INTERNATIONAL FARM MANAGEMENT CONGRESS 2003
FARMING AT THE EDGE

CROPPING STRUCTURES ADJUSTMENTS UNDER WATER LIMITATIONS IN THE EGYPTIAN AGRICULTURE

Amin I. Abdou

National Research Centre, Egypt

aminabdou23@yahoo.com

Abstract

Using programming methods, the two models of cropping structures suggested by the study were remarkably different. The first model considered water availability levels , while the second tried to optimize its use. As such, some cash crops were excluded from the second model as water extensive users, such as some kinds of fruits. Hence, the second type models expected net revenues and benefit-cost ratios dropped to nearly one-third the corresponding estimates of the first type, and about 10-20% higher than those of the actual cropping structures in average. Accordingly, encouraging farmers to adopt cropping patterns of rational water use would be in vain unless fortified by taxation tools and guidance toward efficient methods of cost reduction and/or yields promotion.

Introduction

The Egyptian farmer is still struggling to cope with the new situation of governmental ceased intervention , though started over 15 years ago. Farmers are now free in cropping patterns decision making under very few constraints. Even though irrigation water is the most limiting agricultural resource, restrictions on its use are hardly imposed. That is that farmers are not obliged by any means not to produce crops of excessive water use. Nevertheless, with weak flow of necessary marketing information of either inputs or outputs, farmers may not be aware of the best cropping structures they should adopt maximizing their net revenues, which represents their principal goal. Moreover, excessive water use contradicts with the community's ambitions regarding at least agricultural horizontal expansion.

In view of these respects, the study aims to suggest certain cropping structures models for different agronomic zones , such as to maximize the farmers net revenues and simultaneously take into consideration the community's goal of water rational use in favor of development.

Methodology

The study analyzed data was collected within a research project sponsored by NRC(2).The research sites included 4 governorates representing north-, mid- and south- Delta, and upper Egypt. A sample of 190 farmers was selected on basis of stratified sampling according to farm size. Linear programming was applied for both summer and winter seasons. Two models were suggested for each season. The first targeted maximum net revenue constrained by total cultivated area, water availability, total capital excluding credit, and labor supply. The second model considered the water constraint in the objective function through maximizing the net revenue per unit of used water. In both models a specified area for clover was excluded from total area on basis of farm animals needs as a predetermined constraint. Several trials of analysis using approximated linear and gradient nonlinear programming methods (6,10) were performed to reach the study's results.

First model:

$$\text{Max } NR^* = \sum_i nr_i \; x_i$$

$$\text{sub to } \; X^* \geq \sum_i x_i, \; C^* \geq \sum_i c_i x_i, \; L^* \geq \sum_i l_i x_i, \; W^* \geq \sum_i w_i x_i, \; x_i \geq 0 \text{ for all } i$$

Second model:

$$\text{Max } NRW^* = \sum_i (nr/w)_i \, x_i$$

$$\text{sub to } \; X^* \geq \sum_i x_i, \; C^* \geq \sum_i c_i x_i, \; L^* \geq \sum_i l_i x_i, \; x_i \geq 0 \text{ for all } i$$

where NR^* = total net revenue per region.
X^* = total agricultural area minus clover allowance.
C^* = total capital for X^* production.
L^* = total labor mandays available.
W^* = total irrigation water available per region.

Results

Suggested cropping structure models: As shown in table (1), the suggested cropping structures are generally charracterised by diversification less than the actual. Likewise, except the case of mid Delta where both model types were identical, the second type suggested less production of crops of excessive water use, as anticipated and coinciding with results of former studies. Such crops were rice in north Delta, bananas, oranges and apricots in south Delta, and bananas in upper Egypt. However, in addition to bananas, compared with other fruits, potatoes produced in either seasons was the most distinguished crop within the suggested models for both north and south Delta, reaching 9 times its actual area in summer for the last region. On the other hand, maize was excluded from the suggested models, and so was wheat, despite governmental support, in most cases except mid-Delta as facing only weak competition from both broad beans and sugar beets. It is also remarked that due to wide variations among agronomic zones crops like cotton are excluded are excluded from some models and included in others.

<u>Suggested models economic assessment</u>: Table(2) presents a comparison between actual and suggested cropping models for the selected regions. Superiority of the suggested models varied among the different regions, seasons and criteria. Likewise, the first model seems more appealing to the producer as being more profitable. In most cases the first type models seem more appealing to the producers as more profitable. With exception of the upper Egypt models and summer season models of north Delta, only moderate net revenue increases occurred ranging 4-27%. Superiority of the suggested models was less apparent using benefit-cost ratios especially for the winter season of upper Egypt where the net revenue more than tripled while the benefit-cost ratio increased by only52%.

