most importantly,

(ii) quantities shown are indicative of direction rather than absolute magnitude, be it production or trade, although we did attempt to present, in some scenarios, a more realistic pattern of domestic demand and foreign trade.

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[1] _Op. cit._

5. This paper is organized as follows: First, the model and the base solutions and their validations are discussed with algebraic statements shown in Appendix 1 and data used in the model discussed in Appendix 2. Second, alternative trade policies are presented. Third, projections for 1990 and related assumptions in technological changes and demand structures are discussed. Finally, an alternative formulation of the livestock subsector is presented. (For more detailed analysis, see Turkey - Agricultural Development Alternatives for Growth with Exports, Report No. 4204-TU, The World Bank, 1983.)

II. AGRICULTURAL SECTOR MODEL

Model Formulation

6. The model used to simulate the agricultural sector is of the mathematical programming (MP) type. An MP model is chosen because: (i) if a model is properly specified, it can be used to check for internal inconsistencies in the data set and to simulate the important characteristics of the sector, although not all characteristics can be written down in a mathematical formulation; (ii) if (i) can be achieved, we can hope to identify the causes and effects due to alternative policies and more importantly the constraining factors in implementing these policies.

7. The model selected is a linear programming (LP) model of the same type as Duloy and Norton's Chac model for Mexico, Kutcher and Scandizzo's Northeast Brazil model. It incorporates important features such as: (i) linearized demand functions (Duloy and Norton, 1975), (ii) risk aversion (Hazell and Scandizzo, 1974 and 1977), (iii) price-responsive input supply (Hazell, 1979), and (iv) income effects (Norton, Scandizzo and Le-Si, 1982).

Table 1: CORE MATRIX OF THE MODEL

Constraint Block		Land Transfer	Crop Producion	Livestock Production	Fertilizer Use	Production Costs	Total Production	
		Activity Block						
(18)	Objective Function					-1 . . . -1		
(1)	Dry Poor Dry Good Irrigated Poor Irrigated Good Tree Area Pasture	1 1 1 1	11 11 11 11 11	+........+				< Land - Availability
(2)	Dry Either Irrigated Either	-1-1 -1-1	1 1 1 1					= 0
(3)	Labor Requirements		+ ++ + + + + ++	+......+ : : +......+				< Labor - Availability
(3)	Tractor Requirements		+ + + ++					< Tractor - Availability
(3)	Animal Power Requirements		+ + + + + + + +	-......- : : -......-				< 0 -
(5)	Animal Inventory			1 1				< Inventory - Number
(6)	Fertilizer Requirements		+ + + + + +		-1 -1			= 0
(7)	Production Costs		+ + + + + + + + + +	+........+		-1 . . -1		= 0
(8)	Production Balances		+ + + + + +	+ + +++			-1 . . -1	= 0

Note: 1. Number in parentheses indicates equation number appearing in Appendix 1.
2. A minus sign indicates a negative number, and a plus sign indicates a positive number.
3. Animal power used by crop production has a plus sign, and that supplied by livestock production has minus sign.

8. The objective function maximized in the model is the sum of the consumers' and producers' surplus, plus net export revenue, and minus the reservation wage of labor. Risk costs are included as part of the production costs. This implies that as producers get higher yield under certain cropping techniques, thus resulting in a larger variance from the trend, it becomes more risky (i.e., more costly) to plant that crop. With this formulation of the objective function, the optimal solution will find supply equal to domestic plus foreign demand, and shadow prices of all commodities equal to marginal costs of production which includes risk costs and labor reservation wages.

9. The core of the model consists of the production activities and resource constraints, shown in Table 1. The input and output coefficients for crop production are specified for each unit of land, which is one hectare. Besides the six basic land classifications, certain crop rotations can be planted on land which is distinguished only by irrigation (irrigated or non-irrigated) but not by type of rainfall. This land condition implies a block of activity, called 'land transfer', which makes the choice on what type of rainfall land to use.

10. The basic input-output coefficients for each single crop are compiled from a survey conducted by TOPRAKSU in 1979. From these coefficients certain biases due to sample size or regional characteristics are corrected to reflect the aggregate production at the national level (For more details, see Appendix 2). The rotation set (70) used in the model represents the most important rotations practiced in Turkey and the characteristics of the nine agricultural regions (Central North, Aegean, Marmara, Mediterranean, North East, South East, Black Sea, Central East and

Central South) [1]. In addition to land, other input requirements for crop production are labor, tractor, animal power and fertilizer. Labor and tractor are constrained by current availability. Animal power is supplied by livestock production activities (see para. 11). All three types of power are divided into four calendar quarters. This division would help in the identification of constraining factors when different trade policies are experimented. Fertilizers, considered to be traded goods, are not restricted by any physical limit but work through the price-responsive input supply system (Hazell, 1979). For example, in the case of two different production techniques of the same crop where one requires higher fertilizer use than the other, the model would determine whether the costs of extra fertilizer application would be profitable considering the gain in the yield. The costs of production accounted for in the model are labor, tractor, fertilizer, seed and capital (for tree crop maintenance). The model is given a choice of two production techniques: animal or mechanized. It can assign any combination of weights to these two techniques to produce a single crop, depending on the optimal allocation of resources.

11. The livestock sub-sector works similarly to the crop sub-sector. The explicit production cost for animal husbandry is labor. Other inputs required are cereals, straws and forage, which are by-products of crops; alfalfa and fodder, which are produced in rotation with other crops; and concentrates which are derived from crops processed for human consumption.

1/ As defined by State Institute of Statistics.

Table 2: PRODUCT SELLING TABLEAU

	Activity Block								
Constraint Block	Crop Producion	Livestock Production	Total Production	Total Consumption	Import	Export	Processed Product Trade	Demand Function	
(18) Objective Function					−........−	+...... +	− + + +	+......+	
(9) Commodity Balances		− − −− −−	1 1	−1 . . . . −1	1 1	−1 . . . . −1	+ − − −		= 0
(10) Consumption Balances				1 1			1	−− . . . −−	≥ 0
(11) Feed Balances	+ + + +	− − − − − − − − −		+ . . . . +					≥ 0
(12-14) Trade Limits					1 1	1 . . . 1	1 . . . 1		$\leq$ Historical Quantity
(15) Convexity Constraints								1...1 . . . . 1...1	≤ 1

Note: Processed product trade includes both import and export. Therefore a mixture of plus and minus signs.

These are given in fixed proportions. Pasture land is also required for animal grazing, with the exception of poultry, to supplement livestock feeding. There is no cost involved in maintaining this land, but the limit on pasture land acts as an overall constraint on all animal types. Outputs from livestock production activities are meat, milk, wool and hide. In addition to these products, the sub-sector also provides animal power used in crop production activities. The number of animals available are bounded by stock inventory. (Note the reversed signs used in the animal power requirements equations in Table 1: the supply has minus sign and the demand has plus sign.)

12. The commodities produced by the production activities are then distributed between different product selling activities shown in Table 2. First, there are domestic demands which are generated through demand curves (Duloy and Norton, 1975). The model will determine which segment, or adjacent segments, to use to maximize the producers' and consumers' surplus, taking all costs into consideration. Second, there is a demand for cereals used for feeding in the livestock sector. Third, there are export activities at exogenous prices. And fourth, there are export activities through the processed product activities which take raw products and transform them at a certain factor and cost. On the supply side, besides the domestic production, some commodities are allowed to be imported at exogenous prices.

13. Since the data available are most reliable at the farmgate level, all prices and quantities used are determined at this level. Import price is then CIF price plus the transportation and marketing margins to bring it to farmgate level, and export price is FOB minus the margins. This

calculation applies to all commodities, in raw or processed forms. The domestic demand functions are also calculated at the farmgate level: Price given is the price received by farmer minus processing cost (for products that cannot be consumed in raw forms or for products that produce concentrates used in feeding animals) and the quantity consumed is the aggregated demand at the farmgate level. Although the correct formulation of the demand function requires that price elasticities of demand at the farmgate level be used, the model uses the elasticities at the consumer level. Sensitivity analyses of price elasticities show that very little changes occur within a wide range of elasticities.

14. Table 2 shows, in addition to the commodity balance equations, trade limit equations which are used for model validation and as market absorption constraints. The convexity constraints are used to ensure that only one segment or at most two adjacent segments are picked.

15. Agriculture in Turkey, as elsewhere, is a risky activity due to uncontrollable elements. To make the model behave in a more realistic way, risk function is included as part of production costs. The technique developed by Hazell and Scandizzo (1974 and 1977) is more complicated than the one used in this model. The simplified version of this technique is as follows: (i) count only actual negative deviations from mean revenues per hectare for each production activity; (ii) sum all negative deviations; (iii) charge this total double (to reflect full deviations from mean) as costs in the objective function. The objective function cost is scaled by a factor phi (ϕ), which is equal to 1 (average risk). The yield and price time series are from 1974 to 1979.

Table 3: RISK TABLEAU

	Activity Block				
Constraint Block	Crop Production	Livestock Production	Sum of Negative Deviations	Risk Penalty	
(18) Objective Function				–	
(16) Negative Revenue Deviations	– – – – – – – – – – –	– – – – – – – – – – – –	1 1		≥ 0
(17) Sum of Negative Deviations			2.............2	-1	=0

The Base Case

16. The base year model (1979) is constructed as detailed in Appendix 1. The validation of this model is based on the comparison of production, consumption, trade, factor use and prices. In order to reflect the trade constraints imposed by import quotas, export licensing and foreign exchange management, imports and exports of all commodities are restricted to actual quantities traded in 1979. International trade prices have been adjusted to reflect prices at farmgate level. The base model was solved with two foreign exchange rates: (i) TL35 = US$1 and (ii) TL47 = US$1, which are the prevailing foreign exchange rates during calendar 1979.

17. Table 4 shows the observed and simulated production at the two exchange rates for all the products included in the model. The results indicate that both solutions compare very well to the observed production

Table 4: PRODUCTION (1000 MT)

	A	---TL35 = US$1---		---TL47 = US$1---	
		B	C	D	E
	Observed 1979	Simulated 1979	B/A %	Simulated 1979	D/A %
Wheat	13,205	12,371.5	94	13,373.2	101
Corn	1,242	1,242.2	100	1,233.8	99
Rye, etc.	807	697.1	86	722.4	90
Rice	225	278.5	124	269.6	120
Barley	5,000	4,227.2	85	4,389.9	88
Chick Pea	285	328.4	115	328.4	115
Dry Bean	69	75.1	109	71.6	104
Lentil	285	320.9	113	320.9	113
Potato	2,870	3,121.4	109	3,121.4	109
Onion	1,000	1,108.2	111	1,076.8	108
Green Pepper	545	590.3	108	590.3	108
Tomato	3,500	3,896.3	111	3,896.3	111
Cucumber	500	558.6	112	558.6	112
Sunflower	590	644.2	109	610.0	103
Olive	430	436.7	102	436.7	102
Groundnut	57.5	61.9	108	61.9	108
Cotton	476.2	451.5	95	448.9	94
Sugar Beet	8,760	8,768.2	100	9,055.6	103
Tobacco	206.4	209.7	102	209.7	102
Tea	555	623.3	112	623.3	112
Citrus	1,147	1,271.1	111	1,271.1	111
Grape	3,500	3,682.9	105	3,682.9	105
Apple	1,350	1,431.3	106	1,431.3	106
Peach	220	239.0	109	239.0	109
Apricot	110	114.0	104	114.0	104
Cherry	92	95.3	104	93.0	101
Wild Cherry	50	50.6	101	49.3	99
Melon	5,220	5,829 0	112	5,829.0	112
Strawberry	22	23.3	106	23.3	106
Banana	23.3	25.3	109	25.3	109
Quince	45	48.9	109	48.9	109
Pistachio	20	19.2	96	19.2	96
Hazelnut	300	300.6	100	300.6	100
Soybean	3.3	3.2	97	3.0	91
Sesame	26	30.9	119	30.9	119
Sheep Meat	338	338.0	100	338.0	100
Sheep Milk	1,102.2	1,105.5	100	1,105.5	100
Sheep Wool	59.3	59.4	100	59.4	100
Sheep Hide	16.2	18.0	111	18.0	111
Goat Meat	103.5	103.5	100	103.5	100
Goat Milk	571.1	579.0	101	579.0	101
Goat Wool	9.2	9.1	99	9.1	99
Goat Hide	3.8	4.2	111	4.2	111
Angora Meat	6.5	5.1	78	4.7	72
Angora Milk	54.9	42.9	78	40.0	73
Angora Wool	5.8	4.5	78	4.2	72
Angora Hide	0.3	0.3	100	0.2	67
Beef	391	391.0	100	391.0	100
Cow Milk	3,386.4	3,385.8	100	3,385.8	100
Cattle Hide	51.6	51.4	100	51.4	100
Buffalo Meat	34	34.0	100	34.0	100
Buffalo Milk	296.6	296.6	100	296.6	100
Buffalo Hide	2.7	3.1	115	3.1	115
Poultry Meat	132	132.0	100	132.0	100
Eggs	4,322.7	4,501.1	104	4,501.1	104

Table 5: PRICES (US$/MT)

	-----TL35 = US$1---- Observed 1979	Simulated 1979	----TL47 = US$1---- Observed 1979	Simulated 1979	Import CIF	Export FOB
Wheat	150.86	125.60	112.34	109.81		125.6
Corn	168.86	121.52	125.75	96.69		
Rye, etc.	120.86	127.92	90.00	112.02		130.0
Rice	540.57	216.01	402.55	173.48	383.3	
Barley	136.57	88.77	101.70	47.80		141.1
Chick Pea	648.86	389.35	483.19	313.00		589.1
Dry Bean	1,107.43	505.41	824.68	410.68		832.6
Lentil	550.57	358.67	410.00	299.23		396.7
Potato	296.00	152.28	220.43	119.48		171.4
Onion	204.86	93.45	152.55	71.97		94.7
Green Pepper	315.14	175.19	234.68	135.04		497.1
Tomato	236.29	93.75	175.96	72.91		117.8
Cucumber	297.43	120.36	221.49	93.73		
Sunflower	334.86	215.92	249.36	173.43		
Olive	801.14	639.94	596.60	496.79		680.0
Groundnut	809.43	620.24	602.77	489.62		709.6
Cotton	1,417.43	1,686.74	1,055.53	1,371.80		1,751.2
Sugar Beet	31.71	35.90	23.62	28.81		
Tobacco	1,748.00	1,642.30	1,301.70	1,276.39		1,908.3
Tea	414.29	271.72	308.51	202.61		
Citrus	287.14	103.09	213.83	77.79		182.7
Grape	544.00	265.60	405.11	207.22		276.6
Apple	388.57	188.21	289.36	148.20		224.2
Peach	540.47	187.85	402.55	143.36		210.1
Apricot	434.29	288.46	323.40	228.86		
Cherry	494.57	400.48	368.30	312.52		
Wild Cherry	448.00	438.29	333.62	345.05		
Melon	242.00	82.53	180.21	64.06		86.9
Strawberry	1,514.29	764.68	1,127.66	572.75		83.3
Banana	2,305.43	766.41	1,716.81	574.16		
Quince	412.29	158.61	307.02	123.84		184.9
Pistachio	3,186.29	3,529.84	2,372.77	2,654.63		3,760.0
Hazelnut	1,128.29	1,035.42	840.21	778.63		1,115.9
Soybean	295.43	280.97	220.00	229.00		
Sesame	2,094.57	795.42	1,559.79	637.67		
Sheep Meat	1,625.71	1,056.71	1,210.64	786.92		2,220.0
Sheep Milk	508.86	513.94	378.49	382.72		
Sheep Wool	4,842.29	4,890.68	3,605.96	4,315.80	4,315.8	
Sheep Hide	1,714.86	1,114.66	1,277.02	830.06		
Goat Meat	1,293.14	1,306.07	962.98	972.61		2,220.0
Goat Milk	357.14	360.71	265.96	268.62		
Goat Wool	2,836.57	2,354.35	2,112.34	1,753.24		700.2
Goat Hide	1,714.86	1,114.66	1,277.02	830.06		
Angora Meat	1,354.29	1,855.37	1,008.51	1,563.19		2,220.0
Angora Milk	357.14	617.86	265.96	507.98		
Angora Wool	7,681.14	5,768.34	5,720.00	6,082.26		804.6
Angora Hide	1,714.86	2,349.37	1,277.02	1,979.38		
Beef	1,775.14	1,792.89	1,321.92	1,335.13		1,140.0
Cow Milk	408.57	412.66	304.26	307.30		
Cattle Hide	75.43	76.18	56.17	56.73		
Buffalo Meat	1,727.43	1,433.77	1,286.38	1,140.00		1,140.0
Buffalo Milk	366.00	369.66	272.55	275.28		
Bufalo Hide	75.43	35.45	56.17	26.40		
Poultry Meat	4,614.29	2,999.29	3,436.17	2,233.51		762.0
Eggs	94.29	95.23	70.21	70.92		

quantities. Rice is the only crop that tends to over-predict by a large amount. This can be explained by the fact that while demand is low, farmers are operating with very efficient technology, i.e. farmers are operating below optimal level. This is also reflected in the shadow price of rice which is about 40% of the price received by farmers. Comparison between the two solutions shows that most commodities are predicted at about the same levels with a closer fit for cereals in the case of TL47 and a slightly worse fit for Angora goat in the TL47 case.

18. Table 5 shows the observed and shadow prices at the two exchange rates, and the import CIF and export FOB prices. The results here are much less satisfactory than the ones in Table 4. In particular, the prices of some crops, such as rice, dry bean, onion, tomato, cucumber, melon, citrus, grape, apple, peach, strawberry, banana, quince and sesame are at least 50% below their observed prices. As mentioned above, these prices reflect the marginal costs of production, and if there is any confidence in the behavior of the model and its technical coefficients then the results indicate that it might be feasible to expand the production of these commodities. This conclusion is further strengthened by the results of the free trade solutions presented in the next section.

19. Domestic consumption levels predicted in the model are within the range of plus or minus 10% of the observed levels, with more commodities over-predicted than under-predicted. Although production and consumption are within an acceptable range of the observed quantities, prices of some commodities are far below the observed ones. In addition to the explanation given above (farmers operating below optimal level), this result can also be explained by the fact that these commodities have underlying comparative advantage in expansion over other crops.

20. Table 6 below shows the overall indices of quantity and prices. The simulated gross value of production is overestimated by 2.5% in the case of TL35 and 3.3% in the case of TL47.

21. Table 7 compares resources used by the model with official statistics. In comparing these numbers, the following notes should be kept in mind:

(i) Recent World Bank estimates indicate that wheat production, therefore area, could be as much as 25% lower than official estimates. This,in turn, would also reduce the fallowed area (wheat-fallow rotation).

(ii) The labor figure is given in terms of adult male equivalents, with the assumption that the entire rural population is participating in agricultural production.

(iii) The tractor requirement calculated from the model is defined as total yearly use divided by 1500. This includes only hours required for activities directly related to field work, and it does not take into account either the timing of different operations or the extensive use of tractors for transportation.

(iv) Although the model does not have a fertilizer response function for all crops, certain crops are specified with alternative cropping techniques which require higher fertilizer application than the average.

Table 6: GROSS VALUE OF PRODUCTION (million US$)

	TL35		TL47	
	Actual	Simulated	Actual	Simulated
Grains	3,104	2,888	2,311	2,277
of which: Wheat	1,992	1,866	1,483	1,502
Others	1,112	1,022	828	775
Pulses	418	473	311	349
Vegetables	3,465	3,834	2,580	2,851
Fruits and Nuts	3,500	3,687	2,607	2,745
Oil Crops	644	681	480	499
Industrial Crops	1,543	1,543	1,149	1,153
Livestock Products	5,135	5,143	3,824	3,827
$\Sigma P_o Q_o$	17,809		13,262	
$\Sigma P_o Q$	18,249		13,701	
$\Sigma P Q_o$	12,770		9,937	
$\Sigma P Q$	12,873		10,127	

Note: P_o and Q_o are observed prices and quantities. P and Q are model generated.

