The Climate Change Impact of Yield changes on Crop Allocation of Land in Adana

-Regional Agricultural Production Model analysis

Hiroshi KAMEYAMA

College of Agriculture, KAGAWA University

2393 Ikenobe Miki-cho Kita-gun, KAGAWA 761-0795, JAPAN

e-mail: kameyama@ag.kagawa-u.ac.jp

1. Introduction

The purpose of this paper is to introduce the primary model framework for regional agricultural production model, focusing on land use by crops. For this purpose, following analysis are carried out in each section.

(1) Basic framework for regional production model
(2) major crops allocation of land in Adana
(3) impacts of climate change
(4) results of impacts

2. Basic framework for regional agricultural production modeling by mathematical programming

2.1 brief behavioral calibration theory

This section based on the references (Howitt 1995a,b). The process of calibrating models to observed outcomes is integral part of constructing physical and engineering models but is rarely formally analyzed for optimization models in agricultural economics. In this section we show that observed behavioral reactions yield a basis for calibrating models in a formal manner that is consistent with microeconomic theory. Analogously to econometrics, the calibration approach draws a distinction between the two modeling phases of calibration (estimation) and policy prediction.

On a regional level, the information on the product output levels and farm land allocations is usually more accurate than the estimates of marginal crop production costs. This is particularly true when micro data on land class variability, technology, and risk feature in the farmers' decisions, but are absent in the aggregate cost data available to the model builder. Accordingly, the PMP (Positive Mathematical Programming) approach uses the observed acreage allocations and outputs to infer marginal cost conditions for each regional crop allocation observed. This inference is based on parameters that are known to be accurately observed and the usual profit maximizing and concavity assumptions.

2.2 Deviation of the calibration Functions

PMP non-linear calibration approach can be applied to any non-degenerate linear problem. The deviation of the general results proceeds in three steps. The first step shows that the dual value on the calibration constraint for the calibrated activity set is equal to the reduced cost of the activity xi in the un-calibrated base problem. The second step shows that if the correct non-linear penalty function is added to the objective function, the resulting nonlinear problem satisfies the necessary conditions for optimality at the required value of each activity level. Finally, it is shown that the correct penalty function has a gradient at the required value of each activity level equal to the negative of the calibration dual.

3. Data

3.1 input-Output coefficients

The input resource requirements of land, labor, machine, water per hectare (Henrichsmeyer and Kasnakoglu 1992)

3.2 value of crop production

The Area sown, yield, production, price, and value (*Agricultural Structure*, State Institute of Statistics 2000). Table 1 shows the value of crop production in Adana as a whole. Table 2 shows that for major crops in Adana, Regarding vegetables and fruits, area data is not available, they are not included in this time.

As in table 1 the share of vegetables and fruits in values of marketable are very high and, based on the trend analysis, are continuingly expected to increase, so area as well.

3.3 Cost and value

Cost data is available for following crops(Budak , Budak and Dagistan 2001).

(1)Cotton, wheat, corn (second crop), watermelon(greenhouse growing), melon (greenhouse growing) in Adana Province.
(2) Grapes, orange, mandarin, lemon in Cukurova and cotton in Kahramanmaras.
(3) variable cost

Table 3 show the production costs and gross margin in Adana.

Regarding groundnut, soybean, water melon, the ratio of variable cost set at around 75%.

3.4 Price elasticity of supply

All set at 1.0.

4. Impacts of Climate Change

Regarding the Climate Change Impacts on crop productivity, several references are available in international modeling frame. Table 4 shows the impact (Tsigas, Frisvold,& Kuhn 1977). The figures in a parenthesis are % change at the world average.

In case of impact which do not account for direct effect of CO_2 on crop growth, rice(-26%), wheat(-16%), other grains(-18%), other grains (-19%). In case of impact which accounts for direct effects of CO_2 on crop growth, rice (-7%), wheat (-6%), other grains (-9%), other crops (6%). Accordingly, here the yield reduction in wheat is set for -15% as impact.

5. Results

As Table 5 the wheat yield reduction (-15%) leads the change to land allocation by crops. Wheat reduces 0.27%, maize reduces 1.57%, cotton reduces 3.3%, where as, groundnut increases 0.90%, soybean no change, water melon increases 6.11% and as total 0.55% reduced.

As further calculation is required to assess the impact of the climate change, the water resource constraints, such as effective rain and irrigation water required, is available (DSI 1988), then Net irrigation water requirements will be able to calculate.

6. References

Budak F., Budak D. B., Dagistan E.,2001: Cost of Agricultural Products in Cukurova, in Part 5, Regional Comparison of Profit and cost *for major agricultural products in Turkey*, (translated into English from Turkish) Agricultural Economics Research Institute.

DSI 1988: Handbook of water requirement for crops by region (in Turkish).