Table(1)-. Crops area percent of total cultivated area for the suggested models compared to the actual (%)

Region	winter season				summer season			
	Crops	actual	model 1	model 2	Crops	actual	model 1	model 2
North-Delta (Behera)	wheat	40.8	51.4	0	rice	36.9	50	0
	b.beans	11.5	0	65.1	cotton	21.5	0	0
	potatoes	13.1	24.1	10.4	maize	21.4	0	0
	tomatoes	10.4	0	0	potatoes	11.4	50	100
	clover	24.5	24.5	24.5	French harricots	8.8	0	0
Mid-Delta (Kafr El-Shiekh)	wheat	40.4	50	50	rice	64.4	100	100
	b.beans	4.8	0	0	cotton	27.3	0	0
	sugar – beet	33.9	0	0	maize	8.1	0	0
	clover	20.8	50	50				
	wheat	18.8	0	0	potatoes	6.7	13.5	16.5
	b.beans		0	0	maize	25.2	0	0

South-Delta (Kalubia)	potatoes clover oranges bananas apricots pears	1.9 3.8 13.5 29.1 18.7 13.5 0.7	0 13.5 0 86.5 0 0	35.5 13.5 0 51 0 0	squash oranges bananas apricots pears	6.1 29.1 18.7 13.5 0.7	0 0 86.5 0 0	32.5 0 51 0 0
Upper-Egypt (Asuit)	wheat onions chick-peas clover bananas	46.3 15 16.4 16.3 6	0 37.5 0 16.3 46.3	0 83.7 0 16.3 0	cotton maize sorghum bananas	46.3 30.5 17.2 6.0	53.7 0 0 46.3	100 0 0 0

Source: study analysis.

On the other hand, for some of the suggested models , especially for the summer season of the Delta regions, a non-zero slack activity exists for the labor resource , inferring 10-18% saving in labor use, potentially directed to other off-farm activities.

Table (2)- Economic efficiency criteria for the suggested cropping structures models compared to the actual structures

Region	Criterion	winter season			summer season		
		actual	model 1	model 2	actual	model 1	model 2
North-Delta (Behera)	NR% B/C	100 2.59	117 2.79	104 2.72	100 1.7	230 2.39	358 2.39

Mid- Delta (Kafr El-Shiekh)	NR% B/C	100 2.11	138 3.13	138 3.13	100 2.42	127 2.64	127 2.64
South-Delta (Kalubia)	NR% B/C	100 3.02	123 4.39	109 3.52	100 3.21	136 4.76	107 4.31
Upper-Egypt (Asuit)	NR% B/C	100 2.77	311 3.44	154 3.05	100 2.25	264 3.18	119 2.46

NR = net revenue per land unit. B/C= Benefit/cost ratio.
Source: The study analysis.

Discussion and conclusions

Several earlier studies (3,5,9,11) showed that cropping structures constrained by water limitations and tend to economize its use render 30-50% less net revenue than resulted otherwise. Hence, it is logically accepted that the suggested models of the study provide only moderate rise in net revenues over the actual structures. Such result is intuitively apparent for the second type models which are not only constrained by water availability but also tend to maximize the economic efficiency of its use. Such tendency sacrifices a noticeable proportion of gained revenues. For example, net revenues in the upper-Egypt case dropped to less than one-half as giving up production of bananas which was the sole cash crop produced by the sample of producers for the region. Giving up production of water exhausting crops, like rice and fruits, was expected except in areas were other crops were poorly competitive, such as the case of mid-Delta where cotton and maize hardly competed with rice. However, cotton's position strongly developed in other regions such as upper-Egypt against the main cash crop, e.g. bananas, as the last's extensive use of water distorted its competitiveness. On the other hand, two major issues should be considered. First, the suggested models are supposed to maximize the stated objectives under the prevailing conditions of the Egyptian agriculture in the selected areas. That is where some serious infrastructure problems exist, such as high water table and soil salinity. If such problems were efficiently treated the technical coefficients of the input-output relationships would be improved, and someway different results may occur. Second, since irrigation water is not yet priced its economic use would not be among the producers' concerns. Accordingly, the government and other interested parties should resort to means encouraging the farmer to produce less water exhaustive crops, leading as such to more rational use of that scarce resource. Taxation policies and scientific research leading to improved technologies for yields improvement and/or cost reduction for crops of moderate water use would be efficient tools in this respect.

References

1. Abd El-Sadek,G.M. " An Economic Study of Water Resources in The Egyptian Agricultural Economy." Ph.D. thesis ,Cairo University,1994.

2. Abdou,A.I. "Studies on Optimum Cropping Patterns in Old and Newly Reclaimed Lands." Research project no.2/1/1/4/2.final report. NRC, 2000.
3. Ahmad,A.M. " Optimum Cropping Structures Under Contemporary Egyptian Economic Conditions." M.sc. thesis ,Ain-Shams University, 1996.
4. Ahmad,G.E.M. " Economics of Water resources and Infield Irrigation Efficiency in Fayoum Governorate." Ph.D. thesis, Cairo University, Fayoum Branch,1998.
5. Armanuis,S.K. "Economics of Water Resource Use in Egypt." Ph.D. thesis, Almenia University,1997.
6. Baumol,W.J. "Economic Theory and Operations Analysis." 2nd ed., Prentice-Hall of India PVT LTD, New Delhi, 1970.
7. Eid,S.Z. "An Economic Study for Cropping Structures Under Market Economies." Ph.D. thesis, Ain-Shams University, 1997.
8. El-Kheshin,M.G. "An Economic Study for the Egyptian Cropping Structures Under International Economic Contemporary Conditions." Ph.D. thesis, Azhar University, 1992.
9. El-Saadany,R.M. "Egyptian Cropping Structures Under Water Availability."2nd Conference of Agricultural Economics, ESAE, September,1992.
10. Graves,R.L. & R. Wolfe, "Recent Advances in Mathematical Programming." McGraw-Hill Book Company, New York, 1963.
11. Nassar,S.Z. et al. (1995). "Some Factors Influencing Water Efficient Use in Almenia Governorate." Egypt.J.Agr.Econ.,5: (2).
12. Shehata,M.S. "An Economic Study of Water Use in The Egyptian Agriculture." Ph.D. thesis, Ain-Shams University, 1993.