Table 7: RESOURCE USES

	1979 Stocks 1/	1979 Simulated	
		TL35=US$1	TL47=US$1
Land (1000 ha) 2/			
Cultivated Area	25,401	17,953	19,012
of which: Sown	16,605	12,007	12,586
Fallow	8,796	5,946	6,426
Irrigated	2,794	2,794	2,794
Under Tree crops	2,749	2,280	2,279
Pasture	21,746	19,795	20,377
Labor (1000 persons) 3/	6,863	5,489	5,617
Tractor (units) 4/	440,502	49,741	44,830
Fertilizer (MT of nutrients)			
Nitrogen	778,938	763,631	792,013
Phosphate	659,781	781,338	816,692

1/ SIS or TOPRAKSU statistics.

2/ Wheat production and area have been revised downward by about 25% from official estimates. The 1979 stocks for cultivated and fallow areas are official statistics.

3/ Labor is calculated in terms of adult male equivalents of 1,800 hours per year, from the number of hours worked during peak season.

4/ Tractor figures for simulated results are calculated at 1,500 hours per year. The results indicate the numbers of tractors working full-time year round.

22. The low shadow prices at optimal conditions reflect the comparative advantage of Turkey's agricultural sector. This is demonstrated in Table 8 which shows the Domestic Resource Costs (DRC), Effective Protection Coefficient (EPC) and Nominal Protection Coefficient (NPC) for all crops. DRC is the ratio of non-traded inputs over value added at border prices. EPC is the ratio of value added at domestic prices over value added at border prices. NPC is the ratio of the two corresponding prices. Table 8 indicates that in 1979 at TL35/US$, Turkey had an absolute comparative advantage in all crops, with the exception of soybean, and that under a free trade scenario, agriculture would have expanded in the export market and made a positive contribution to the trade balance.

Table 8: ANALYSIS OF COMPARATIVE ADVANTAGE IN 1979 (TL35 = US$1)

	DRC	EPC	NPC
Wheat	.513	1.634	1.201
Corn	.608	1.214	1.000
Rye, etc.	.532	1.369	.930
Rice	.487	1.950	1.650
Barley	.288	.837	.803
Chick Pea	.497	.954	.914
Dry Bean	.495	1.163	1.104
Lentil	.421	1.707	1.388
Potato	.308	1.922	1.727
Onion	.695	1.590	1.406
Green Pepper	.301	.256	.412
Tomato	.534	1.411	1.304
Cucumber	.220	1.017	1.000
Sunflower	.386	1.081	1.000
Olive	.467	.638	.720
Groundnut	.617	.850	.856
Cotton	.771	.626	.688
Sugar Beet	.880	1.143	1.000
Tobacco	.720	.601	.687
Tea	.043	1.004	1.000
Citrus	.550	.574	.707
Grape	.614	1.592	1.377
Apple	.535	.634	.780
Peach	.549	1.258	1.158
Apricot	.318	1.032	1.000
Cherry	.537	1.017	1.000
Wild Cherry	.668	1.048	1.000
Melon	.457	2.269	1.950
Strawberry	.573	.873	.912
Banana	.045	1.007	1.000
Quince	.599	1.038	1.004
Pistachio	.276	.857	.847
Hazelnut	.727	.795	.809
Soybean	1.280	1.039	1.000
Sesame	.140	1.022	1.000

23. For this type of model, the validation procedure is a very important step in assessing the usefulness of a model in policy testing and projection mode. Unfortunately, there is no standard procedure for this kind of validation. Since we are most interested in production (and production techniques), consumption, trade patterns, resource uses and shadow prices, a comparison of observed and simulated values should give a good indication as to the performance of the model. Considering that the constraints applied in the model are only physical limitations, besides bounds limiting trade, the model reproduces conditions of the base year under either exchange rate quite closely. To further study the stability of the model, several tests are made by halving and doubling the price elasticities of some commodity groups. The results do not change significantly during these tests. The questions of policy testing and projection mode will have to be answered by checking the results to see whether they are sensible or not, since there are no observed data for comparison purpose.

III. ALTERNATIVE TRADE POLICIES

24. The base solutions under the two foreign exchange regimes indicate that Turkey certainly has a comparative advantage in agricultural products. To explore the impact of different trade regimes on the base conditions (1979) in terms of production patterns, resource allocations and international trade, we experiment with the following policies:

"Policy I". Imports and exports of commodities are restricted to those actually traded in 1979, but the historical trade limits are removed from the model (equations 12-14 are not included in the model, see Appendix 1). To account for physical limitations and other considerations, production is allowed to move only within the range of 50% to 200% of the observed levels and areas under tree crops cannot move beyond plus or minus 25% of the base solution areas. This policy can also be described as "actual trade regime" in 1979 without restriction on foreign exchange management.

"Policy II". In addition to conditions specified in Policy I, import possibilities are opened to most of the commodities.

"Policy III". This is the same as in Policy II, but with quantity restrictions imposed on exported commodities (equations 12-14 are inserted back). This policy would represent more realistically the absortion capacity of foreign markets for Turkish products. In addition, for wheat and barley, it is assumed that marginal export revenues decline sharply after a certain quantity has been reached.

25. Tables 9 and 10 show production, consumption and net trade under the three trade policies for both exchange rates. These tables show that the lifting of trade restrictions makes a large impact on production. The

Table 9: ALTERNATIVE TRADE POLCIES AT TL35 US$1 (US$ million)

	Policy I			Policy II			Policy III		
	Production	Consumption	Net Trade	Production	Consumption	Net Trade	Production	Consumption	Net Trade
Grains	3,669	2,087	924.8	3,654	2,085	913.4	3,362	2,150	520.2
of which	(+27)	(-1.4)	(11)	(+26.5)	(-1.5)	(11)	(+16.4)	(+1.6)	(6)
Wheat	1,858	1,657	82.7	1,852	1,657	78.0	1,919	1,704	92.5
	(-0.4)	(-0.5)	(1)	(-0.7)	(-0.5)	(1)	(+2.8)	(+2.3)	(1)
Other	1,811	430	842.1	1,802	428	835.4	1,443	446	427.7
	(+77.2)	(-4.9)	(648)	(+76.3)	(-5.3)	(643)	(+41.2)	(-1.3)	(329)
Pulses	837	355	388.0	837	355	388.0	757	379	304.9
	(+76.9)	(-6.8)	(5)	(+76.9)	(-6.8)	(5)	(+60)	(-0.5)	(4)
Vegetables	5,668	3,712	825.2	6,077	3,713	971.9	4,115	3,781	224.6
	(47.8)	(-1.8)	(56)	(+58.5)	(-1.8)	(66)	(+7.3)	(0)	(15)
Fruits and Nuts	4,563	3,129	215.7	4,563	3,129	215.7	4,065	3,129	186.8
	(23.8)	(-0.3)	(5)	(+23.8)	(-0.4)	(5)	(+10.3)	(-0.4)	(4)
Oil Crops	746	550	165.7	505	596	-53.6	450	596	-87.6
	(+9.5)	(+5.2)	(32)	(-25.9)	(+6.8)	(-)	(-33.9)	(+6.8)	(-)
Industrial Crops	1,745	1,141	534.5	1,749	1,137	541.7	1,909	1,159	731.9
	(+13.1)	(-4.7)	(1)	(+13.3)	(-5)	(2)	(+23.7)	(-3.2)	(2)
Livestock Products	5,225	4,321	524.6	5,219	4,954	380.2	5,219	4,954	380.2
	(+1.6)	(-4.2)	(5)	(+1.5)	(+9.8)	(6)	(+1.5)	(+9.8)	(5)
Total	22,453	15,295	3,378.5	22,604	15,969	3,357.3	19,876	16,148	2,261.2
	(+23)	(-2.5)	(5)	(+23.9)	(+1.8)	(5)	(+8.9)	(+3)	(3)

Note: Numbers in parentheses represent percentage change from base solution. Under net trade these numbers represent ratios.

Table 10: ALTERNATIVE TRADE POLCIES AT TL47 per US$1 (US$ million)

	Policy I			Policy II			Policy III		
	Production	Consumption	Net Trade	Production	Consumption	Net Trade	Production	Consumption	Net Trade
Grains	2,830	1,547	1,054.4	2,861	1,571	1,056.3	2,734	1,600	784.1
of which	(+24.3)	(-4)	(7)	(+25.6)	(-2.5)	(7)	(+20.1)	(-0.7)	(5)
Wheat	1,413	1,252	94.8	1,439	1,269	103.7	1,638	1,279	314.0
	(-5.9)	(-2.3)	(.6)	(-4.2)	(0.9)	(.7)	(+9.1)	(-0.2)	(2)
Other	1,417	295	959.6	1,422	302	952.6	1,096	321	470.1
	(+82.8)	(-10.9)	(685)	(+83.5)	(-8.8)	(680)	(+41.4)	(-3)	(336)
Pulses	623	244	411.4	623	244	411.4	556	272	307.9
	(+78.5)	(-12.9)	(6)	(+78.5)	(-12.9)	(6)	(+59.3)	(-2.9)	(4)
Vegetables	4,952	2,679	1,234.7	4,964	2,677	1,244.7	3,060	2,811	224.6
	(+73.7)	(-4.5)	(84)	(+74.1)	(-4.6)	(85)	(+7.3)	(+0.2)	(15)
Fruits and Nuts	3,396	2,296	253.9	3,397.7	2,259	253.9	3,026	2,313	205.8
	(+23.7)	(-1.7)	(6)	(+23.7)	(-3.3)	(6)	(+10.2)	(-1)	(5)
Oil Crops	545	360	189.6	420	431	-9.4	422	433	-9.5
	(+9.2)	(-11.5)	(40)	(-15.8)	(+5.9)	(-)	(-15.4)	(+6.4)	(-)
Industrial Crops	1,307	750	632.6	1,314	753	639.4	1,423	821	731.9
	(+13.4)	(-15)	(2)	(+14)	(-14.6)	(2)	(+23.4)	(-6.9)	(2)
Livestock Products	3,809	2,995	572.5	3,887	3,434	794.6	3,887	3,434	794.6
	(-0.5)	(-10.1)	(7)	(+1.6)	(+3.1)	(10)	(+1.6)	(+3.1)	(10)
Total	17,462	10,871	4,349.1	17,466	11,369	4,390.9	15,107	11,684	3,039.3
	(+27.5)	(-6.7)	(6)	(+27.5)	(-2.5)	(6)	(+10.3)	(+0.3)	(4)

Note: Numbers in parentheses represent percentage change from base solution. Under net trade these numbers represent ratios.

sector gains range from 8.9% to 27.5%. The greatest gains are made by pulses, vegetables, grains (barley over wheat), fruits and nuts, and industrial crops. These gains are much more than compensated for by a sharp drop in oil crops production under Policies II and III. The reversal of oil crops (mainly sunflower and groundnut) is due to two factors: the change in the cropping pattern that produces crops with high comparative advantage for exports, and the fact that these crops are competing for the same irrigated area. The high gains made by pulses and vegetables are not surprising since recent data show that they are being exported at a much higher rate during the last two years than previously. The same is observed with the expansion of export in barley over wheat. It should be emphasized here that these results are only indicative of the directions of the cropping patterns and trade rather than relative magnitudes, especially under Policies I and II.

26. As expected consumption suffers a slight loss due to the expansion of exports. This loss is not unique to export crops. It also affects non-export crops as well. The cause for this is that non-export crops are competing for the same resources as export crops. It is interesting to note that the availability of imports does not reduce consumption loss in all commodity groups (compare Policies I and II). Only oil crops and livestock show some gains in consumption, while other commodity groups losses remain constant or get worst. In Policy III when export bounds are imposed on most of the commodities (to portray a more realistic picture of the world's absortion of Turkish products), consumption shows an improvement over the base year, gaining by 3% for TL35 and 0.3% for TL47. Under this policy the largest consumption loss is

registered by industrial crops in the case of TL47, otherwise consumption losses by some commodity groups are less than 1%. With the observations made above, this Policy III can be regarded as 'minimum consumption loss' policy, i.e. expand exports with a minimum reduction in consumption.

27. As observed previously, the alternative trade policies results show a sharp increase in export of pulses and vegetables. Potato and tomato paste are the most important export crops for vegetables in terms of revenue. Barley export exceeds wheat in all three policies and this trend is likely to continue since FOB price for barley is about 10% higher than that of wheat and input requirement for barley is less than wheat. Citrus, apple, raisin and hazelnuts show the most gains over the base year. In the livestock sub-sector, sheep and goat meats and beef have the most potential as export commodities. In particular under TL47 for Policies II and III beef shows a very strong potential.

28. Assuming that tractor and fertilizer costs contain 25% foreign exchange component and that working capital for orchards includes 50% foreign exchange, the total imported input costs for the agricultural sector is given below for both foreign exchange regimes.

Policies	I	II	III	
TL35	680.2	674.8	545.3	
TL47	604.3	607.1	515.8	(US$ million)

This import bill is about 20% of the TL35 and 14% of the TL47 net inflow of agricultural product trade.

29. Under these three trade policies, the model shows an increase in the uses of all resources. Labor employed during the peak season is at about 20% higher than in the base period. The shadow prices of irrigated land under these policies is nearly double the shadow prices in the base solution.

IV. PROJECTIONS FOR 1990 [1]

30. To study further the impact of alternative trade policies (and, implicitly, technology), the agricultural sector model is used to project for the year 1990. The year 1990 is selected because it is long enough for market conditions to adjust to trade policies. Policy II is chosen as the prevailing policy in 1990 and the exchange rate is TL47/US$. Briefly, the assumptions are as follows:

(i) GNP annual growth rate from 1979 is 4.07% and its corresponding consumption rate is 4.06%. The savings rate in 1990 is assumed to be 22.4% (compared to 22.3% in 1979). The agricultural income multiplier is 2. These assumptions are necessary to re-position the demand curves to the right to reflect changes in demand due to population growth and food-basket composition. (For method used, see Norton, Scandizzo, Le-Si, 1982, and for equations, see Appendix 1).

(ii) Yield increases at an annual rate of 1 to 2% a year. The fertilizer requirement increases for most crops at about 4%. Labor, animal and mechanical power increase at about 1%. Assuming that the sector will become more mechanized, animal power availability decreases 4% a year. These assumptions are made with the considerations that the

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1/ A projection of year 1990 under Policy II with no change in productivity to highlight the impact of technology is discussed in Appendix 3.

Table 11: 1990 GROWTH RATES UNDER ALTERNATIVE TRADE REGIMES

	1990 Unrestricted Free Trade	1990 Limited Free Trade and Minimum Consumption	Selected Historical Growth Rate 1975-80	Income Elasticities
Wheat	0.9	1.3	2.3	0
Corn	1.0	1.9	0.7	0
Rye, etc.	-0.1	0.8	-5.4	0
Rice	3.0	3.8	-1.0	0.38
Barley	6.5	4.3	3.3	0
Chick Pea	6.5	6.5	9.8	0.6
Dry Bean	6.5	6.5	1.3	0.6
Lentil	-0.8	-0.6	7.6	0.6
Potato	1.4	2.8		0.3
Onion	6.5	3.8		0.6
Green Pepper	6.5	5.6		0.6
Tomato	6.5	3.8		0.6
Cucumber	2.9	3.1		0.6
Sunflower	-6.1	-6.1	-0.2*	0.6
Olive	-2.4	-2.4	2.4*	0.6
Groundnut	-6.1	-6.1		0.6
Cotton	1.6	1.7	0.8	0.5
Sugar Beet	1.9	2.4	-0.5	0.6
Tobacco	6.5	5.6	3.2	0.5
Tea	6.5	6.5	18.8*	0.5
Citrus	4.8	4.8	4.1*	0.75
Grape	5.4	2.7	2.1	0.1
Apple	7.5	3.9	9.2	0.8
Peach	7.5	7.5	3.7	0.8
Apricot	3.2	3.1	0	0.8
Cherry	3.2	3.1	5.6	0.8
Wild Cherry	3.2	3.1		0.8
Melon	6.5	3.2		0.6
Strawberry	6.5	6.5		0.8
Banana	3.2	3.7		0.8
Quince	6.5	6.5	4.6	0.8
Pistachio	6.5	6.5		0.5
Hazelnut	6.5	4.9	-5.4	0.5
Soybean	2.0	1.9		0.6
Sesame	3.2	3.8		0.6
Sheep Meat	1.4	1.4		1.2
Sheep Milk	1.4	1.4		0.95
Sheep Wool	1.4	1.4		1.18
Sheep Hide	2.3	2.3		1.18
Goat Meat	1.4	1.4		1.2
Goat Milk	1.5	1.5		0.95
Goat Wool	1.2	1.2		1.18
Goat Hide	2.4	2.4		1.18
Angora Meat	1.4	1.4		1.2
Angora Milk	1.4	1.4		0.95
Angora Wool	1.4	1.4		1.18
Angora Hide	2.2	2.2		1.18
Beef	2.2	2.2	-6.4*	0.45
Cow Milk	2.2	2.2	2.4	1.75
Cattle Hide	2.1	2.1		1.18
Buffalo Meat	2.2	2.2		0.45
Buffalo Milk	2.2	2.2		1.75
Buffalo Hide	3.6	3.6		1.18
Poultry Meat	5.4	5.4		0.9
Eggs	5.9	5.9		0.85

* 1975-78.

cropping rotations remain the same and gains in production are due only to improved production techniques. Livestock products yield increases at 10% (70% for poultry) due to an increase in the feeding requirement.

(iii) On the resources side, irrigated land increases to a total of 3,543.7 million hectares, while rainfed land decreases accordingly and other land remains constant. Labor would increase 1% annually, after taking into consideration migration to urban area. Animal herd size increases 6% per year.

31. As shown in the previous section, free trade policy results in a loss to consumption. In the projections, therefore, a new policy is introduced: Policy IV, 'limited free trade' (Policy III) together with an assumption that per capita consumption balances are maintained at their 1979 levels. 1/ Table 11 shows an annual growth rate under these two policies. As can be seen there is little difference in production growth between the two policies. It is interesting to note that oil crops continue to import about one-third of the domestic demand for either policy. Compared to historical growth rates of 1975-1980, the model presents a slightly better projection, but this can be traced through the improvement in production techniques.

32. Table 12 presents the value of production, consumption and trade for Policies II and IV in 1990. A comparison of Policy II in Table 12 and

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1/ This level is calculated by multiplying the 1979 per capita consumption by the projected population in 1990.

Table 12: VALUES OF PRODUCTION, CONSUMPTION AND TRADE IN 1990 (US$ million)

	Policy II				Policy IV			
	Production	Consumption	Import	Export	Production	Consumption	Import	Export
Grains	3,021	1,597	0	1,050	2,922	2,001	0	353
of which								
Wheat	1,633	1,259	0	312	1,708	1,610	0	0
Others	1,388	338	0	738	1,214	391	0	353
Pulses	497	324	0	202	499	352	0	171
Vegetables	4,565	3,333	0	562	3,728	3,501	0	182
Fruits and Nuts	4,841	2,727	0	466	3,875	2,731	0	317
Oil Crops	345	537	145	0	348	536	142	0
Industrial Crops	1,730	1,032	0	837	1,708	894	0	732
Livestock Products	5,138	5,038	128	257	5,138	5,087	119	169
TOTAL	20,136	14,588	273	3,374	18,217	15,102	261	1,662

Table 13: GAINS AND LOSSES DUE TO MINIMUM CONSUMPTION REQUIREMENT (US$ million)

	Policy II	Policy IV	IV-II
Total Welfare 1/	45,263	44,142	-1,121
Labor Income	4,490	4,337	-153
Non-Labor Costs	4,013	3,572	-441
Value of Production	20,136	18,217	-1,919
Consumer's Surplus 2/	29,140	29,497	357
Producer's Surplus 3/	11,633	10,308	-1,325

1/ Total Welfare = Labor Income + Consumers' Surplus + Producer's Surplus
2/ Consumer's Surplus = Objective Function - Producer's Surplus
3/ Producer's Surplus = Gross Value of Production - Labor Income - Non-Labor Costs

base solution at TL47 in Table 10 shows that agricultural production gains 3.6% annually of which productivity change accounts for 1.7%. 1/ Grains gain 2.6% annually (wheat 0.8% and others 5.4%). Pulses and oil crops lose about 3%. Vegetables, and fruits and nuts make the most gains at about 4.4% and 5.3% respectively. Industrial crops increase 3.8% annually and livestock products, 2.7%. The losses in pulses and oil crops are mainly due to the change in cropping patterns to support a switch in consumption and trading pattern. As income grows, there is a higher demand for high income elasticity products, e.g. livestock products; consequently, there is a growth in demand for feed. There is also a higher growth in sugar beet production, which makes up the largest value in the industrial crop category. The consumption pattern reflects income elasticities used in the model. There is growth in all categories with the exception of wheat. Despite the high domestic demand for agricultural products, foreign trade continues to increase at a fast rate. The net trade value goes from US$766 million to US$3,374 million, representing a gain of 14.4% annually.