Henrichsmeyer W., and Kasnakoglu H., 1992: Annex 5A, estimation of data related to irrigation, in Agricultural Commodities Marketing Survey Planning of Crop Pattern and Integration of Marketing and Crop Pattern Studies, Republic of Turkey Prime Ministry Southeastern Anatolia Project Regional Development Administration.

Howitt, R. E.,1995a:Positive Mathematical Programming, *Amer. J. of Agr. Econ.*, **77(2)**, pp. 329-42.

Howitt, R. E.,1995b.:A Calibration Method for Agricultural Economic Production Models, *J. of Agr. Econ.*, 46, pp. 147-59.

Tsigas, M., Frisvold G. B., and Kuhn B. 1997: Grobal Climate Change and Agriculture, in Chapter 11 *Global Trade Analysis*, edited by T V. Hertel, Cambridge University Press, pp. 280-304.

SIS 2000: *Agricultural Structure*, State Institute of Statistics.

Table 1 Value of crop production in Adana

	production Ton	value MillionTL	Value of market-able MillionTL	(%)
Field crops	2,144,640	249,647,956	174,818,149	48
Vegetables	868,085	97,005,729	81,005,587	22
Fruit	715,220	119,872,682	108,348,235	30
Total	3,727,945	466,526,367	364,171,971	100

Source: Agricultural Structure(Production, Price, Value), State Institute of Statistics, 2000.

Table 2 Value of crop production (major field crops and) in Adana

Crop	Harvested (ha) ①	Yield (kg/ha) ②	Production (Tons) ③=①*②/1000	Price (TL/kg) ④	Value (Million TL) ⑤=③*④/1000	(%)
Wheat	324,116	3,593	1,164,549	102,295	119,127,518	(42)
Maize	84,617	6,550	554,241	85,111	47,172,036	(17)
Chickpeas	12,705	782	9,935	377,510	3,750,679	(1)
Sugar beat	614	29,155	17,901	36,612	655,398	(0)
Cotton	44,926	3,177	142,730	255,424	36,456,642	(13)
Groundnuts	7,900	3,377	26,678	522,917	13,950,537	(5)
Soybean	7,277	3,035	22,086	144,722	3,196,286	(1)
Watermelon	15,830	41*	641,246	93,667	60,063,589	(21)
Total					284,372,684	(100)

Source: Budak F., Budak D. B., Dagistan E.,2001, and own calculation.

Table 3 Production costs and gross margin in Adana

Crop	Price	Yield	Gross Production Value	Variable cost		Area	Gross Margin	
	1000TL/kg	1000kg/ha	1,000,000TL	Mill TL	(%)	ha	Mill TL	(%)
	①	②	③=①*②	④				
Wheat	102,295	3.598	368,057	288,325	78.3	324,116	25,842,549,800	40
Maize	85,111	6.55	557,477	435,000	78.0	84,617	10,363,640,540	16
Cotton	255,424	3.177	811,482	620,000	76.4	44,926	8,602,522,488	14
Groundnut	522,917	3.377	1,765,891	1,324,400	75.0	7,900	3,487,776,601	5
Soybean	144,722	3.035	439,231	330,000	75.1	7,277	794,875,952	1
water melon	93,667	40.5	3,793,514	2,884,000	76.0	15,830	14,397,598,705	22
Total							63,488,964,086	100

Source: Budak F., Budak D. B., Dagistan E.,2001, and own calculation.

Table 4 Climate change impacts on crop productivity (%)

Commodity	Region CAN	US	MEX	EU	CHN	ASEAN	AUS	ROW	Ave-rage
A. Impacts do not Account for Direct Effects of CO_2 on Crop Growth									
Rice	0	-18	-43	0	-24	-35	-13	-26	-26
Wheat	-12	-21	-53	-12	-5	0	-18	-22	-16
Other grains	-5	-20	-43	-8	-21	-40	-16	-16	-18
Other crops	1	-15	-43	-10	-15	-35	-16	-23	-19
Regional average	-3	-17	-43	-9	-17	-34	-16	-22	
B. Impacts Account for Direct Effect of CO_2 on Crop Growth									
Rice	0	1	-24	0	-3	-8	-12	-8	-7
Wheat	27	-2	-31	8	16	0	8	5	6
Other grains	15	-16	-35	1	-14	-33	5	-3	-9
Other crops	26	14	-18	15	13	-11	9	2	6
Regional average	24	2	-24	11	3	-11	8	-1	

Source: Table 11.2 in Tsigas, M., Frisvold G. B., and Kuhn B. 1997

Table 5 Impact of wheat yield reduction

crop	observed land allocation	simulated land allocation	Change
	ha	ha	(%)
wheat	324,116	323,243	-0.27
maize	84,617	83,292	-1.57
cotton	44,926	43,430	-3.33
groundnut	7,900	7,973	0.92
soybean	7,277	7,277	0.00
water melon	15,830	16,797	6.11
total	484,666	482,012	-0.55

Note: my own simulation result