33. In Policy IV where there is a minimum consumption requirement, production is reduced by nearly US$2,000 million. This reduction in gross value of production comes from a change in the cropping pattern. As can be seen in Table 12, wheat consumption increases by 28% and non-wheat by 16% (compare Policies II and IV). Consumption of other commodites is nearly the same. The requirement for higher production of grains (especially wheat) makes it unprofitable to use rotations which have higher export potential, e.g. vegetables. The drop in production is accompanied by a drop in foreign trade. Net trade value in Policy IV is registered at US$1,401 million, or 45% of Policy II. Gains and losses due to the

1/ See Appendix 3.

minimum consumption are presented in Table 13 for both producers and consumers. This table shows that the minimum consumption requirement produces a loss of US$1,325 million to the producers and a gain of only US$357 million to consumers.

34. Irrigated land is binding in either policy as in the base solution, with shadow prices of US$271 per hectare for land with poor rainfall and US$367 for land with good rainfall. Area under trees is only binding for Policy II with the shadow price of US$509. Labor use in the third quarter is 88.4% for Policy II and 82.3% for Policy IV, compared to 81.8% in 1979. Most of the gains in labor employment can be attributed to the higher labor requirement of the "improved" cropping technique. Tractor use is up to 94,618 and 78,653 "units" for policies II and IV, respectively, compared to 44,830 "units" in 1979 (Table 7). Fertilizer consumption is nearly twice that amount in 1979.

35. The intensive use of tractor and fertilizer forces the agricultural sector import bills for inputs alone to increase to US$727 million and US$619 million for Policies II and IV, further reducing the net foreign exchange inflow to US$2,374 million and US$782 million, respectively.

V. ALTERNATIVE LIVESTOCK VERSION (TASM-ALV) 1/

36. The livestock sub-sector as presented in TASM is a rigid system. For each type of animal a fixed amount of land, feed, concentrates, straws

1/ For more details, see Evans, M.C. and V. Le-Si, "Turkey Agricultural Sector Model - Further Results from the Livestock Sub-sector," The World Bank, 1983.

and fodder is required. There are a total of 19 inputs required per animal. To remove the rigidity of this system and to investigate the trade-off between different feeding regimes and herd composition, i.e. 'improved' versus 'unimproved' breeds, the livestock sub-sector is reformulated with a feed energy unit as the only input required. The feed energy unit, calculated in terms of starch equivalents can come from any of three sources: pasture and grazing land, feed grains and concentrates, straws and fodder. Each of the latter two requirements can be derived from any number of products. The three feeding sources are only subject to a minimum and maximum level to guarantee a proper mix to provide a fixed output ratio.

37. Instead of the six types of livestock in TASM, ten are specified for TASM-ALV: 'unimproved' and 'improved' sheep, ordinary and Angora goats, 'unimproved', 'semi-improved' and 'improved' cattle, buffalo, mule and poultry. The technical coefficients for these new livestock activities consist of:

(i) labor, required for maintaining the herd;

(ii) feed energy units, calculated in terms of kilograms of starch equivalents;

(iii) output, composed of meat and milk, and animal power for unimproved cattle, buffalo and mule only.

38. The feed energy can come from any of the following three sources:

(i) Group A: pasture and fallow land grazing;

(ii) Group B: Grains: wheat, corn, rye and barley; Concentrates: wheat, rye, barley and sugar beet; Oilseed cakes: sunflower, groundnut, cotton and soybean;

(iii) Group C: Straws: wheat, corn, rye, barley, and pulses;

Fodder: alfalfa, sainfoin/vetch.

Each of the products is converted into feed energy units by appropriate factor. From various sources of information, a minimum and maximum range that each group can provide towards the total energy unit required by each animal type is determined. This range is necessary to maintain a balanced diet of green and dried materials, although some degree of substitution between any of the three groups is allowed. The last constraint set on this formulation is the composition of grains. They are as follows: wheat 10-15%, corn 10-15%, rye 5-10%, and barley 65-75%. This range is based on historical data.

39. It should be noted that the estimated production of livestock products used in TASM-ALV is lower than in TASM. TASM production data are based on SPO estimates, which, by comparison with other sources (specifically, with the 1981 household consumption survey), seem to be high. The production levels in TASM-ALV, therefore, are revised downward by about 40%, and yields of meat and milk are also reduced. Wool and hides are ignored in TASM-ALV since they constitute only a small part of the livestock sub-sector production value.

40. TASM-ALV is validated at TL35=US$1. The results are shown in Table 14. The results for TASM-ALV are similar to those of TASM with the exception of 'semi-improved' cattle. The 'semi-improved' cattle is not as competitive as the 'unimproved' and 'improved' breeds; therefore, the production is only at about 22% of the observed level and the gross value of production for the livestock subsector is more than 9% below the actual 1979 level. TASM-ALV is then solved for three policies: (i) Policy II,

free trade; (ii) Policy II with sheep and cattle herd size increase and new composition of these two herds (more 'semi-improved' and 'improved' and less 'unimproved' breeds); and (iii) as (ii) with limited trade. The results from these three experiments are similar to the alternative trade policies tested with TASM. The results on herd size composition are more interesting and shown in Table 15. It can be seen clearly that the 'improved' breed is the most profitable activity with the 'unimproved' next and the 'semi-improved' breed last.

Table 14: VALIDATION OF TASM-ALV

	1979 Actual	TASM-ALV Predicted	Predicted/ Actual (%)
(US$ million)			
Grains	3,104	2,937	94.6
of which			
Wheat	1,992	2,011	101.0
Others	1,112	926	83.3
Pulses	418	479	114.6
Vegetables	3,465	3,834	110.6
Fruits and Nuts	3,500	3,687	105.3
Oil Crops	644	693	107.6
Industrial Crops	1,543	1,525	98.8
Livestock Products 1/	3,469	3,147	90.7
TOTAL	16,143	16,302	101.0
(1000 heads)			
Sheep - 'Unimproved'	43,725	39,796	91.0
'Improved'	2,301	2,301	100.0
Goats - 'Ordinary'	15,109	13,840	91.6
'Angora'	3,666	2,963	80.8
Cattle - 'Unimproved'	13,232	13,232	100.0
'Semi-Improved'	2,257	505	22.4
'Improved'	78	78	100.0
Buffalo	1,040	1,040	100.0
Mules, etc.	2,453	2,453	100.0
Poultry	58,939	58,939	100.0

1/ This value does not include wool, hair and hides.

Table 15: HERD SIZE COMPOSITION FOR TASM-ALV
(1000 heads)

		Base	Free Trade	New Herd & Free Trade	New Herd & Limited Trade
Sheep	- 'Unimproved'	39,796	43,725*	33,764	31,240
	- 'Improved'	2,301*	2,301*	12,703*	12,703*
Goats	- Ordinary	13,840	15,109	15,110*	15,110*
	- Angora	2,963	3,557	3,557	3,161
Cattle	- 'Unimproved'	13,232*	13,232*	13,378	13,046
	- 'Semi-Improved'	505	905	0	0
	- 'Improved'	78*	78*	430*	430*
Buffalo		1,040*	1,040*	1,040*	1,040*
Mules, etc.		2,453*	2,453*	2,453*	2,453*
Poultry		58,939*	58,939*	58,939*	58,939*

* These numbers reach the upper bounds.

VI. CONCLUSION

41. Turkey has been following a freer trade policy during the last two years. Assuming that it will continue to do so in the future, the analyses performed with TASM permit us to draw some conclusions regarding the agricultural sector's comparative advantage, alternative trade policies and future development:

(i) Turkey has a comparative advantage in most of its agricultural products. The only products that seem to be in disadvantage are the oil crops. The constraining factors in the expansion of production are mainly the irrigated land, areas under orchards and livestock inventory. This expansion also indicates the more intensive use of other resources, i.e. labor, tractors and fertilizer.

(ii) With free trade policies, barley will overtake wheat as the most important grain exports for the current and future years. Pulses, vegetables, fruits and nuts, industrial crops and livestock will continue to do just as well. Within the livestock sub-sector, cattle have better future potential than sheep and goats.

(iii) With the expansion of crop exports, there is a higher demand for imports in inputs and oil crops. This position of higher trade might run into capacity constraints in related industries, e.g. marketing and processing of fruits and vegetables, and gasoline and fertilizer production. (It should be noted again that no constraints on these inputs are imposed in TASM.)

(iv) The projections for 1990 indicate that the agricultural sector could average an annual increase of about 3.6%. This increase can accomodate the domestic demands but cannot sustain the rate of exports as in the early 1980's. Again the constraining factors are irrigated areas, areas under orchards and livestock inventory.

(v) Finally, to maintain the same level of per capita consumption in all commodities as recorded in 1979, the sector would suffer a considerable loss in foreign exchange (the balance still remains positive) with few gains achieved by consumers and larger losses suffered by producers.

APPENDIX 1. ALGEBRAIC STATEMENT OF THE MODEL

INDICES

s_1 Basic Land Types

Dry Poor Rainfall	Dry Good Rainfall
Irrigated Poor Rainfall	Irrigated Good Rainfall
Tree Area	Pasture

s_2 Land Types without Rainfall Distinction

Dry Either	Irrigated Either

l Labor (Divided into 4 quarters)

Labor 1Q	Labor 2Q
Labor 3Q	Labor 4Q

a Animal Power (Divided into 4 quarters)

Animal 1Q	Animal 2Q
Animal 3Q	Animal 4Q

m Tractor Power (Divided into 4 quarters)

Tractor 1Q	Tractor 2Q
Tractor 3Q	Tractor 4Q

f Fertilizer

Nitrogen	Phosphate

d Seeds

Wheat	Corn
Rye, Oats, Millet, etc.	Rice
Barley	Chick Pea
Dry Bean	Lentil
Potato	Onion
Green Pepper	Tomato
Cucumber	Sunflower
Groundnut	Cotton
Sugar Beet	Tobacco
Melon	Pistachio
Alfafa	Fodder

o <u>Output</u>

Wheat	Corn
Rye, Oats, Millet, etc.	Rice
Barley	Chick Pea
Dry Bean	Lentil
Potato	Onion
Green Pepper	Tomato
Cucumber	Sunflower
Olive	Groundnut
Cotton	Sugar Beet
Tobacco	Tea
Citrus	Grape
Apple	Peach
Apricot	Cherry
Wild Cherry	Melon
Strawberry	Banana
Quince	Pistachio
Hazelnut	Soybean
Sesame	
Sheep Meat	Sheep Milk
Sheep Wool	Sheep Hide
Goat Meat	Goat Milk
Goat Wool	Goat Hide
Angora Meat	Angora Milk
Angora Wool	Angora Hide
Beef	Cow Milk
Cow Hide	Buffalo Meat
Buffalo Milk	Buffalo Hide
Poultry Meat	Eggs

g <u>Livestock Inputs from Crop By-Products*</u>

F - Wheat	F - Corn
F - Rye	F - Rice
F - Barley	F - Pulses
F - Alfalfa	Fodder
F - Fodder	C - Wheat
C - Rye	C - Barley
C - Sugar Beet	

t <u>Production Technique</u>

Animal	Mechanized

---

* F Stands for straws and C stands for concentrates or pulps.

c **Land Choices (Either poor or good rainfall)**

Dry Poor Rainfall | Dry Good Rainfall
Irrigated Poor Rainfall | Irrigated Good rainfall

i **Crop Production Activities**

15 tree crops and 70 rotations

j **Livestock Production Activities**

Sheep	Goat
Angora	Cattle
Buffalo	Mules, Camels, Horses, etc.
Poultry	

y **Year**

1974 to 1979

n **Segment**

0 to 10

po **Processed Products**

Wheat Flour	Tomato Paste
Sunflower Oil	Olive Oil
Dry Tea	Raisin
Shelled Hazelnut	

e **Production Cost Structure**

Labor	Tractor
Fertilizer	Seed
Capitals	

e_1 As e less Labor

PARAMETERS (DATA)

P	Crop production coefficients
Q	Livestock production coefficients
Ioc	Land Matrix for undifferentiated rainfall
Pcost	Crop production costs
Qcost	Livestock production costs
Qq	Crop used for feed index (1 = yes, 0 = no)
Proctrade	Conversion factor for processed products
Qdem	Quantity under demand curves
Odem	Area under demand curves
Rdem	Gross revenue under demand curves
Concentrate	Concentrate coefficients derived from crop processing
Revcrop	Negative deviation for crop production activity
Revlive	Negative deviation for livestock production activity
Exprice	Export prices
Imprice	Import prices
Negdevobj	Risk costs
Ppprice	Processed product prices
Resav	Resource availability
Iel	Income elasticities
Basenetagr	Base year net agricultural income
Mu	Agricultural income multiplier
Sr	Savings rate
BaseGNP	Base year GNP
Basecons	Base year consumption

ACTIVITIES (VARIABLES)

CROPS	Crop production activities
PRODUCT	Livestock production activities
LANDC	Land choice between poor and good rainfall
PFERT	Fertilizer use
PRCOST	Production costs
TOTALPROD	Total production
TOTALCONS	Total consumption
IMPORT	Import
EXPORT	Export
PPTRADE	Processed product trade (both import and export)
DEMFCN	Demand function
TNEGDEV	T negative deviation counters
SUMNEGDEV	Sum of negative deviation z
DCONS	Change in consumption
CONS	Consumption
DAGRINCOME	Change in agricultural income
AGRINCOME	Agricultural inocme
DGNP	Change in GNP

Land Constraints

(1) $$\sum_i \sum_t P_{s_1,i,t} * CROPS_{i,t} \quad + \quad \sum_j Q_{s_1,j} * PRODUCT_j \quad +$$

[Land use by crop and livestock production]

$$\sum_c Ioc_{s_1,c} * LANDC_c \quad \leq \quad Resav_{s_1} \qquad \text{for all } s_1$$

[Undifferentiated* land use] [Land availability]

(2) $$\sum_i \sum_t P_{s_2,i,t} * CROPS_{i,t} \quad = \quad \sum_c Ioc_{s_2,c} * LANDC$$

for all s_2

[Undifferentiated* land use by crop production] [Total undifferentiated* land use]

Labor and Tractor Constraints

(3) $$\sum_i \sum_t P_{l,i,t} * CROPS_{i,t} \quad + \quad \sum_j Q_{l,j} * PRODUCT_j$$

[Labor use by crop and livestock production]

$$\leq \quad Resav_l \qquad \text{for all } l$$

[Labor availability]

Equation (3) with index m instead of l refers to tractor constraints.

* Undifferentiated land refers to poor and good rainfall land.

Animal Constraints

(4) $$\sum_{i}\sum_{t} P_{a,i,t} * CROPS_{i,t} \leq \sum_{j} Q_{a,j} * PRODUCT_{j}$$ for all a

[Animal power required by crop production] [Animal power provided by livestock production]

(5) $$PRODUCT_{j} \leq Resav_{j}$$ for all j

[Livestock production] [Animal inventory]

Fertilizer Accounting

(6) $$\sum_{i}\sum_{t} P_{f,i,t} * CROPS_{i,t} = PFERT_{f}$$ for all f

[Fertilizer used by crop production] [Total fertilizer use]

Production Costs

(7) $$\sum_{i}\sum_{t} Pcost_{e,i,t} * CROPS_{i,t} + \sum_{j} Qcost_{e,j} * PRODUCT_{j}$$

[Cost of production by crop and livestock]

$$= PRCOST_{e}$$ for all e

[Total production cost]

Production Balances

(8) $\sum_i \sum_t P_{o,i,t} * CROPS_{i,t} + \sum_j (1-Qq_o) * Q_{o,j} * PRODUCT_j$

[Products produced by crop and livestock production]

$= TOTALPROD_o$ for all o

[Total production]

Commodity Balances

(9) $TOTALPROD_o + IMPORT_o =$

[Total production] [Import]

$TOTALCONS_o + \sum_j Qq_o * Q_{o,j} * PRODUCT_j +$

[Total consumption] [Crops used as livestock feed]

$EXPORT_o + \sum_{po} (1/Proctrade_o) * PPTRADE_o$ for all o

[Export] [Trade of processed products]

Consumption Balances

(10) $TOTALCONS_o \quad + \quad \sum_{po} Impppind_{po,o} * PPTRADE_o$

[Total consumption] [Import of processed products]

$\geqslant \quad \sum_{n} Qdem_{o,n} * DEMFCN_{o,n}$ for all o

[Quantity under the demand curves]

Feed Balances

(11) $\sum_{i}\sum_{t} P_{g,i,t} * CROPS_{i,t} \quad + \quad \sum_{o} Concentrate_{g,o} * TOTALCONS_o$

[Feed produced by crop production] [Concentrates derived from human consumption]

$\geqslant \quad \sum_{j} Q_{g,j} * PRODUCT_j$ for all g

[Feed required by livestock]

Trade Limits

(12) $IMPORT_o \quad \leqslant$ Historical Quantity

(13) $EXPORT_o \quad \leqslant$ Historical Quantity

(14) $PPTRADE_{po} \quad \leqslant$ Historical Quantity

Convexity Constraints

(15) $\sum_{n}$ $DEMFCN_{o,n}$ $\leq$ 1 for all o

[Sum of all segments]

Risk Constraints

(16) $\sum_{i}\sum_{t}$ $Revcrop_{y,i,t}$ * $CROPS_{i,t}$ + $\sum_{j}$ $Revliv_{y,j}$ * $PRODUCT_{j}$

[Negative revenue from crop and livestock production]

+ $TNEGDEV_{y}$ $\geq$ 0 for all y

[T negative deviation counters]

(17) $\sum_{y}$ 2 * $TNEGDEV_{y}$ = SUMNEGDEV

[T negative deviation counters] [Sum of negative deviation z]

Objective Function

$$(18) \quad \sum_o \sum_n Odem_{o,n} * DEMFCN_{o,n} + \sum_o Exprice_o * EXPORT_o -$$

[Area under demand curves] [Export revenue]

$$\sum_e PRCOST_e - \sum_o Imprice_o * IMPORT_o -$$

[Production costs] [Import costs]

$$Negdevobj * SUMNEGDEV + \sum_{po} Ppprice_{po} * PPTRADE_{po}$$

[Risk costs] [Net revenue from processed products trade]

FORMULATION OF DEMAND CURVE SHIFT

Convexity Constraints

$$(15') \quad \sum_n DEMFCN_{o,n} \leq 1.257 + Iel_o * (0.292 + DCONS) \quad \text{for all } o$$

[Sum of all segments] [Shift due to income and consumption]

Agricultural Income

(19) $\sum_{o}\sum_{n}$ Rdem$_{o,n}$ * DEMFCN$_{o,n}$ = $\sum_{e_1}$ PRCOST$_{e_1}$ +

[Gross revenue under demand curves] [Non-labor production costs]

1000 * AGRINCOME

[Agricultural income]

Change in Agricultural Income

(20) AGRINCOME - DAGRINCOME = Basenetagr

[Agricultural income] [Change in agricultural income] [Base net agricultural income]

Marginal Agricultural Income

(21) (1 + Mu) * DAGRINCOME = DGNP

[Change in agricultural income [Change in GNP]

Change in Consumption

(22)	[1 / (1 - Sr)] * CONS	=	BaseGNP	+	DGNP
	[Consumption rate]		[Base GNP]		[Change in GNP]

Consumption Growth

(23)	(1 / Basecons) * CONS	=	1	+	DCONS
	[Consumption growth]				[Change in consumption]

APPENDIX 2. TURKEY AGRICULTURAL SECTOR MODEL (TASM) DATA

An Overview

2.1 TASM is based on 15 types of orchards, 70 crop rotations and 7 livestock activities. The list of inputs and outputs accounted in TASM is given in Appendix 4, pp. 1-2. Taking into account the two production techniques, namely mechanized and non-mechanized for crop production, the total number of production activities specified in the model is 176.

2.2 The crop and livestock production activities in TASM are interrelated as shown in Figure 1, in the sense that they compete for common inputs and use outputs produced by some activities as inputs required by others.

2.3 The data used in the model are gathered mainly from SIS, SPO, FAO and TOPRAKSU sources. The lack of Turkish statistics suitable for this kind of modeling exercise forced the researchers to piece together the required data from different sources and hence to make some adjustments to the raw data to construct a consistent and representative set of data.

2.4 In the following sections we state in detail the sources and nature of the data, assumptions and adjustments made, and discuss the direction of biases that might have been introduced into the results due to lack of more precise and reliable data.

Crop Production

2.5 The basic input-output coefficients corresponding to the crop production activities 1/ for mechanized technology are gathered mainly from

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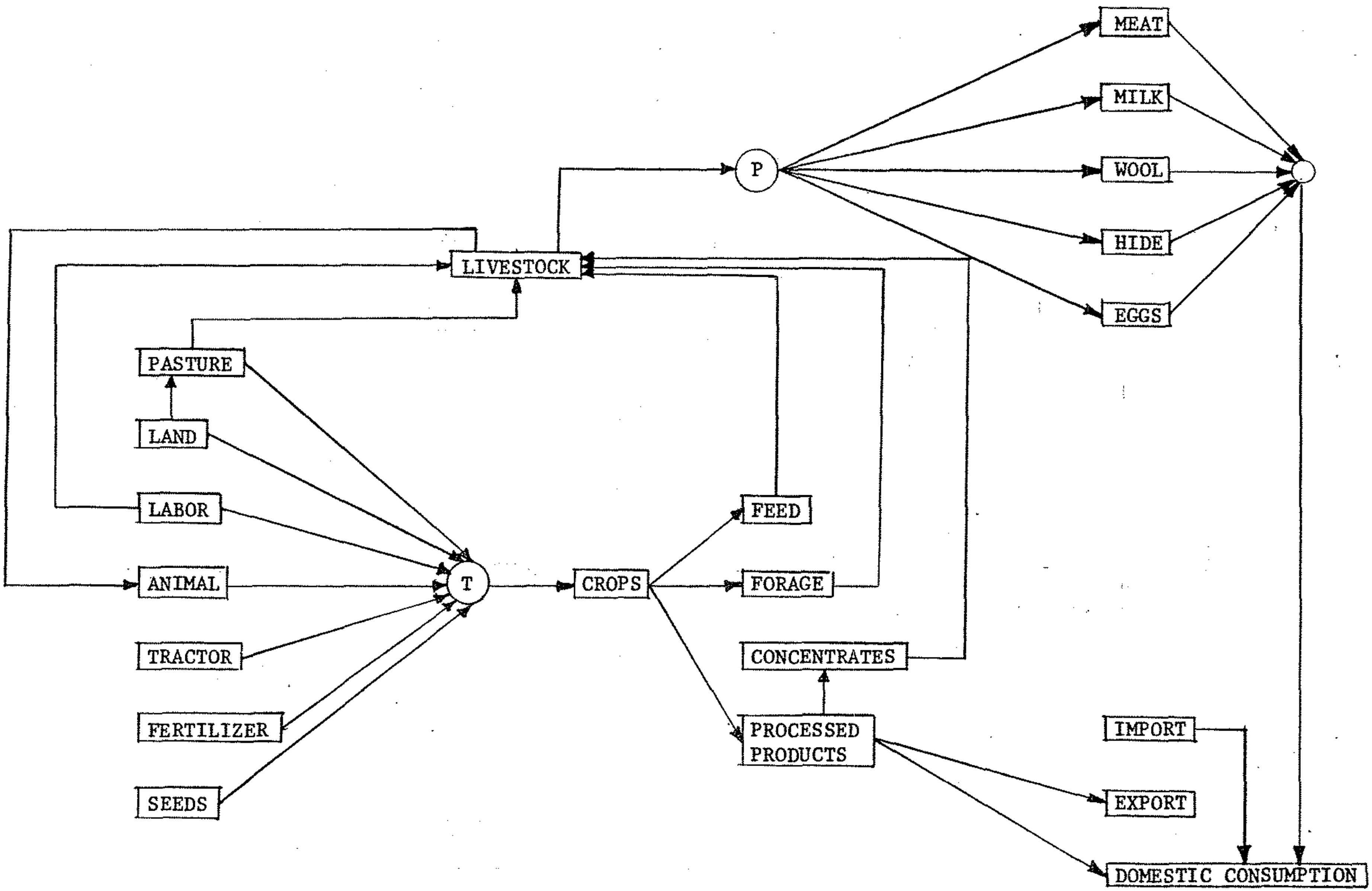
1/ In TASM, there are 46 annual crop activities (some crops may appear more than once, depending on soil conditions) and 15 perennial crops (orchards).

Figure 1: THE INTERACTION OF CROP AND LIVESTOCK PRODUCTION ACTIVITIES



the preliminary results of the ongoing "Production Inputs and Costs of Agricultural Crops in Turkey" research conducted by TOPRAKSU. The data in this research are collected by bookkeeping method on an individual crop basis. The farmers selected were given record books to be filled daily for some specified crop. The records were checked and controlled by the agricultural engineers on weekly visits. The records kept for the whole farming season were collected at the end of the harvest and marketing period to be tabulated. For some crops, the same procedure is repeated for 2-4 years.

2.6 While the data collected by TOPRAKSU is the most reliable data of its kind currently available in Turkey, it is nevertheless not free of biases, especially in its preliminary stages. The limitations and biases of TOPRAKSU data are briefly summarized below:

a. The farms selected for the study are not selected by a systematic sampling procedure. They are selected from those who are willing and able to cooperate in daily recordkeeping, and from those who, in the subjective opinion of TOPRAKSU experts, represent an average farmer of the region. It is most likely therefore that the production coefficients based on these farmers to have an upward bias in yields and to be biased towards more mechanized technology.

b. The regions for which the study has been completed or the study has been started may not in some cases represent the average production techniques. To date, the regions covered in the study have been fairly limited and production coefficients for certain crops, especially vegetables and fruits are based on results from a single region. The bias introduced can be in either direction depending on whether the region studied is below or above an average region. The regions covered by the TOPRAKSU study are shown in Figure 2.

c. Furthermore, while the bookkeeping method employed results in very reliable data for the farms surveyed, it is a very labor intensive method and the number of farms studied has to be very small, as in the TOPRAKSU study), too small in some cases to conduct a meaningful variance analysis. Certainly when the whole project is completed with 2-4 years of data on each crop and in each region, this problem will be eliminated to some extent.

d. Despite the limitations mentioned in a-c, the TOPRAKSU data is reliable and the results obtained with this data are not likely to vary significantly when the final tabulations are made on the data collected. This conclusion is based on the following observations:

(i) The data set is internally consistent and represents the relative if not the absolute input-output relations since the results are more sensitive to the relative values of the production coefficients than their absolute values.

(ii) Even in those crops where TOPRAKSU data appears to have a large bias (such as in tomato) the bias does not significantly influence the results, since both the input and output coefficients are likely to have the same biases in the same direction. Hence the biases, cancelling each other out and due to other physical constraints imposed on the model, will have at most only minor effect on the outcome of the model.

2.7 The production coefficients for non-mechanized single-crop activities are given in Appendix 4, pp. 3-8. The crop production coefficients with the exception of rice 1/, hazelnuts 2/, tea 3/, soybean and sesame 4/ are basically derived from TOPRAKSU data. Whenever data was available for more than one region and/or year, simple averages were taken. Since the TOPRAKSU data is reported for mechanized technology only, the following formulae are used to convert mechanized activities to non-mechanized activities, with the assumptions that 1 hour of tractor power is equivalent to 10 hours of animal power.

$$\text{Labor } N_{iq} = [\text{Labor } M_{iq} - \text{Tractor } M_{iq}] + \text{Animal Power } N_{iq}$$

$$\text{Animal Power } N_{iq} = 10 * \text{Tractor } M_{iq}$$

$$\text{Labor } N_{iq} = \text{Labor } M_{iq} + 9 * \text{Tractor } M_{iq}$$

where, M=Mechanized Technology
N=Non-mechanized Technology
$i=i^{th}$ crop activity $i=1,\ldots,46$
$q=q^{th}$ quarter $q=1,2,3,4$

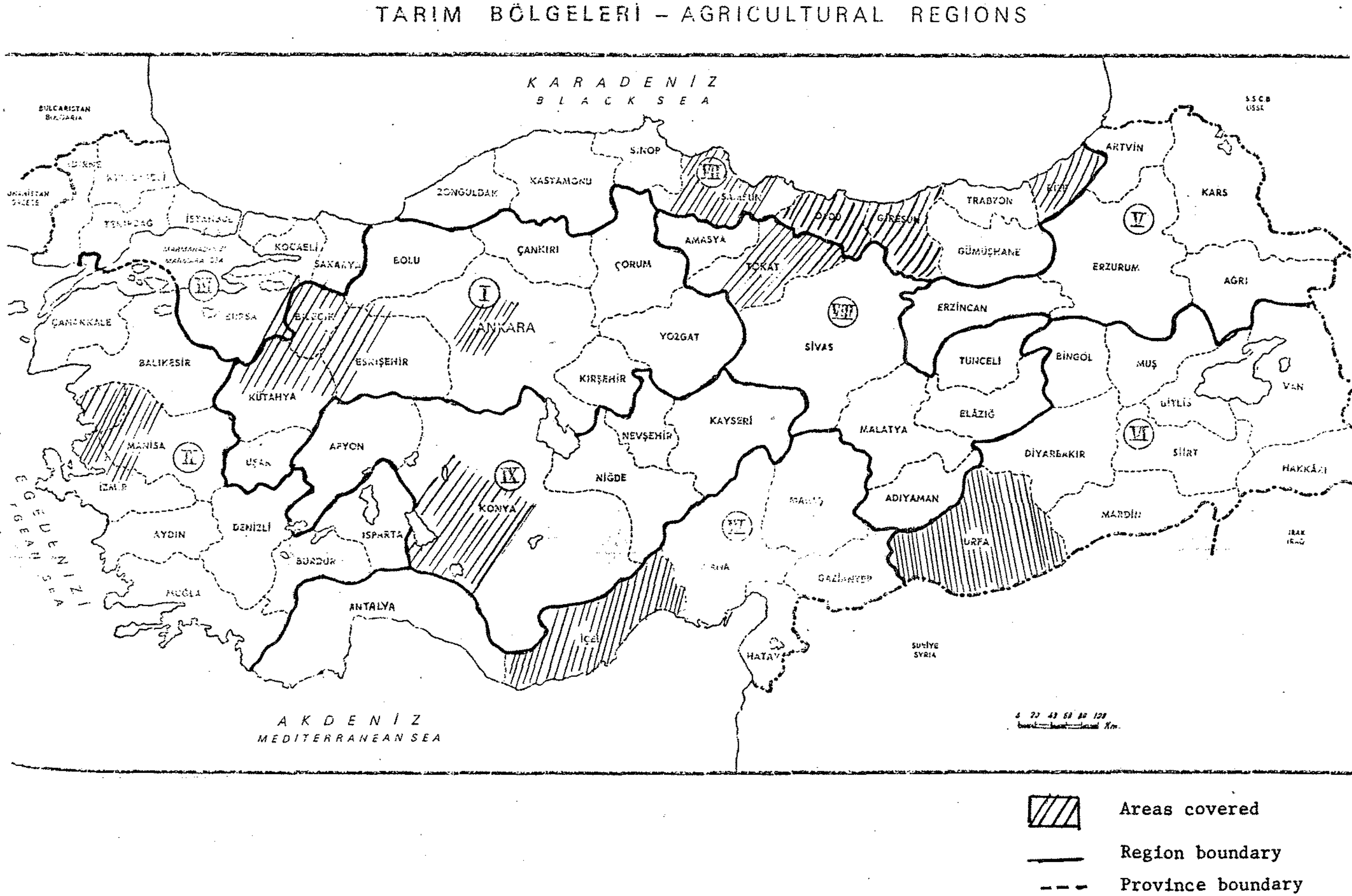
1/ Gunes, T. "Economies of Paddy in Turkey", A.U. Faculty of Agriculture, Pub. No. 509/281, Ankara, 1971.

2/ Ministry of Agriculture, Department of Planning and Research, "Analysis of Hazelnut Production in the Provinces of Ordu and Giresun", Pub. No. 50, Ankara, 1972

3/ Yilmaz, D.A., "Technical Efficiency in Tea," Seminar Paper submitted at METU, Ankara, 1981.

4/ Soybean and sesame yields are from SIS "The Summary of Agricultural Statistics," 1979.

Figure 2: SURVEYED AREAS FOR WHICH DATA WERE USED IN TASM.



Crop Rotation Activities

2.8 Seventy crop rotations 1/ are generated from the 46 annual crop activities for each of the two technologies. The rotation activities are computed by linear combinations of the single crop activities. The list of crop activities used is given in Appendix 4, pp. 10-12, together with the appropriate land types. In practice, using rotations in production (if properly selected) results in higher yields and/or savings in input costs. Thus combining single crop activities linearly, due to lack of data, results in a downward bias in rotation yields and upward bias in rotation input use. When these rotations are specified together with the single crop activities in the model then one of the set would be redundant. Single crop activities are less restrictive, in allowing the model to choose any combination with any weights, than rotation activities which combine crops in specific ratios.

2.9 To resolve the question of which set to use, we have experimented with using single crop and rotation activities simultaneously by incorporating additional constraints on single or rotation activities, as well as with using single and rotation activities separately. The final version of the model for which the results are presented in this report specifies only rotation activities and single crop with fallow activities (cereal crops). Another advantage in specifying only rotation activities is the incorporation of agronomic constraints that cannot be specified by mathematical equations. For example sugarbeet can only be planted on the same land no more than two years in a row.

1/ These are determined by the study team and agronomists in the Ministry of Agriculture and Forestry to be the most important rotations practiced in Turkey.

Livestock Activities

2.10 Seven livestock activities are specified in TASM. The production coefficients are pieced together from SIS, SPO, TSKB and the World Bank's Agricultural Sector Study Mission. The 7 livestock activities include sheep, ordinary goat, Angora goat, cattle (cow, oxen, bull, young cattle), buffalo, mule (horse, mule, donkey) and poultry (hens, cocks, turkey). On the input side, besides outputs and by-products from crop activities (feed-grains, forages, fodder and concentrates), pasture land and labor are required. The outputs of the livestock activities include meat, milk, wool, hide and eggs in addition to animal power provided to crop production activities.

2.11 The labor requirement coefficients are taken from A. Erkus. 1/ The feed, forage, fodder and concentrate inputs are estimated by updating the results of N. Demir et al 2/ with the assumption that the same proportion of crop production will be used for feed, forage, fodder and concentrate in 1979 as in 1970, and further, the distribution of the inputs among the livestock activities will remain the same between 1970-1979.

2.12 The livestock yields are based on SIS figures, with modifications in meat yields and milk yield for cattle and buffalo based on Agricultural Sector Study Mission estimates.

1/ Erkus, A., "Principles and Methods of Planning in Agricultural Enterprises and Their Application to Agricultural Projects," pp. 5-6, Ministry of Village Affairs, Ankara, 1974.

2/ Demir, N., et al, "Agricultural Planning Studies (Input-Output and Consumption), Projections in Turkey 1977," SPO Pub. No. 1341, pp. 80-82, Ankara, 1974.

Inputs

2.13 Six groups of inputs (land, labor, animal power, tractor, fertilizer and seeds) are incorporated in TASM. Labor, animal power and tractors are introduced on a quarterly basis, the quarters being the calendar year quarters.

2.14 Seven classes of land are identified. The classification on coverage of the land input is shown below:

Name	Land Type	Characteristics
DRY-POOR	Rainfed land with low rainfall	600 mm or less per year
DRY-GOOD	Rainfed land with good rainfall	more than 600 mm per year
DRY-EITHER	Rainfed land	No rain distinction (DRY-POOR + DRY-GOOD)
IRR-POOR	Irrigated land with low rainfall	600 mm or less per year
IRR-GOOD	Irrigated land with good rainfall	More than 600 mm per year
IRR-EITHER	Irrigated land	No rain distinction (IRR-POOR + IRR-GOOD)
TREE-LAND	Tree Land	Vineyards, orchards, olive groves, tea, hazelnut and pistachio gardens.

2.15 The labor input is measured in man-hour equivalents and shows the actual time required for a given activity on the field. The weights used to convert labor into man-hour equivalents are given below:

Age	Sex	Weight
0-6	Male-Female	0.0
7-14	Male-Female	0.5
15-49	Male	1.0
15-49	Female	0.75
50-65	Male	0.75
50-65	Female	0.5
65+	Male-Female	0.0

Unfortunately, TOPRAKSU data does not report the labor associated with the usage of tractors as labor hours, but only reports the tractor hours. Therefore, whenever tractor hours are reported in the data, the respective labor hours are imputed and assigned by the researchers, assuming that 1 tractor hour requires 2 hours of labor in planting and harvesting and only 1 hour of labor in other activities.

2.16 The tractor hours correspond to the usage of tractors in actual production and transportation directly related to the production activities.

2.17 TOPRASKU data reports the non-labor power used in terms of the 'dominating' power. Therefore, since the 'dominating' technology in the sample surveyed used tractor power, no animal power was reported. In the non-mechanized activities, animal power is computed by the researchers, assuming that 1 hour of tractor power is equivalent to 10 hours of animal power (see page 5 for the conversion formulae).

2.18 Two kinds of fertilizers, namely Nitrogen (N) and Phosphate (P^2O^5). The fertilizer inputs are measured in terms of nutrient contents.

2.19 In the case of annual crops amounts of seed input required are calculated as production costs (for green peppers, tomato, tobacco, seedlings are specified instead of seeds). For non-annual or perennial crops (grape, olive, quinces, apples, apricot, cherry, wild cherry, peaches, strawberry, banana, citrus, pistachios and tea) fixed investment costs are assigned (see pg. 23 in Appendix 4) instead of seed or seedling costs.

Crop Yields

2.20 Output from crop production activities are divided into three: crop yield for human consumption, feed yield for animal consumption 1/, and forage yield or crop by-products for animal consumption. In addition concentrates are derived from the processing of raw materials for human consumption. The list of crops falling into this category is listed in Appendix 4, pp. 1-2 and 22.

2.21 The yield reported in the original TOPRAKSU data includes both the output for human consumption and feed for animal consumption, but does not report the forage yield. Therefore, forage yield is imputed by the reseachers using the following formulae:

Let Y_t = TOPAKSU Yield

Y_m = Model Yield for Human Consumption

Y_f = Model Feed Yield for Animal Consumption

1/ These two yields are combined into one in the model.

Y_s = Model Forage Yield for Animal Consumption

F = Ratio of crop output used as feed

G = Ratio of forage output to total crop output

$Y_m = Y_t - F\ Y_t = (1-F)\ Y_t$

$Y_f = F\ Y_t$

$Y_s = G\ Y_t$

The ratios of F and G are from N. Demir et al (1974, pp. 80-81). They are given below:

Crop	Feed Yield/ Total Yield	Forage/ Total Yield
Wheat	0.02	1.2
Corn	0.25	2.0
Rye, Oats, Millet, Spelt	0.80	1.2
Paddy	—	1.2
Barley	0.65	1.2
Chick Pea	—	1.2
Dry Bean	—	1.8
Lentil	—	1.125

2.22 The historical crop yields (1974-1979) used for risk calculations are given in Appendix 4, pp. 15-16. The historical yield data is basically from SIS statistics, except for vegetables and tree crops, which are not presented, and had to be imputed using the following procedures:

Vegetables

Let Y_{Ti}^{79} = Yield of i^{th} vegetable given by TOPRAKSU in 1979

P_{Si}^{79} = Production of i^{th} vegetable given by SIS in 1979

$$\frac{P_{Si}^{79}}{Y_{Ti}^{79}} = A_{Mi}^{79} = \text{Area imputed for } i^{th} \text{ vegetable in 1979}$$

$$\frac{A_{Mi}^{79}}{\sum_i A_{Mi}^{79}} = S_{Mi}^{79} = \text{Percentage of area covered by } i^{th} \text{ vegetable in 1979}$$

Assume that the percentage of the area covered by i^{th} vegetable remained unchanged between 1974-79, then

$$Y_{Mi}^{j} = \frac{P_{Si}^{j}}{A_{Mi}^{j}} = \text{Yield used in the model for } i^{th} \text{ vegetable in year } j,$$

where $A_{Mi}^{j} = S_{Mi}^{79} * \sum_i A_{Si}^{j}$ = Area of i^{th} vegetable in year j, and

$\sum_i A_{Si}^{j}$ = Total vegetable area for j^{th} year given by SIS.

$\therefore$ To impute the historical yields for vegetables, P_{Si}^{j} and $\sum_i A_{Si}^{j}$ are based on SIS figures and Y_{Ti}^{79} are based on TOPRAKSU figures.

Tree Crops

Let R_{Si}^{75} = Estimated number of trees per hectare ratios in 1975 for i^{th} tree crop used by SIS

T_{Si}^{j} = Total number of trees of i^{th} tree crop in year j reported by SIS

P_{Si}^{j} = Total production of i^{th} tree crop in year j reported by SIS

$$YT_{Mi}^{j} = \frac{P_{Si}^{j}}{(T_{Si}^{j} \big/ R_{Si}^{75})} = \text{Yield for } i^{th} \text{ tree crop in year j used in the model.}$$

prices which were computed by converting the per head prices given by SIS to per kg prices, using the conversion factors from TSKB (1980, pg.30).1/

2.28 SIS gathers output prices on a bi-monthly basis, the prices reported in their publications are claimed to be the simple arithmetic means of the bi-monthly prices. This certainly might distort the relative farmgate prices. Therefore, to investigate the size and direction of biases, we have collected the bi-monthly farmgate prices for 1979 from unpublished SIS files and constructed a weighted farmgate price set for all commodities included in the model, using the weights used by the Turkish Agricultural Bank to construct its own weighted prices. This exercise resulted in two very interesting observations. First, although SIS claims that their annual farmgate prices are simple arithmetic averages (see SIS Statistical Yearbook 1981, pg. 361) of the bi-monthly data, the simple average of their raw data does not match with the published average price. 2/ Second, the weighted farmgate prices computed from the raw data are fairly close to the simple average farmgate prices reported by SIS, more so than the calculated simple averages and the reported prices. What apparently might have happened is that SIS adjusted its simple average farmgate prices by a method not reported in their publications. Therefore, we have decided to

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1/ Kilicoglu, A., "Livestock, Meat and Meat Products," TSKB Pub. No. 30, Istanbul, 1980.

2/ The difference approaches 25% in some crops. In other cases, the simple average price is outside the range of the reported monthly prices. For example, red lentil and green lentil prices are given to be 1543, 1660, 1701 and 1584, 1638, 1743 (kurus/kg for the months July-August, September-October, November-December) with published average prices of 1944 and 1910 respectively.

use in the model the "unweighted prices" reported by SIS, which actually represented the weighted prices.

Inputs Costs

2.29 The 1979 costs of labor, tractor, fertilizer, seed/seedling for annual crops and fixed capital for perennial crops are given in Appendix 4, pp. 23-24. With the exception of sugarbeet seed prices (gathered by the Sugar Company) the input cost data are from TOPRAKSU's "Production Inputs and Costs of Agricultural Crops in Turkey" survey.

Resource Availability

2.30 The 1979 resource availability data are given in Appendix 4, pg. 25. These include labor, tractor, land types, livestock and tree stocks.

2.31 The data for tree land and pasture land are from the TOPRAKSU Statistical Bulletin 1980. 1/ The land types by irrigation and rainfall distinction are imputed using TOPRAKSU (1981) and SIS (1982) data. While TOPRAKSU reports provincial data with irrigated and rainfed distinction, it does not distinguish land by rainfall. On the other hand, while SIS reports provincial data with rainfall distinction, it does not distinguish for irrigation. The two sets of data are pieced together by classifying the provinces for rainfall using SIS data, and then re-aggregating the TOPRAKSU data for irrigated and rainfed land with rainfall distinction.

2.32 Labor resource availability for 1979 is computed by converting the agricultural labor force in 1979 to man-hour equivalents, with the

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1/ Ministry of Village Affairs and Cooperatives, General Directorate of TOPRAKSU, "Statistical Bulletin of TOPRAKSU 1980", Ankara 1981, pp. 17-83.

assumption that there are 294 working days in a year and 5 working hours in a day 1/ as shown below:

Age	1975 Agr. Pop.	Weights (Male/Female) 1/	Male Equiv. 1975 Ag. Pop.
12-14	1,019,656	.5/.5	509,828
15-49	7,245,891	1/.75	6,340,155
50-65	1,513,382	.75/.5	945,866
TOTAL (1975)	9,778,929		7,795,849
Ratio of 1979-1975	1.08		1.08
TOTAL (1979)	10,561,243		8,419,517
Man-Hours (1979)			12,353,804,000

1/ It is assumed the male and female population constitute equal shares of the total agricultural labor force.

2.33 Available tractor hours for 1979 are calculated by assuming 300 working days and 5 working hours for each tractor. The numbers of tractors in 1979 are 440,502. The number of hours is 440,502 x 5 x 300/4 = 165,188,250 hrs/quarter.

2.34 Livestock inventory data comes from SIS "The Summary of Agricultural Statistics 1979," pp. 13-14.

2.35 Tree stock in 1979 covers areas of both bearing and non-bearing trees. The figures here are computed using the technique outlined in para. 2.22.

Processing Costs and Factors

2.36 The following crops are processed for consumption: Wheat, corn, rye, rice, sunflower, olive, soybean, sesame, sugarbeet and tea. Their

1/ Madran, N., "Agricultural Guide Book," Istanbul, 1970.

respective processing conversion factors and associated costs are given in Appendix 4, pg. 21. The conversion factors for soybean and sesame are from FAO's Technical Conversion Factors for Agricultural Commodities, and the rest are from N. Demir et al (1974, pp. 60-61). The processing costs are computed using the following formula, with the assumption that the profit margin in processing is 20% for all crops:

Processing Cost = [(Export Price of Processing Product)-(Export Price of Raw Product)](0.80)[Processing Factor].

The processing costs for sugar and tea are based on the World Bank Agriculture Sector Mission and Sri Lanka "Tea Subsector Memorandum V," Annex 1, Table 5, pg. 1, Nov. 1979 respectively.

Concentrates Coefficients

2.37 Concentrates are by-products of processing for human consumption. The concentrate coefficients are taken from N. Demir et al (1974: pp. 58-61, 82-83), and are given on page 22 of Appendix 4.

Crop and Livestock Production in 1979

2.38 The crop and livestock production data used in TASM are given in Appendix 4, pp. 19-20. The data come mainly from SIS "Agricultural Structure and Production 1979." The production data for wheat, dry beans, barley, corn, and rye, oats, millet were deflated and the production data for lentils and chickpeas were inflated slightly based on the findings and new estimates produced by World Bank's Agricultural Sector Study Mission.

2.39 In view of the central position which wheat occupies in the Turkish agricultural economy, it is appropriate to explain in a little more detail how the base year figures used in TASM are derived. The basic problem with the SIS estimates of total production (17.5 million mt for

1979) is that it is difficult to account satisfactorily for the disappearance of this quantity without assuming very high levels of human consumption. Estimates from Turkish sources for annual per capita consumption of wheat and wheat-based products within the last ten years range from 160 to 188 kg of wheat flour equivalent (200 to 235 kg in terms of raw wheat). Taking into account also the additional, though small, amounts of other cereals also consumed by the human population, the result is a proportion of cereal in the diet which is much higher than in most semi-industrialized countries. In Turkey, this tends to be explained in such terms as the traditional eating habits of the people and the high proportion of bread which is thrown away uneaten. These reasons are not entirely convincing in the absence of good corroborative statistics. The only direct estimates of consumption (as distinct from feed balance studies) available are the Nutrition, Health and Food Consumption Survey 1974 and the household consumption survey of 1981 which is discussed in the Turkey Agricultural Sector Study Mission's report. 1/ The earlier survey produced a fiture of 166.2 kg/person/year as the national average of consumption (in wheat flour equivalent) for wheat products. 2/. Preliminary analysis of the first round only of the later survey indicated a higher level of 182.9 kg/person/year. Assuming that complete analysis of the results of the 1981 survey confirms this figure it is difficult to explain why per capita consumption of wheat should have increased so much during the period between the two surveys.

1/ Report No. 4204-TU, Annex 2.

2/ This figure assumes that 1 kg of bread in the original data is equivalent to 0.8 kg of wheat flour.

2.40 A reasonable view is that per capita consumption of wheat in all forms lays in the 160-180 kg range (in wheat flour equivalent) in 1979. Most estates of the amount of raw wheat needed for animal feed in this year fall in a range of 400,000 to 600,000 mt, though some agricultural economists believe the figure could have been higher. The proportion of the total harvested crop which is lost or wasted is put at 4-8% by most experts, while the proportion retained for seed is calculated to be 10-12%. Excluding export demand and stock changes, these values indicate a producton level in the range of 10.65 to 13.07 million mt of raw wheat in 1979 1/. Net exports of wheat and wheat flour averaged 1.23 million mt during 1978/1979 and 1979/80 and stock changes - 100,000 mt (i.e., a draw-down), although this latter figure is very speculative. For the purposes of defining base year production in TASM, the following values were adopted:

Human consumption	(kg/head/year)	:	170 (wheat flour) 212 (raw wheat)
Animal consumption	('000 mt/year)	:	660
Exports	('000 mt/year)	:	1,231
Loss & Seed (proportion of total production)		:	16%
Stock change	('000 mt/year)	:	-100

1/ Assuming the population was 43.8 million and that 1 kg raw wheat is equivalent to 0.8 kg of wheat flour.

Thus total production is estimated as follows:

		'000 mt raw wheat
Human consumption		
(212 kg x 43.8 million)	: 9,286 say	9,300
Animal consumption	:	660
Exports		1,231
Stock draw-down		-100
Total requrements from domestic production, before seed and loss	:	11,091
Total production after allowance for seed and loss at 16% = 13,204, say	:	13,205

Given the ranges of the estimates for the various components of wheat distribution, a production figure of 13.2 million mt for 1979 is to be regarded as conservative. However, it is equally clear that a figure as high as 17.5 million mt is much less plausible 1/.

2.41 A reduced estimate of what production for the base year has major implications for estimates of land use. Using the official SIS figure for average wheat yields for 1979/80 (1.867mt/ha) implies a wheat area of 7.07 million ha to produce 13.2 million mt. The official SIS figure is 9.4 million ha (to produce 17.5 million mt) while the unpublished results of

1/ FAO and IFPRI both report difficulties with constructing satisfactory 'supply and utilization accounts' for wheat in Turkey because of the apparent over-estimation of production (Private communications, 1982).

the 1980 Agricultural Census give a wheat area of 6.15 million ha and a yield of 1.74 mt/ha. The Census area figure is almost certainly an under-estimate of the true figure, in view of the large area of 'unused' land also reported in the Census which probably refelcts reluctance on the part of farmers to declare all their land.

2.42 Base year production values used in TASM for barely, corn and the 'rye group' and dry beans were set below the official SIS figures in view of the low Census estimates for 1980 compared with the official figures for that year. For the same reason, production values for lentils and chick peas were increased.

2.43 For the meat output of the livestock activities, estimates of the above mission based on SPO figures were used rather than SIS figures which cover only meat produced from animals processed in municipal slaughterhouses, and which are likely to underestimate the production considerably. Estimates of milk production are also based on SPO figures. The animal hide production figures are based on SIS data converted from number of hides to kg of hides using the conversion factors given in para 2.26.

Foreign Trade

2.44 The data related to foreign trade in 1979, shown on pp. 19-20 of Appendix 4, involves trade in unprocessed as well as processed products.

2.45 Unprocessed Products. The quantity of exports and imports are from SIS Foreign Trade Statistics 1979, with the exception of wheat, chick pea, lentil, rye-oats-millet and livestock meat which are based on the estimates of the World Bank's Agricultural Sector Study Mission.

2.46 The trade prices are FOB and CIF at farmgate. All import and export prices given in SIS statistics are changed according to the assumptions taken from the Second Fruit and Vegetable Project estimates to reflect marketing and transportation costs. The following exception are made: wheat, potato, lentil, pistachio and rye have no margin and cotton is subsidized. The livestock trade prices are based on the estimates provided by the World Bank's Agricultural Sector Study Mission.

2.47 Processed Products. Foreign trade is allowed for the following processed products: wheat flour, tomato paste, sunflower oil, olive oil, dry tea, raisin and shelled hazelnut. The conversion factors, trade quantities and prices for these processed products are given on pg. 20 of Appendix 4. The conversion factors are from N. Demir et al (1974, pp. 60-77). The trade quantities are from SIS Trade Statistics 1979. The trade prices are FOB and CIF at farmgate.

Consumption and Demand

2.48 The domestic consumption is defined as: Production + Import-Export-Feed-Change in Stocks. 1/ Wheat, corn, rye, paddy rice, sunflower, olive, soybean, sesame, sugarbeet and green tea are processed for consumption. The processing factors are given on page 21 of Appendix 4.

2.49 The demand function relates the observed consumption quantity to observed prices net of processing costs. The price elasticities used in TASM are estimated from the income elasticities given in World Bank Report

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1/ Given on pg. 19 of Appendix 4, under OTH-Q.

No. 3641-TU 1/ using the Frisch Method. 2/ For those products with negative income elasticities or no income elasticities provided, the price elasticities are imputed from the elasticities of similar products. Also for all wool and hides a price elasticity of 1.18 is assumed. The price and income elasticities used in TASM are given on pp. 21-22 of Appendix 4.

1/ World Bank, Turkey Industrialization and Trade Strategy, Report No. 3641-TU, February 1982.

2/ Frisch, R., "A Complete Scheme for Computing All Direct and Cross Demand Elasticities in a Model with Many Sectors," Econometrica, Vol. 27, 1959, pp. 177-196.

APPENDIX 3. RESULTS FROM TASM PROJECTIONS TO 1990 WITH NO CHANGE IN PRODUCTIVITY

3.1 In the main report we present results from projections to 1990 with the assumptions that (i) GNP grows at 4.07% p.a. and consequently consumption grows and shifts to different composition; (ii) productivity in crop and livestock sub-sectors increases due to higher input use; and (iii) more irrigated land will be available (therefore less rainfed land), labor grows at 1% p.a. and animal population grows at 6% p.a. These projections under different trade regimes show the combined impact of both technology and trade regimes on the base conditions that are prevailing in 1979. To study the impact of technology alone on the base conditions, we project for 1990 with assumptions (i) and (iii), with the exception that crop and pasture remain as in 1979.

3.2 Table A3.1 shows production, consumption and net trade for Policy II with and without productivity change. Under 'with' assumption, production increases 3.6% p.a. while it increases only 1.9% p.a. under 'without'. Pulses, vegetables and oil crops show marked differences. Consumption, on the other hand, increases at the same rate for both assumptions, with the exception of livestock which is higher under 'with' assumption. This is due mostly to the improvement in the yield of cereals and fodder. The difference in production is reflected in net trade figures. Total net trade increases by 13.7% p.a. and 4.8% p.a. for the two assumptions, respectively.

3.3 Table A3.2 compares the value-added under the two assumptions. Value-added under 'with' assumption grows about three times that under 'without'. The difference in terms of rural employment is only 0.2%. Consequently, the value-added per worker in the 'with' scenario is growing at more than 1% p.a. compared to less than 0.1% p.a. under 'without'. This index shows the importance of productivity in the growth of the agricultural sector in Turkey.

3.4 Table A3.3 summarizes the effects of growth due to productivity change in TASM projections. Comparison of this table with percentages given in para. 32 of main text indicates that for grains most of the increase come from productivity change. More than half of the gains recorded by fruits, nuts and livestock are due to productivity increase. On the other hand, pulses, vegetables and oil crops record no gains from productivity change but all effects are accounted by changes in trade regime.

Table A3.1: COMPARISON OF TASM SOLUTIONS IN 1990 WITH AND WITHOUT PRODUCTIVITY CHANGE
(US$ million)

	1979 Base	Policy II WITH	Policy II WITHOUT
PRODUCTION			
Grains	2,277	3,021 (2.6)	2,204 (-0.3)
of which			
Wheat	1,502	1,633 (0.8)	1,419 (-0.5)
Others	775	1,388 (5.4)	785 (0.1)
Pulses	349	497 (3.3)	497 (3.3)
Vegetables	2,851	4,565 (4.4)	4,565 (4.4)
Fruit and Nuts	2,745	4,841 (5.3)	3,601 (2.5)
Oil Crops	499	345 (-3.3)	348 (-3.2)
Industrial Crops	1,153	1,730 (3.8)	1,517 (2.5)
Livestock Products	3,827	5,138 (2.7)	4,059 (0.5)
TOTAL	13,701	20,136 (3.6)	16,791 (1.9)
CONSUMPTION			
Grains	1,612	1,597 (-0.1)	1,597 (-0.1)
of which			
Wheat	1,281	1,259 (-0.2)	1,259 (-0.2)
Others	331	338 (0.2)	338 (0.2)
Pulses	280	324 (1.3)	324 (1.3)
Vegetables	2,805	3,333 (1.6)	3,385 (1.7)
Fruits and Nuts	2,336	2,727 (1.4)	2,746 (1.5)
Oil Crops	407	537 (2.6)	541 (2.6)
Industrial Crops	882	1,032 (1.4)	1,003 (1.2)
Livestock Products	3,332	5,038 (3.8)	4,235 (2.2)
TOTAL	11,654	14,588 (2.1)	13,830 (1.6)
NET TRADE			
Grains	156	1,050 (18.9)	106 (-3.5)
of which			
Wheat	155	312 (6.6)	82 (-5.6)
Others	1	738 (82.3)	24 (33.5)
Pulses	73	202 (9.7)	201 (9.6)
Vegetables	15	562 (39.0)	538 (38.5)
Fruits and Nuts	44	466 (23.9)	185 (13.9)
Oil Crops	5	-145(-36.2)	-145(-36.2)
Industrial Crops	397	837 (7.0)	.619 (4.1)
Livestock Products	68	129 (6.0)	-241(-14.8)
TOTAL	756	3,101 (13.7)	1,263 (4.8)

Figures in parentheses represent the annual growth rate from the base case.

Table A3.2: COMPARISON OF VALUE-ADDED

		Base Solution 1979 Restricted Trade	Projections 1990 Policy II With	Projections 1990 Policy II Without
Gross Value of Production				
- Total ($M)		13,701	20,136	16,791
- Growth Rate 1979-90 (% p.a.)			3.56	1.87
Value-Added in Agriculture a/				
- Total ($M)		11,914	16,123	13,163
- Growth Rate 1979-90 (% p.a.)			2.79	0.91
Number Employed in Agriculture b/				
- Total ('000)	I	5,617	6,772	6,646
- Growth Rate 1979-90 (% p.a.)			1.71	1.54
	II	4,173	4,690	4,581
			1.07	0.85
Value-Added per Worker				
- Total ($)	I	2,121	2,381	1,981
- Growth Rate 1979-90 (% p.a.)			1.06	-0.62
	II	2,855	3,438	2,873
			1.70	0.06
Labor Content of Total Costs (%) c/		69	53	55
Labor Content of Net Income (%) c/		33	28	38

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a/ 'Value-added' = gross value of production less cost of seed, fertilizer, animal/tractor power and certain other working capital items. Thus the costs of fixed asset investment and other overheads are not taken into account. Values at 1979 actual farmgate prices.

b/ Male adult equivalents, assuming 6 hours per day are actually spent in the fields and 300 days are worked per year.
I= Number on the basis of hours of employment during the peak quarter of the year.
II = Number on the basis of total hours of employment during all quarters of the year.

c/ All labor, whether hired or supplied to the household by the household, is costed at TL25/hour.

Table A3.3: EFFECTS ON AGRICULTURAL SECTOR GROWTH DUE TO PRODUCTIVITY INCREASE
(% p.a.)

PRODUCTION	
Grains	2.9
of which	
Wheat	1.3
Others	5.3
Pulses	0
Vegetables	0
Fruits and Nuts	2.8
Oil Crops	-0.1
Industrial Crops	1.3
Livestock Products	2.2
TOTAL	1.7
Value Added in Agriculture	1.88
Employment I	.17
II	.22
Value-Added per Worker I	1.68
II	1.64

Appendix 4: TASM BASE MODEL IN GAMS* FORMAT

* General Algebraic Modeling System (World Bank Research Project No. RPO 671-58)

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                                                                      NEW MARGIN = 002-080
     SETS S   LAND TYPES/
          DRY-POOR, DRY-GOOD, DRY-EITHER, IRR-POOR, IRR-GOOD, IRR-EITHER,
          TREE-LAND, PASTURE/

          S1   BASIC LAND TYPES/
          DRY-POOR, DRY-GOOD, IRR-POOR, IRR-GOOD, TREE-LAND, PASTURE/

          S2   LAND WITHOUT RAINFALL DISTINCTION/
          DRY-EITHER, IRR-EITHER/

          L   LABOR/
          LABOR-1Q, LABOR-2Q, LABOR-3Q, LABOR-4Q/

          A   ANIMAL/
          ANIMAL-1Q, ANIMAL-2Q, ANIMAL-3Q, ANIMAL-4Q/

          M   TRACTOR/
          TRACTOR-1Q, TRACTOR-2Q, TRACTOR-3Q, TRACTOR-4Q/

          F   FERTILIZER/
          FERT-N, FERT-P/

          D   SEEDS/
          S-WHEAT,       S-CORN,        S-RYE,         S-RICE,
          S-BARLEY,      S-CHICKPEA,    S-DRYBEAN,     S-LENTIL,
          S-POTATO,      S-ONION,       S-GRPEPPER,    S-TOMATO,
          S-CUCUMBER,    S-SUNFLWR,     S-GRNUT,       S-COTTON,
          S-SBEET,       S-TOBACCO,     S-MELON,       S-PISTACH,
          S-ALFALFA,     S-FODDER/

          O   OUTPUT/
          WHEAT,         CORN,          RYE,           RICE,
          BARLEY,        CHICKPEA,      DRYBEAN,       LENTIL,
          POTATO,        ONION,         GRPEPPER,      TOMATO,
          CUCUMBER,      SUNFLOWER,     OLIVE,         GROUNDNUT,
          COTTON,        SUGARBEET,     TOBACCO,       TEA,
          CITRUS,        GRAPE,         APPLE,         PEACH,
          APRICOT,       CHERRY,        WILDCHERRY,    MELON,
          STRAWBERRY,    BANANA,        QUINCE,        PISTACHIO,
          HAZELNUT,      SOYABEAN,      SESAME,

          S-MUTTON,      S-MILK,        S-WOOL,        S-HIDE,
          G-MUTTON,      G-MILK,        G-WOOL,        G-HIDE,
          A-MUTTON,      A-MILK,        A-WOOL,        A-HIDE,
          BEEF,          COW-MILK,                     C-HIDE
          B-MEAT,        B-MILK,                       B-HIDE,
          P-MEAT,        EGGS/

          G   LIVESTOCK DEMAND FROM CROPS/
          F-WHEAT,       F-CORN,        F-RYE,         F-RICE,
          F-BARLEY,      F-PULSES,      F-ALFALFA,     FODDER,
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        F-FODDER,
        C-WHEAT,      C-RYE,        C-BARLEY,     C-SBEET/

        T   TECHNIQUE/
        ANIMAL, MECHANIZED/

        C   LAND CHOICES/
        DRY-POOR,     DRY-GOOD,     IRR-POOR,     IRR-GOOD/

        I   SINGLE CROP/
        WHEAT-D, WHEATFD, WHEAT-I, CORN--D, CORN--I, RYE---D, RICE--I,
        BARLY-D, BARLYFD, CKPEA-D, CKPEA-I, DBEAN-I, LENTL-D, POTAT-I,
        ONION-D, ONION-I, GPEPP-I, TOMAT-I, CUCUM-I, SUNFL-D, SUNFL-I,
        OLIVE-D, GRNUT-I, COTTN-I, SBEET-I, TOBAC-D, TEA---D, CITRS-I,
        GRAPE-D, GRAPE-I, APPLE-I, PEACH-I, APRIC-I, CHERR-I, WCHER-I,
        MELON-D, MELON-I, STBER-I, BANAN-I, QUINC-I, PISTA-D, HAZEL-D,
        ALFAL-I, FODDR-D, SBEAN-I, SESAM-I/

        I1   TREE CROP/
        OLIVE-D, TEA---D, CITRS-I, GRAPE-D, GRAPE-I, APPLE-I, PEACH-I,
        APRIC-I, CHERR-I, WCHER-I, STBER-I, BANAN-I, QUINC-I, PISTA-D,
        HAZEL-D/

        R   CROP ROTATION/
        R01*R70/

        J   LIVESTOCK/
        SHEEP, GOAT, ANGORA, CATTLE, BUFFALO, MULE, POULTRY/

        Y   YEAR/
        1974*1979/

        E   PRODUCTION COST STRUCTURE/
        LABOR, TRACTOR, FERTILIZER, SEED, CAPITAL/

        SEG      SEGMENT NUMBER/
        1*11/

SET     LM    LABOR AND TRACTOR; LM(L)=YES; LM(M) = YES;

SET     LMF    LABOR TRACTOR AND FERTILIZER; LMF(LM)=YES; LMF(F)=YES;

SET     IO    ALL I-O COEFFICIENTS EXCEPT LAND; IO(L)=YES; IO(A)=YES; IO(M)=YES;
        IO(F)=YES; IO(D)=YES; IO(O)=YES; IO(G)=YES;

SET     IR    SINGLE AND ROTATION CROPS; IR(I1)=YES; IR(R)=YES;

SET     IRJ    ALL PRODUCTION ACTIVITIES; IRJ(IR)=YES; IRJ(J)=YES;
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TABLE IOC       BASIC PRODUCTION COEFFICIENTS

                 WHEAT-D    WHEATPD    WHEAT-I    CORN--D    CORN--I    RYE---D

DRY-POOR                       1
DRY-GOOD            1
DRY-EITHER                                           1                     1
IRR-EITHER                                1                     1

LABOR-1Q           .8         18         1.4        14         88         11.2
LABOR-2Q          4           27.2      28.9        87.4      258.3       32.7
LABOR-3Q          28.3        25.2      45.9        75.6      177.6       22.3
LABOR-4Q          46.4        31.2      52.8                   64.9       29.2

ANIMAL-1Q                     14                    14         88         11
ANIMAL-2Q          2          26         4          19.2       17         32
ANIMAL-3Q         27          24        43           3.6                  21
ANIMAL-4Q         43          30        49                     35         28

FERT-N            75          48.4      60.8        48         66         40
FERT-P            56.7        62.2      67          60         32.5       50

S-WHEAT          193.3       186.8     188
WHEAT              1.55        2         3.4
F-WHEAT            1.85        2.4       4.1
S-CORN                                              60         60
CORN                                                 1.7        4.7
F-CORN                                               3.4        9.4
S-RYE                                                                    185.4
RYE                                                                        1.5
F-RYE                                                                      1.8



+                RICE--I    BARLY-D    BARLYFD    CKPEA-D    CKPEA-I    DBEAN-I

DRY-POOR                                  1
DRY-GOOD                       1
DRY-EITHER                                           1
IRR-EITHER          1                                           1          1

LABOR-1Q                       2.5       8          27         14         19
LABOR-2Q          400          1        38.2        56.4      289        223.7
LABOR-3Q          105        168.1      19.4        88.1      165.2      238.8
LABOR-4Q                      20.1      27.2        28         14         57.7

ANIMAL-1Q                                8          27         14         19
ANIMAL-2Q         100                   38          15         30         44
ANIMAL-3Q          25         95        18           4         15         31
ANIMAL-4Q                     17        26          28         14         40

FERT-N            100         42        40.4        20         27         30
```

FERT-P	50	50	55	50	69	62.5
S-RICE	120					
RICE	4.62					
F-RICE	5.55					
S-BARLEY		250	184			
BARLEY		2.3	2			
F-BARLEY		2.8	2.4			
S-CHICKPEA				140	100	
CHICKPEA				.9	1.8	
F-PULSES				1.1	2.16	2.7
S-DRYBEAN						110
DRYBEAN						1.5

+	LENTL-D	POTAT-I	ONION-D	ONION-I	GPEPP-I	TOMAT-I
DRY-EITHER	1		1			
IRR-EITHER		1		1	1	1
LABOR-1Q	5	16	197	197.6	33	126.9
LABOR-2Q	67.7	315.7	205.6	416.7	331.4	728.8
LABOR-3Q	143.8	324.4	527.2	565.3	1040.2	1067.4
LABOR-4Q	10.4	176.2		48.6		105.3
ANIMAL-1Q	5	16	57	87	33	57
ANIMAL-2Q	33	53		10	68	54
ANIMAL-3Q	52	47	33	44	56	122
ANIMAL-4Q	10	101		27		42
FERT-N	21.3	70.6	60	88.5	110	118
FERT-P	8.3	84	80	102	110	75.5
S-LENTIL	99					
LENTIL	1					
F-PULSES	1.1					
S-POTATO		1555				
POTATO		13.9				
S-ONION			31	22		
ONION			9.2	18.6		
S-GRPEPPER					36000	
GRPEPPER					16	
S-TOMATO						22667
TOMATO						32.4

+	CUCUM-I	SUNFL-D	SUNFL-I	OLIVE-D	GRNUT-I	COTTN-I
DRY-EITHER		1				
IRR-EITHER	1		1		1	1

TREE-LAND				1		
LABOR-1Q	41	35.2	41.8	42.8	59	41
LABOR-2Q	262.9	132.1	104.7	36.1	304	317.8
LABOR-3Q	948.4	21.3	21.9	1.9	353.3	451.6
LABOR-4Q	34		8	139.6	371.5	403.7
ANIMAL-1Q	41	34	38	30.4	57	41
ANIMAL-2Q	19	17	10	30.4	75	131
ANIMAL-3Q	95	19			6	64
ANIMAL-4Q	34		6	19	39	41
FERT-N	90	30	40	7.6	50	160
FERT-P	90	30	40	5.7	50	100
S-CUCUMBER	5.5					
CUCUMBER	16.7					
S-SUNFLWR		10	11.5			
SUNFLOWER		1.15	1.7			
OLIVE				.912		
S-GRNUT					100	
GROUNDNUT					2.4	
S-COTTON						75
COTTON						.925

+	SBEET-I	TOBAC-D	TEA---D	CITRS-I	GRAPE-D	GRAPE-I
DRY-EITHER		1				
IRR-EITHER	1					
TREE-LAND			1	1	1	1
LABOR-1Q	43.4	26	12	711.7	158.7	203.9
LABOR-2Q	470.6	476.5	74	368.6	185.5	279.2
LABOR-3Q	184.6	662.2	55	190	347	417.3
LABOR-4Q	362.9	378.2	15	515.3	77.9	162.4
ANIMAL-1Q	41.7	26		45.6		39
ANIMAL-2Q	28.9	90	2		55	79
ANIMAL-3Q	58.7	15			44	37
ANIMAL-4Q	89.3	20		45.6	28	52
FERT-N	153.4	28	25.9	152	25	50
FERT-P	144.9	21	7.5	152	40	80
S-SBEET	10					
SUGARBEET	40.29					
S-TOBACCO		200000				
TOBACCO		.9				
TEA			6.316			
CITRUS				22.8		

GRAPE					4.029	4.59

+	APPLE-I	PEACH-I	APRIC-I	CHERR-I	WCHER-I	MELON-D
DRY-EITHER						1
TREE-LAND	1	1	1	1	1	
LABOR-1Q	69.9	103.9	107.2	256.5	85.1	11.7
LABOR-2Q	101.2	63.4	419.3	1365.7	340	28.5
LABOR-3Q	220.6	632.5	234.1	58	1151.3	353.8
LABOR-4Q	112.6	101.9	40	30	30	83.5
ANIMAL-1Q				137		10
ANIMAL-2Q	61.6		181	172	244	26
ANIMAL-3Q	74.8	77	9		28	96
ANIMAL-4Q	23.8	39.3				
FERT-N	15.8	6.2	40	50	50	30
FERT-P	30.8	23.1	50	40	80	20
APPLE	5.852					
PEACH		9.81				
APRICOT			4.04			
CHERRY				4.7		
WILDCHERRY					4.35	
S-MELON						6.9
MELON						10.4

+	MELON-I	STBER-I	BANAN-I	QUINC-I	PISTA-D	HAZEL-D
IRR-EITHER	1					
TREE-LAND		1	1	1	1	1
LABOR-1Q	42	102.4	86	66.8	159	113
LABOR-2Q	173.7	1580.6	894	161.5	18	113
LABOR-3Q	320.3	77.5	285	159.4	170	591
LABOR-4Q	16	281	972.5	165.4	154.4	113
ANIMAL-1Q	42				120	
ANIMAL-2Q	58	8.6		93.5	18	
ANIMAL-3Q	98	8.1			10	10
ANIMAL-4Q	16	31.5	127	22.6		
FERT-N	54	24.8	400	27.5		130
FERT-P	63		240	55	20	1.7
S-MELON	4.5					
MELON	18.3					

```
STRAWBERRY                  4.41
BANANA                                 15.6
QUINCE                                            6.16
S-PISTACH                                                    15
PISTACHIO                                                      .38
HAZELNUT                                                                  .9


*            ALFAL-I    FODDR-D    DRY-POOR   DRY-GOOD   IRR-POOR   IRR-GOOD

DRY-POOR                                1
DRY-GOOD                                           1
IRR-POOR                                                      1
IRR-GOOD                                                                 1
DRY-EITHER                  1           1          1
IRR-EITHER        1                                           1          1

LABOR-1Q                   15
LABOR-2Q        85         40.5
LABOR-3Q       185.5       68.5

ANIMAL-1Q                  15
ANIMAL-2Q       50         35
ANIMAL-3Q       33         20

FERT-N          10         30
FERT-P          10

S-ALFALFA       30
F-ALFALFA       11
S-FODDER                  200
FODDER                      1
F-FODDER                    2.1



*            SBEAN-I    SESAM-I

IRR-EITHER        1          1

LABOR-2Q                  188.3
LABOR-3Q       142.3      111.8
LABOR-4Q       257.7       58.9

ANIMAL-2Q                  54.5
ANIMAL-3Q       50.2       21.5
ANIMAL-4Q       61.8       42

FERT-N          60        120
FERT-P                     40
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S-SOYA          15
SOYABEAN         1.6
S-SESAME                  70
SESAME                     1.25



+              SHEEP      GOAT    ANGORA    CATTLE   BUFFALO      MULE   POULTRY

PASTURE         0.17      0.17      0.17      0.5       0.5       0.5

LABOR          11.53     11.53     11.53    142        65        78          .66

ANIMALPOWR                                   40        60       120

WHEAT           4.6       5.0       7.4      18.8      26.2      18.8        .4
CORN            4.6       5.0       7.4      19.0      26.4      19.0        .2
RYE             1.9       2.1       3.2       8.1      11.2      10.7        .1
BARLEY         21.4      23.3      34.4      88.1     122.6      88.4       1.1
FODDER          0.6       0.7       0.7       2.6       3.5       2.9

F-WHEAT       106.0     111.7     123.9     432.5     587.9     484.4
F-CORN         16.5      17.4      19.3      67.3      91.5      75.4
F-RYE           5.8       6.2       6.8      23.9      32.5      26.7
F-BARLEY       36.2      38.2      42.2     147.6     200.7     165.3
F-PULSES        5         5.2       5.8      20.4      27.7      22.9
F-ALFALFA       7.1       7.4       8.3      28.8      39.2      32.3
D-ALFALFA       4.1       4.4       4.8      16.9      22.9      18.9
F-FODDER        3.2       3.4       3.8      13.1      17.8      14.7
D-FODDER        2.2       2.2       2.5       8.7      12         9.8

C-WHEAT        11.4      12.4      18.3      46.9      65.3      47.1        .6
C-RYE            .3        .3        .4       1.1       1.6       1.1        .01
C-BARLEY         .05       .05       .08       .2        .3        .2        .004
C-SBEET        30.2      32.8      48.5     124.2     172.8     124.5       1.6

S-MUTTON        7.34
S-MILK         24.02
S-WOOL          1.29
S-HIDE           .39
G-MUTTON                  6.85
G-MILK                   38.32
G-WOOL                     .6
G-HIDE                     .28
A-MUTTON                            1.77
A-MILK                             15
A-WOOL                              1.58
A-HIDE                               .09
BEEF                                         25.12
COW-MILK                                    217.5
C-HIDE                                        3.3
B-MEAT                                                 32.68
```

416	B-MILK	285.1	
417	B-HIDE	3.02	
418	EGGS		76.37
419	P-MEAT		2.24

TABLE RS CROP ROTATION LAND USE

	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12
DRY-POOR	1	1										
DRY-GOOD				1	1	1	1	1	1	1	1	
DRY-EITHER			1									1
YEAR	2	2	4	2	2	2	2	2	2	2	2	2
WHEAT-D				1	1	1	1	1	1	1	1	
WHEATFD	1											
CORN--D			3	1								1
BARLYFD		1										
CKPEA-D					1							1
LENTL-D						1						
ONION-D									1			
SUNFL-D							1					
TOBAC-D								1				
MELON-D										1		
FODDR-D											1	

+	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24
DRY-GOOD	1	1	1	1	1	1	1					
DRY-EITHER								1	1	1	1	1
YEAR	2	2	2	2	2	2	2	2	2	2	2	2
BARLY-D	1	1	1	1	1	1	1					
CORN--D	1							1				
RYE---D								1	1	1	1	1
CKPEA-D		1							1			
LENTL-D			1							1		
SUNFL-D				1							1	
TOBAC-D					1							1
MELON-D						1						
FODDR-D							1					

CROP ROTATION COEFFICIENTS

+	R25	R26	R27	R28	R29	R30	R31	R32	R33	R34	R35	R36
DRY-GOOD				1	1							
DRY-EITHER	1	1	1									
IRR-GOOD								1		1		1
IRR-EITHER						1	1		1		1	
YEAR	2	2	2	4	5	4	3	4	3	4	3	2
WHEAT-D				2	2							
WHEAT-I								1	1	1	2	1
CORN--I								1				
RYE---D	1	1	1									
RICE--I						3						
DBEAN-I										1		
LENTL-D				1	1							
POTAT-I											1	
ONION-D		1										
GPEPP-I								1				
CUCUM-I										1		
COTTN-I							2					1
SBEET-I								1	1	1		
MELON-D	1											
ALFAL-I									1			
FODDR-D			1	1	1							

+	R37	R38	R39	R40	R41	R42	R43	R44	R45	R46	R47	R48
IRR-GOOD	1			1	1	1	1	1	1	1		
IRR-EITHER		1	1								1	1
YEAR	2	2	3	3	3	3	3	3	4	3	3	2
WHEAT-I	1	1	1	1	1	1	1	1	1	1	1	1
CORN--I										1		
RICE--I								1				
DBEAN-I											1	
POTAT-I					1							1
TOMAT-I			1		1							
SUNFL-I		1		1								
GRNUT-I						2						
COTTN-I							1	1	1	1		
SBEET-I	1			1							1	
MELON-I			1				1		1			
SBEAN-I									1			

+	R49	R50	R51	R52	R53	R54	R55	R56	R57	R58	R59	R60
IRR-GOOD		1			1	1		1		1		1
IRR-EITHER	1		1	1			1		1		1	
YEAR	2	3	3	2	2	2	2	2	2	4	3	1
WHEAT-I	1	1	1	1	1	1	1		1	1	1	.5
CORN--I						1						
RICE--I								1	1			
DBEAN-I												.125
ONION-I							1					
GPEPP-I												.125
TOMAT-I												.125
CUCUM-I												.125
SUNFL-I		1										
COTTN-I		1		1	1	1		1		3		
MELON-I					1						2	
ALFAL-I	1											
SBEAN-I			1	1								
SESAM-I			1									

+	R61	R62	R63	R64	R65	R66	R67	R68	R69	R70
IRR-GOOD	1	1	1				1			
IRR-EITHER				1	1	1		1	1	1
YEAR	1	1	1	2	2	2	3	2	2	2
WHEAT-I				1				1		
CORN--I	.5				1	1			1	
CKPEA-I				1	1					
DBEAN-I	.125	.125	.125				1			
POTAT-I			.5							
ONION-I							1			
GPEPP-I	.125	.125	.125				1			
TOMAT-I	.125	.125	.125							
CUCUM-I	.125	.125	.125							
SUNFL-I		.5								
GRNUT-I						1				
ALFAL-I										1
SESAM-I								1	1	1

```
PARAMETER P   CROP PRODUCTION COEFFICIENTS,     P1 BASIC CROP PRODUCTION COEFF,
     RR   CROP ROTATION LAND USE ;


P1(S,I,T) = IOC(S,I) ;
P1(L,I,'ANIMAL') = IOC(L,I) ;
P1('LABOR-1Q',I,'MECHANIZED') = IOC('LABOR-1Q',I) - 0.90 * IOC('ANIMAL-1Q',I) ;
P1('LABOR-2Q',I,'MECHANIZED') = IOC('LABOR-2Q',I) - 0.90 * IOC('ANIMAL-2Q',I) ;
P1('LABOR-3Q',I,'MECHANIZED') = IOC('LABOR-3Q',I) - 0.90 * IOC('ANIMAL-3Q',I) ;
P1('LABOR-4Q',I,'MECHANIZED') = IOC('LABOR-4Q',I) - 0.90 * IOC('ANIMAL-4Q',I) ;
P1(A,I,'ANIMAL') = IOC(A,I) ;
P1('TRACTOR-1Q',I,'MECHANIZED') = 0.10 * IOC('ANIMAL-1Q',I) ;
P1('TRACTOR-2Q',I,'MECHANIZED') = 0.10 * IOC('ANIMAL-2Q',I) ;
P1('TRACTOR-3Q',I,'MECHANIZED') = 0.10 * IOC('ANIMAL-3Q',I) ;
P1('TRACTOR-4Q',I,'MECHANIZED') = 0.10 * IOC('ANIMAL-4Q',I) ;
P1(F,I,T) = IOC(F,I) ;
P1(D,I,T) = IOC(D,I) ;
P1(O,I,T) = IOC(O,I) ;
P1(G,I,T) = IOC(G,I) ;
P1(S,'TEA---D','MECHANIZED') = 0 ;     P1(IO,'TEA---D','MECHANIZED') = 0 ;

P(S,I1,T) = P1(S,I1,T) ;
P(IO,I1,T) = P1(IO,I1,T) ;
P(S,R,T) = RS(S,R) ;
P(IO,R,T) = SUM(I, RS(I,R)*P1(IO,I,T)) / RS('YEAR',R) ;
RR(O,R) = SUM((S,I)$IOC(O,I), IOC(S,I)*RS(I,R)) ;
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PARAMETERS Q   LIVESTOCK PRODUCTION COEFFICIENTS,
           QQ   INDEX OF LIVESTOCK GRAIN CONSUMPTION/
    WHEAT=1, CORN=1, RYE=1, BARLEY=1/ ;


Q(S,J) = IOC(S,J) ;
Q(L,J) = IOC('LABOR',J) / 4 ;
Q(A,J) = IOC('ANIMALPOWR',J) / 4 ;
Q(O,J) = IOC(O,J) / 1000 ;
Q(G,J) = IOC(G,J) / 1000 ;
```

TABLE YIELD YIELD TIME SERIES (KG/HA)

	1974	1975	1976	1977	1978	1979
WHEAT	1257	1595	1787	1785	1796	1867
CORN	1935	2000	2192	2181	2241	2308
RYE	1068	1379	1477	1412	1417	1428
RICE	3846	4212	4502	4377	4175	4615
BARLEY	1293	1731	1860	1813	1827	1871
CHICKPEA	1114	1229	1241	1304	1220	1125
DRYBEAN	1450	1649	1559	1538	1560	1500
LENTIL	1026	1083	1129	1083	1015	1046
POTATO	12297	13911	15323	15556	15278	16982
ONION	10000	11167	12160	12071	12571	14493
GRPEPPER	10862	11009	11154	14092	14972	16000
TOMATO	26875	28049	32738	33721	30841	32407
CUCUMBER	14783	16167	17000	15714	16964	16667
SUNFLOWER	988	1167	1236	1217	1169	1326
OLIVE	1070	700	1353	490	1356	530
GROUNDNUT	2444	2222	2738	2304	2364	2300
SOYABEAN	2429	1089	1328	1019	1063	1031
SESAME	630	611	584	748	674	578
COTTON	714	716	817	740	727	778
SUGARBEET	30507	32388	37564	36042	31905	36511
TOBACCO	884	828	1027	897	977	929
TEA	4980	5206	5787	7553	8503	10366
CITRUS	21937	22400	21344	23504	20768	22650
GRAPE	4210	4110	4010	4184	4425	4118
APPLE	4939	4639	4823	4257	4788	5786
PEACH	8221	10063	9366	8778	10667	9843
APRICOT	2930	4211	3840	3686	3570	4015
CHERRY	3842	4101	4610	4841	4740	4694
WILDCHERRY	3541	3853	4176	4184	4491	4348
MELON	9897	10996	12371	10474	11395	14350
STRAWBERRY	5006	4765	5143	6000	6000	4400
BANANA	16761	17004	10579	16923	16429	15533
QUINCE	4933	5405	5733	6156	5601	6050
PISTACHIO	96	127	19	154	24	75
HAZELNUT	715	909	689	806	853	784
S-MUTTON	10.60	11.42	10.60	9.38	8.97	6.93
S-MILK	23.7	24.1	24.2	24.2	24.0	23.9
S-WOOL	1.3	1.3	1.3	1.3	1.3	1.3
S-HIDE	0.5	0.6	0.6	0.5	0.6	0.4
G-MUTTON	6.39	7.31	8.68	7.31	6.39	6.85
G-MILK	37.7	38.1	38.2	38.2	38.3	37.8
G-WOOL	0.6	0.6	0.6	0.6	0.6	0.6
G-HIDE	0.2	0.3	0.3	0.3	0.2	0.3
A-MUTTON	1.77	1.77	2.66	2.21	1.77	1.77
A-MILK	14.9	15.2	14.8	15.2	14.8	15.0
A-WOOL	1.6	1.6	1.6	1.6	1.6	1.4
A-HIDE	0.1	0.1	0.1	0.1	0.1	0.1
BEEF	24.59	25.12	21.42	23.00	18.25	25.12

COW-MILK	210.0	208.1	219.8	213.8	214.8	217.5
C-HIDE	3.3	3.4	2.9	3.0	2.6	3.3
B-MEAT	43.73	45.42	40.61	37.21	32.20	32.68
B-MILK	267.1	269.2	263.8	219.6	275.5	285.1
B-HIDE	4.1	3.4	3.0	2.4	2.5	2.6
P-MEAT	2.24	2.24	2.24	2.24	2.24	2.24
EGGS	62.4	62.2	64.2	78.3	76.4	73.3

TABLE PRICE FARM-GATE PRICE TIME SERIES (TL/KG)

	1974	1975	1976	1977	1978	1979
WHEAT	2.30	2.66	2.61	2.89	2.18	5.28
CORN	2.29	2.61	2.66	3.30	4.36	5.91
RYE	1.68	1.91	1.93	2.18	2.95	4.23
RICE	5.18	5.27	5.40	9.35	13.93	18.92
BARLEY	1.88	2.07	2.10	2.41	3.35	4.78
CHICKPEA	5.24	5.40	6.58	11.69	19.96	22.71
DRYBEAN	8.01	9.78	10.43	14.50	26.10	38.76
LENTIL	7.00	7.61	7.71	9.56	13.99	19.27
POTATO	1.96	2.23	3.12	3.36	6.39	10.36
ONION	2.16	2.28	3.15	3.96	6.03	7.17
GRPEPPER	2.60	3.24	4.13	5.12	9.26	11.03
TOMATO	2.07	2.30	2.37	3.91	7.02	8.27
CUCUMBER	2.65	2.54	3.00	4.64	8.28	10.41
SUNFLOWER	4.62	5.22	5.77	7.07	8.21	11.72
OLIVE	5.97	5.82	5.38	8.63	12.37	28.04
GROUNDNUT	9.26	8.65	10.04	14.93	18.32	28.33
SOYABEAN	2.68	3.91	4.40	5.39	8.97	10.34
SESAME	12.97	19.00	15.50	18.50	23.13	73.31
COTTON	21.21	18.16	24.18	28.49	31.03	49.61
SUGARBEET	0.36	0.45	0.57	0.63	0.74	1.11
TOBACCO	19.94	29.91	36.05	45.19	48.00	61.18
TEA	6.25	7.50	8.50	10.00	12.00	14.50
CITRUS	2.81	3.12	3.24	4.56	7.53	10.05
GRAPE	3.93	3.97	4.94	8.35	12.62	19.04
APPLE	3.07	3.50	3.91	5.28	8.95	13.60
PEACH	3.07	3.59	4.35	7.81	11.49	18.92
APRICOT	3.85	4.01	4.62	8.55	11.49	15.20
CHERRY	5.34	5.51	7.61	11.27	13.00	17.31
WILDCHERRY	3.65	4.81	5.42	8.20	16.31	15.68
MELON	1.94	1.76	2.11	3.30	5.67	8.47
STRAWBERRY	2.67	7.74	12.80	20.00	25.00	53.00
BANANA	6.38	13.97	19.49	30.45	38.06	80.69
QUINCE	2.97	3.93	4.22	5.36	10.11	14.43
PISTACHIO	30.94	31.28	36.57	49.72	54.85	111.52
HAZELNUT	11.62	12.76	14.25	15.41	20.88	39.49
S-MUTTON	12.62	13.77	16.94	23.24	37.26	56.90

695	S-MILK	3.58	4.96	5.61	7.63	9.79	17.81
696	S-WOOL	22.02	33.12	44.42	58.52	76.42	169.48
697	S-HIDE	15.60	17.04	16.40	18.51	33.35	60.02
698	G-MUTTON	9.67	10.89	12.44	16.49	26.06	45.26
699	G-MILK	3.15	4.61	5.57	5.82	8.20	12.50
700	G-WOOL	19.90	20.83	24.25	31.41	55.41	99.28
701	G-HIDE	15.60	17.04	16.40	18.51	33.35	60.02
702	A-MUTTON	10.01	11.33	13.38	19.60	28.56	47.40
703	A-MILK	3.15	4.61	5.57	5.82	8.20	12.50
704	A-WOOL	44.78	49.53	64.65	75.70	94.93	268.84
705	A-HIDE	15.60	17.04	16.40	18.51	33.35	60.02
706	BEEF	12.50	13.26	16.60	24.67	32.16	62.13
707	COW-MILK	3.45	4.70	5.48	6.34	10.04	14.30
708	C-HIDE	.46	.35	.40	.52	1.28	2.64
709	B-MEAT	10.80	12.85	14.49	21.18	25.71	60.46
710	B-MILK	3.61	4.76	5.44	6.31	8.78	12.81
711	B-HIDE	.46	.35	.40	.52	1.28	2.64
712	P-MEAT	31.70	36.00	45.80	64.90	107.25	161.50
713	EGGS	0.98	1.13	1.26	1.45	2.18	3.30

```
PARAMETER X   YEAR INDEX/1974=1, 1975=2, 1976=3, 1977=4, 1978=5, 1979=6/ ;
SCALARS SX   SUM OF X/21/,   SX2   SUM OF XX/91/,   EXRATE   EXCHANGE RATE/35/,
        PHI   RISK COEFFICIENT/1/,   PI   MATHEMATICAL CONSTANT/3.141592654/ ;
PARAMETERS SY   SUM OF Y,   SXY   SUM OF PRODUCT X AND Y,
           AR   REGRESSION INTERCEPT,   BR   REGRESSION SLOPE,
           RESID   RESIDUAL,   DEPRICE   DETRENDED PRICE,
           ADJY   ADJUSTED YIELD,   REVCROP   CROP NEG DEVIATION OF REVENUE,
           REVLIVE   LIVESTOCK NEG DEVIATION OF REVENUE,
           DELTA   RISK COEFFICIENT,   NEGDEVOBJ   NEG DEVIATION COST ;


PRICE(O,Y) = PRICE(O,Y) * 1000 / EXRATE ;
SY(O) = SUM(Y, PRICE(O,Y)) ;
SXY(O) = SUM(Y, X(Y)*PRICE(O,Y)) ;
BR(O) = (6*SXY(O) - SX*SY(O)) / (6*SX2 - SX**2) ;
AR(O) = (SY(O)/6) - BR(O)*SX/6 ;
RESID(O,Y) = PRICE(O,Y) - AR(O) - BR(O)*X(Y) ;
DEPRICE(O,Y) = PRICE(O,'1979') + RESID(O,Y) ;

DEPRICE(O,'AVERAGE') = SUM(Y, DEPRICE(O,Y)) / 6 ;
YIELD(O,Y) = YIELD(O,Y) / 1000 ;
YIELD(O,'AVERAGE') = SUM(Y, YIELD(O,Y)) / 6 ;
ADJY(O,IR,Y) = YIELD(O,Y) * P(O,IR,'ANIMAL') / YIELD(O,'AVERAGE') ;
ADJY(O,J,Y) = YIELD(O,Y) * Q(O,J) / YIELD(O,'AVERAGE') ;
ADJY(O,IRJ,'AVERAGE') = SUM(Y, ADJY(O,IRJ,Y)) / 6 ;
REVCROP(Y,IR,T) = SUM(O, DEPRICE(O,Y)*ADJY(O,IR,Y)) -
     SUM(O, DEPRICE(O,'AVERAGE')*P(O,IR,T)) ;
REVCROP(Y,'TEA---D','MECHANIZED') = 0 ;
REVCROP(Y,IR,T)$(REVCROP(Y,IR,T) GT 0) = 0 ;
REVLIVE(Y,J) = SUM(O, DEPRICE(O,Y)*ADJY(O,J,Y)) -
     SUM(O, DEPRICE(O,'AVERAGE')*Q(O,J)) ;
REVLIVE(Y,J)$(REVLIVE(Y,J) GT 0) = 0 ;

DELTA = (PI / 60) ** 0.50 ;
NEGDEVOBJ = PHI * DELTA ;
```

TABLE TRADE 1979 PRODUCTION AND FOREIGN TRADE (1000MT AND $/MT)

	PRO-Q	EXP-Q	EXP-P	IMP-Q	IMP-P	OTH-Q
WHEAT	13205	1231	125,6			607
CORN	1242					680
RYE	807	10	130			399
RICE	225			22,8	383,3	
BARLEY	5000	0,5	141,1			3975
CHICKPEA	285	50	589,1			-10
DRYBEAN	69	0,3	832,6			6
LENTIL	285	108	396,7			-20
POTATO	2870	12,9	171,4			
ONION	1000	76,5	94,7			
GRPEPPER	545	0,4	497,1			
TOMATO	3500	25,6	117,8			92,5
CUCUMBER	500					
SUNFLOWER	590					-39
OLIVE	430	5,4	680			148
GROUNDNUT	57,5	1,4	709,6			
SOYABEAN	3,3					
SESAME	26					
COTTON	476,2	150,6	1751,2			
SUGARBEET	8760					
TOBACCO	206,4	69,6	1908,3			
TEA	555					30
CITRUS	1147	131,5	182,7			
GRAPE	3500	8,1	276,6			302
APPLE	1350	29,7	224,2			
PEACH	220	0,9	210,1			
APRICOT	110					
CHERRY	92					
WILDCHERRY	50					
MELON	5220	23,2	86,9			
STRAWBERRY	22	0,1	830,3			
BANANA	23,3					
QUINCE	45	0,1	184,9			
PISTACHIO	20	0,6	3760			
HAZELNUT	300	7,4	1115,9			282
S-MUTTON	338	31	2220			
S-MILK	1102,2					
S-WOOL	59,3			6	4315,8	
S-HIDE	16,2					
G-MUTTON	103,5	2,8	2220			
G-MILK	571,1					
G-WOOL	9,2	0,3	700,2			
G-HIDE	3,8					
A-MUTTON	6,5	0,2	2220			
A-MILK	54,9					
A-WOOL	5,8	1,5	804,6			
A-HIDE	,3					
BEEF	391	4	1140			

```
COW-MILK          3386.4
C-HIDE              51.6
B-MEAT              34         3        1140
B-MILK             296.6
B-HIDE               2.7
P-MEAT             132        18         762
EGGS              4322.7



PARAMETERS IMPRICE   IMPORT PRICE, IMPINDEX   IMPORT INDEX,
           EXPRICE   EXPORT PRICE, EXPINDEX   EXPORT INDEX ;


IMPRICE(O) = TRADE(O,'IMP-P') ;
IMPINDEX(O)$IMPRICE(O) = 1 ;
EXPRICE(O) = TRADE(O,'EXP-P') ;
EXPINDEX(O)$EXPRICE(O) = 1 ;





TABLE PROCTRADE     TRADE OF PROCESSED PRODUCTS

                 WHEAT   TOMATO   SUNFLOWER   OLIVE      TEA    GRAPE    HAZELNUT

FACTOR             .85      .20        .33      .20      .19      .25         .45
TPRICE      132        604.4   -1183.0     3308   2223.3   1164.5      2699.3
WHEATFLOUR  40
TOMATPASTE           18.5
SUNFL-OIL                         13
OLIVE-OIL                                  29.6
DRY-TEA                                             5.7
RAISIN                                                      75.6
SH-HAZELNT                                                               127



SET  PO   PROCESSED PRODUCTS/
   WHEATFLOUR, TOMATPASTE, SUNFL-OIL, OLIVE-OIL, DRY-TEA, RAISIN, SH-HAZELNT/ ;

PARAMETERS IMPPPIND   IMPORTED PROCESSED PRODUCT INDEX,
           EXPPPIND   EXPORTED PROCESSED PRODUCT INDEX ;


PROCTRADE('FACTOR',O)$(PROCTRADE('FACTOR',O) EQ 0) = 1 ;
IMPPPIND(PO,O)$(PROCTRADE(PO,O) NE 0 AND PROCTRADE('TPRICE',O) LT 0) = 1 ;
EXPPPIND(PO,O)$(PROCTRADE(PO,O) NE 0 AND PROCTRADE('TPRICE',O) GT 0) = 1 ;
PROCTRADE(PO,'PPPRICE') = SUM(O$PROCTRADE(PO,O), PROCTRADE('TPRICE',O)) ;
```

TABLE CONSUME CONSUMPTION DATA

	DEMAND	INCOME	FACTOR	COST
WHEAT	-0.337	0	0.85	47.95
CORN	-0.3	0	0.90	44.55
RYE	-0.2	0	0.90	43.18
RICE	-0.2	0.38	0.65	89.77
BARLEY	-0.25	0		
CHICKPEA	-0.31	0.6		
DRYBEAN	-0.31	0.6		
LENTIL	-0.31	0.6		
POTATO	-0.2	0.3		
ONION	-0.189	0.6		
GRPEPPER	-0.189	0.6		
TOMATO	-0.189	0.6		
CUCUMBER	-0.189	0.6		
SUNFLOWER	-0.302	0.6	0.33	290.18
OLIVE	-0.305	0.6	0.20	290.18
GROUNDNUT	-0.305	0.6		
SOYABEAN	-0.305	0.6	0.18	290.18
SESAME	-0.305	0.6	0.40	290.18
COTTON	-0.3	0.5		
SUGARBEET	-0.303	0.6	0.11	98.50
TOBACCO	-0.3	0.5		
TEA	-0.5	0.5	0.19	241.42
CITRUS	-0.1971	0.75		
GRAPE	-0.13	0.1		
APPLE	-0.14	0.8		
PEACH	-0.14	0.8		
APRICOT	-0.14	0.8		
CHERRY	-0.14	0.8		
WILDCHERRY	-0.14	0.8		
MELON	-0.189	0.6		
STRAWBERRY	-0.14	0.8		
BANANA	-0.14	0.8		
QUINCE	-0.14	0.8		
PISTACHIO	-0.4	0.5		
HAZELNUT	-0.4	0.5		
S-MUTTON	-0.5	1.2		
S-MILK	-0.3	0.95		
S-WOOL	-0.2	1.18		
S-HIDE	-0.365	1.18		
G-MUTTON	-0.5	1.2		
G-MILK	-0.3	0.95		
G-WOOL	-0.2	1.18		
G-HIDE	-0.365	1.18		
A-MUTTON	-0.5	1.2		
A-MILK	-0.3	0.95		
A-WOOL	-0.2	1.18		
A-HIDE	-0.365	1.18		
BEEF	-0.605	0.45		

```
COW-MILK          -0.5       1.75
C-HIDE            -0.365     1.18
B-MEAT            -0.5       0.45
B-MILK            -0.5       1.75
B-HIDE            -0.365     1.18
P-MEAT            -0.605     0.9
EGGS              -0.6       0.85




TABLE CONCENTRAT     CONCENTRATES COEFFICIENTS

            WHEAT   CORN   RYE   RICE   BARLEY   SUNFLOWER   COTTON   SUGARBEET

C-WHEAT      0.15
C-CORN              0.10
C-RYE                      0.10
C-RICE                            0.10
C-BARLEY                                 0.15
C-SUNFLWR                                          0.26
C-COTTON                                                      0.40
C-SBEET                                                                 0.50
```

```
PARAMETERS COSTS     INPUT COSTS (TL PER KG OR HR) AND CAPITAL (TL PER HA) /
*    TRACTOR COST US$ PER HR
*    FERTILIZER COST US$ PER KG

LABOR-1Q            25
LABOR-2Q            25
LABOR-3Q            25
LABOR-4Q            25

TRACTOR-1Q          15
TRACTOR-2Q          15
TRACTOR-3Q          15
TRACTOR-4Q          15

FERT-N                .15714
FERT-P                .1

S-WHEAT              6.5
S-CORN               8
S-RYE                6
S-RICE              24
S-BARLEY             4.5
S-CHICKPEA          32.5
S-DRYBEAN           39
S-LENTIL            18.5
S-POTATO            10.5
S-ONION              7.5
S-GRPEPPER           0.2
S-TOMATO             0.4
S-CUCUMBER         900
S-SUNFLWR           20
S-GRNUT             35
S-COTTON            10
S-SBEET             64
S-TOBACCO            0.02
S-MELON            585
S-ALFALFA           60
S-FODDER            22.5

OLIVE-D           1000
TEA---D          25000
CITRS-I           5000
GRAPE-D           3820
GRAPE-I           4310
APPLE-I           3920
PEACH-I          10810
APRIC-I           5990
CHERR-I           7590
WCHER-I           6730
STBER-I          46470
BANAN-I          72980
QUINC-I           6380
```

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PISTA-D             2000
HAZEL-D             2000    /,

             PCOST   CROP PRODUCTION COSTS,
             QCOST   LIVESTOCK PRODUCTION COSTS,
             TCON   CONSUMPTION OF RAW PRODUCTS,
             DPRI   DEMAND CURVE PRICES,
             ALPHA   DEMAND CURVE INTERCEPT,   BETA   DEMAND CURVE SLOPE,
             PMAX   MAXIMUM PRICE,   PMIN   MINIMUM PRICE,
             QMAX   MAXIMUM QUANTITY,   QMIN   MINIMUM QUANTITY,
             QLEN   QUANTITY LENGTH,   QDEM   DEMAND QUANTITY,
             ODEM   AREA UNDER DEMAND CURVE,   RDEM   AREA UNDER DEMAND CURVE,
             CDEM   DEMAND CURVE INDEX ;


CONSUME(O,'FACTOR')$(CONSUME(O,'FACTOR') EQ 0) = 1 ;

COSTS(L) = COSTS(L) / EXRATE ;
COSTS(D) = COSTS(D) / EXRATE ;
COSTS(I) = COSTS(I) / EXRATE ;
PCOST('LABOR',IR,T) = SUM(L, COSTS(L)*P(L,IR,T)) ;
PCOST('TRACTOR',IR,T) = SUM(M, COSTS(M)*P(M,IR,T)) ;
PCOST('FERTILIZER',IR,T) = SUM(F, COSTS(F)*P(F,IR,T)) ;
PCOST('SEED',IR,T) = SUM(D, COSTS(D)*P(D,IR,T)) ;
PCOST('CAPITAL',I,T) = SUM(S, COSTS(I)*P(S,I,T)) ;
QCOST('LABOR',J) = SUM(L, COSTS(L)*Q(L,J)) ;

*
*      DEMAND CURVES CALCULATIONS
*

TCON(O) = TRADE(O,'PRO-Q') + TRADE(O,'IMP-Q') -
     TRADE(O,'EXP-Q') - TRADE(O,'OTH-Q') ;
DPRI(O) = PRICE(O,'1979') - (CONSUME(O,'FACTOR')*CONSUME(O,'COST')) ;
BETA(O) = DPRI(O) / (CONSUME(O,'DEMAND') * TCON(O)) ;
ALPHA(O) = DPRI(O) - BETA(O) * TCON(O) ;
PMAX(O) = 2 * DPRI(O) ;
PMIN(O) = 0.2 * DPRI(O) ;
QMAX(O) = (PMIN(O) - ALPHA(O)) / BETA(O) ;
QMIN(O) = (PMAX(O) - ALPHA(O)) / BETA(O) ;
QMIN(O)$(PMAX(O) GE ALPHA(O)) = 0 ;
QLEN(O) = (QMAX(O) - QMIN(O)) / 10 ;
QDEM(O,SEG) = QMIN(O) + (ORD(SEG) - 1) * QLEN(O) ;
ODEM(O,SEG) = QDEM(O,SEG) * (ALPHA(O) + 0.50 * BETA(O) * QDEM(O,SEG)) ;
RDEM(O,SEG) = QDEM(O,SEG) * (ALPHA(O) + BETA(O) * QDEM(O,SEG)) ;
QDEM(O,'1')$(PMAX(O) GE ALPHA(O)) = 0 ;
ODEM(O,'1')$(PMAX(O) GE ALPHA(O)) = 0 ;
RDEM(O,'1')$(PMAX(O) GE ALPHA(O)) = 0 ;
CDEM(O,SEG)$QDEM(O,SEG) = 1 ;
```

```
TABLE RESAV     RESOURCE AVAILABILITY (1000 HA, HOURS OR HEADS)

                    TOTAL

DRY-POOR          16047.4
DRY-GOOD           6560
IRR-POOR           1571.9
IRR-GOOD           1221.8
TREE-LAND          2748.8
PASTURE           21745.7

LABOR-1Q        3088451
LABOR-2Q        3088451
LABOR-3Q        3088451
LABOR-4Q        3088451

TRACTOR-1Q        165188
TRACTOR-2Q        165188
TRACTOR-3Q        165188
TRACTOR-4Q        165188

SHEEP              46026
GOAT               15109
ANGORA              3666
CATTLE             15567.1
BUFFALO             1040.3
MULE                2453
POULTRY            58938.7

OLIVE-D              811
TEA---D               53.6
CITRS-I               56.1
GRAPE-D              765
GRAPE-I               85
APPLE-I              233.3
PEACH-I               22.4
APRIC-I               27.4
CHERR-I               19.6
WCHER-I               11.5
STBER-I                5
BANAN-I                1.5
QUINC-I                7.4
PISTA-D              267.1
HAZEL-D              382.9
```

```
EQUATIONS LAND          BASIC LAND CONSTRAINTS
          LANDEITHER    LAND WITHOUT RAINFALL DISTINCTIONS
          LABTRAC       LABOR AND TRACTOR CONSTRAINTS
          ANIMALPWR     ANIMAL POWER BALANCES
          ANIMALINV     ANIMAL INVENTORY
          PURCFERT      PURCHASE OF FERTILIZER
          PRODCOST      PRODUCTION COSTS
          PRODUCTION    PRODUCTION BALANCES
          COMBAL        COMMODITY BALANCES
          CONSUMPTN     CONSUMPTION BALANCES
          LIVFEED       LIVESTOCK FEED BALANCES
          IMPORTL       IMPORT LIMIT
          EXPORTL       EXPORT LIMIT
          PPTRADEL      PROCESSED PRODUCT TRADE LIMIT
          CONVEX        CONVEXITY CONSTRAINTS ON DEMAND CURVES
          TREVENUE      NEGATIVE DEVIATION OVER TIME
          ZIDENTITY     Z IDENTITY
          SURPLUS       OBJECTIVE FUNCTION ;



POSITIVE
VARIABLES CROPS         PRODUCTION OF CROP
          PRODUCT       PRODUCTION OF LIVESTOCK
          LANDC         LAND CHOICES FOR CROPS
          PFERT         PURCHASE OF FERTILIZER
          PRCOST        PRODUCTION COSTS
          TOTALPROD     TOTAL PRODUCTION IN RAW FORMS
          TOTALCONS     TOTAL CONSUMPTION IN PROCESSED FORMS
          DEMFCN        DEMAND CURVES OF CROPS AND LIVESTOCK
          IMPORT        IMPORT OF CROP AND LIVESTOCK
          EXPORT        EXPORT OF CROP AND LIVESTOCK
          PPTRADE       TRADE OF PROCESSED PRODUCT
          TNEGDEV       T NEGATIVE DEVIATION COUNTERS
          SUMNEGDEV     SUM OF NEGATIVE DEVIATION Z ;
VARIABLE  PROFIT        OBJECTIVE FUNCTION ;
```

```
LAND(S1)..          SUM((IR,T), P(S1,IR,T)*CROPS(IR,T)) +
                    SUM(J, Q(S1,J)*PRODUCT(J)) + SUM(C, IOC(S1,C)*LANDC(C))
                    =L=     RESAV(S1,'TOTAL') ;

LANDEITHER(S2)..    SUM((IR,T), P(S2,IR,T)*CROPS(IR,T))      =E=
                    SUM(C, IOC(S2,C)*LANDC(C)) ;

LABTRAC(LM)..       SUM((IR,T), P(LM,IR,T)*CROPS(IR,T)) +
                    SUM(J, Q(LM,J)*PRODUCT(J))      =L=     RESAV(LM,'TOTAL') ;

ANIMALPWR(A)..      SUM((IR,T), P(A,IR,T)*CROPS(IR,T))      =L=
                    SUM(J, Q(A,J)*PRODUCT(J)) ;

ANIMALINV(J)..      PRODUCT(J)     =L=     RESAV(J,'TOTAL');

PURCFERT(F)..       SUM((IR,T), P(F,IR,T)*CROPS(IR,T))      =E=     PFERT(F) ;

PRODCOST(E)..       SUM((IR,T), PCOST(E,IR,T)*CROPS(IR,T)) +
                    SUM(J, QCOST(E,J)*PRODUCT(J))      =E=     PRCOST(E) ;


PRODUCTION(O)..     SUM((IR,T), P(O,IR,T)*CROPS(IR,T)) +
                    SUM(J, (1-QQ(O))*Q(O,J)*PRODUCT(J))    =E=   TOTALPROD(O) ;

COMBAL(O)..         TOTALPROD(O) + IMPINDEX(O)*IMPORT(O)      =E=
                    TOTALCONS(O) + SUM(J, QQ(O)*Q(O,J)*PRODUCT(J)) +
                    EXPINDEX(O)*EXPORT(O) + SUM(PO, EXPPPIND(PO,O)*
                    (1/PROCTRADE('FACTOR',O))*PPTRADE(PO)) ;

CONSUMPTN(O)..      TOTALCONS(O) + SUM(PO, IMPPPIND(PO,O)*PPTRADE(PO))
                    =G=   SUM(SEG, QDEM(O,SEG)*DEMFCN(O,SEG)) ;

LIVFEED(G)..        SUM((IR,T), P(G,IR,T)*CROPS(IR,T)) +
                    SUM(O, CONCENTRAT(G,O)*TOTALCONS(O))
                    =G=     SUM(J, Q(G,J)*PRODUCT(J)) ;


IMPORTL(O)..        IMPINDEX(O)*IMPORT(O)      =L=     TRADE(O,'IMP-Q') ;

EXPORTL(O)..        EXPINDEX(O)*EXPORT(O)      =L=     TRADE(O,'EXP-Q') ;

PPTRADEL(PO)..      SUM(O, (IMPPPIND(PO,O)+EXPPPIND(PO,O))*PPTRADE(PO))      =L=
                    SUM(O, (IMPPPIND(PO,O)+EXPPPIND(PO,O))*PROCTRADE(PO,O)) ;


CONVEX(O)..         SUM(SEG, CDEM(O,SEG)*DEMFCN(O,SEG))      =L=     1 ;


TREVENUE(Y)..       SUM((IR,T), REVCROP(Y,IR,T)*CROPS(IR,T)) +
                    SUM(J, REVLIVE(Y,J)*PRODUCT(J)) +
                    TNEGDEV(Y)     =G=     0 ;
```

```
ZIDENTITY..        SUM(Y, 2*TNEGDEV(Y))   =E=     SUMNEGDEV ;

SURPLUS..          SUM((O,SEG), ODEM(O,SEG)*DEMFCN(O,SEG)) +
                   SUM(O, EXPRICE(O)*EXPORT(O)) - SUM(E, PRCOST(E)) -
                   SUM(O, IMPRICE(O)*IMPORT(O)) - NEGDEVOBJ*SUMNEGDEV +
                   SUM(PO, PROCTRADE(PO,'PPPRICE')*PPTRADE(PO))
                   =E= PROFIT ;

MODEL TURKEY1979 /ALL/ ;
OPTIONS LIMCOL=-1, LIMROW=-1, ITERLIM=4000 ;
SOLVE TURKEY1979 MAXIMIZING PROFIT USING APEX1 ;
```

```
SETS CR   CEREALS/WHEAT, CORN, RYE, RICE, BARLEY/

     FV   FRUITS AND VEGETABLES/
     POTATO, ONION, GRPEPPER, TOMATO, CUCUMBER, CITRUS, GRAPE, APPLE,
     PEACH, APRICOT, CHERRY, WILDCHERRY, MELON, STRAWBERRY, BANANA,
     QUINCE, PISTACHIO, HAZELNUT/

     CTP   COMMODITY TYPES/
     GRAINS, PULSES, VEGETABLES, OIL-CROPS, INDUSTRIAL, FRUITS, LIVESTOCK/

     AG   AGGREGATED OUTPUTS/
     GRAINS.(WHEAT, CORN, RYE, RICE, BARLEY),
     PULSES.(CHICKPEA, DRYBEAN, LENTIL),
     VEGETABLES.(POTATO, ONION, GRPEPPER, TOMATO, CUCUMBER, MELON),
     OIL-CROPS.(SUNFLOWER, OLIVE, GROUNDNUT, SOYABEAN, SESAME),
     INDUSTRIAL.(COTTON, SUGARBEET, TOBACCO, TEA),
     FRUITS.(CITRUS, GRAPE, APPLE, PEACH, APRICOT, CHERRY, WILDCHERRY,
             STRAWBERRY, BANANA, QUINCE, PISTACHIO, HAZELNUT),
     LIVESTOCK.(S-MUTTON, S-MILK, S-WOOL, S-HIDE, G-MUTTON, G-MILK,
                G-WOOL, G-HIDE, A-MUTTON, A-MILK, A-WOOL, A-HIDE,
                BEEF, COW-MILK, C-HIDE, B-MEAT, B-MILK, B-HIDE, P-MEAT,
                EGGS)/

     TDRC   /PRD-VAL, PRD-VAL-X, TRADED-INP, TRAD-INP-X, NON-TR-INP,
         N-TR-INP-X, VAL-ADDED, V-ADD-X, NB, NB-X, DRC-X, EPC, NPC/

PARAMETERS PRICES, PRODACT   PRODUCTION ACCOUNTING, AREA, AVGYIELD, AVGINP ;


PRICES(O,'1979FARMER') = PRICE(O,'1979') ;
PRICES(O,'1979IMPORT') = IMPRICE(O) ;
PRICES(O,'1979EXPORT') = EXPRICE(O) ;
PRICES(O,'MARGINAL') = COMBAL.M(O) ;

PRODACT(O,'1979-PROD') = TRADE(O,'PRO-Q') ;
PRODACT(O,'1979-EXP') = TRADE(O,'EXP-Q') ;
PRODACT(O,'1979-IMP') = TRADE(O,'IMP-Q') ;
PRODACT(O,'MOD-CONSUM') = TOTALCONS.L(O) - CONSUMPTN.L(O) ;
PRODACT(O,'MOD-EXPORT') = EXPORT.L(O) ;
PRODACT(O,'MOD-SURPLS') = CONSUMPTN.L(O) ;
PRODACT(O,'MOD-IMPORT') = IMPORT.L(O) ;
PRODACT(O,'MOD-PRODCT') = TOTALPROD.L(O) ;
PRODACT(PO,'MOD-TRADE') = PPTRADE.L(PO) ;

AVGYIELD(O,'1979') = YIELD(O,'1979') ;
AREA(O) = SUM((I1,T)$P(O,I1,T), CROPS.L(I1,T)) +
     SUM((R,T)$P(O,R,T), CROPS.L(R,T)*RR(O,R)/RS('YEAR',R)) +
     SUM(J$Q(O,J), (1-QQ(O))*PRODUCT.L(J)) ;
AVGYIELD(O,'MODEL') = TOTALPROD.L(O) / AREA(O) ;


DISPLAY PRICES, PRODACT, CROPS.L, AREA, AVGYIELD, DEMFCN.L ;
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PARAMETER PR, NETINCOME, NETIMPORT, DRC, CULTAREA ;

NETINCOME(CTP) = SUM(O$AG(CTP,O), PRICE(O,'1979')*TOTALPROD.L(O)) / 1000 ;
NETINCOME('PRODCTNVAL') = SUM(CTP, NETINCOME(CTP)) ;
NETINCOME(E) = PRCOST.L(E) / 1000 ;
NETINCOME('TOTALCOSTS') = SUM(E, NETINCOME(E)) ;
NETINCOME('NET') = NETINCOME('PRODCTNVAL') - NETINCOME('TOTALCOSTS') ;

NETIMPORT(CTP,'MOD-IMPORT') = SUM(O$AG(CTP,O), IMPRICE(O)*IMPORT.L(O)) / 1000 ;
NETIMPORT(CTP,'MOD-EXPORT') = SUM(O$AG(CTP,O), EXPRICE(O)*EXPORT.L(O)) / 1000 ;
NETIMPORT(CTP,'NET')=NETIMPORT(CTP,'MOD-EXPORT')-NETIMPORT(CTP,'MOD-IMPORT') ;
NETIMPORT('TOTAL','MOD-IMPORT') = SUM(CTP, NETIMPORT(CTP,'MOD-IMPORT')) ;
NETIMPORT('TOTAL','MOD-EXPORT') = SUM(CTP, NETIMPORT(CTP,'MOD-EXPORT')) ;
NETIMPORT('TOTAL','NET')    = SUM(CTP, NETIMPORT(CTP,'NET')) ;


DISPLAY NETINCOME, NETIMPORT ;
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