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Full Length Research Paper

Programming, efficiency and management of tobacco farms in Greece

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In the present paper, the possibilities of programming and improving the organization and management of Greek tobacco farms are investigated including issues of great interest since the latest reform of the Common Agricultural Policy (CAP). Primary techno-economical data from 1181 tobacco farms for the period 2005 - 2006 were used. Data Envelopment Analysis (DEA) methodology was applied in order to investigate if the tobacco farms use effectively their inputs, to determine the average efficiency of farms and to investigate whether the scale of operation affects their efficiency. Afterwards, the method of Linear Programming (LP) was applied for the present input organization and for the suggested ones as derived from DEA. According to the empirical results, farms operate under increasing returns to scale, so as consequence is necessary to increase the size of the scale of operation. The technical efficiency is low, while the Eastern-type tobaccos are still hold in the efficient production plans in contrast to Virginia tobacco, which should be replaced with other crops. Finally, new optimal and efficient production plans that will assist the farms to cope with the competitive conditions resulted from the application of the new CAP are presented and useful policy recommendations are derived.

Key words: Optimization, efficient input use, farm management, agricultural policy, tobacco farms.

INTRODUCTION

The tobacco sector is considered as an important agricultural sector for Greece, in a socioeconomic point of view. The great significance of tobacco consists in its cultivation in less favored rural regions of the country (almost 55% of tobacco acreage) where it would be difficult for many other crops to be grown. The high labour requirements of this crop ensure income and employment opportunities to many rural families of these regions (Arfini et al., 2005). It would be difficult for tobacco farmers of these areas to switch to alternative crops or other rural activities, due to the specif characteristics of the soil (CEC, 2003).

The main countries in E.U where tobacco is cultivated are Greece and Italy (FAO, 2007). Its production is concentrated in certain regions of the above countries (Campania, Umbria, Veneto, Central Macedonia and Thraki) (Borresch et al., 2005). It is worth noting that the majority of the EU tobacco farms are in Greece (CEC, 2003). In the whole period 2000 - 2005, the Greek tobacco production and cultivated land were decreased by 9.4 and 13.4% respectively. In 2005, the Greek domestic tobacco production was 123,729 tones and the land cultivated with tobacco was 54,500 hectares (National Statistical Service of Greece, 2006).Leaver (2003) emphasizes the fact that even with significant profit and income decreases, there will be tobacco farmers who will keep growing tobacco. Semos (2000) emphasizes the significance of tobacco production for Greece and Mattas et al. (1999) deduce that if tobacco cultivation is being reduced, great loss in income and reduction in employment would occur, especially where no alternative opportunities exist.

The 2003-2004 CAP (Common Agricultural Policy)

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Reform constitutes a fundamental change in the agricultural policy of the enlarged EU, introducing Single Farm Payment (SFP) which is decoupled from type and quantity of production and is based on fixed historical returns of farmers for the period 2000 - 2002. This reform changes the economic environment in European agriculture, in general, and in the tobacco sector, in particular. According to the decision by the Greek Ministry of Rural Development and Food, tobacco support has been completely decoupled from production since the year 2006 (Ministry of Rural Development and Food, 2007). Moreover, in the tobacco sector, 50% of decoupled farm payments will be directed to restructuring programs under the rural development policy, following the year 2010 (Council Regulation No 1782/2003 and 864/2004).

Arfini et al. (2005) studied the potential consequences of the last CAP reform on tobacco sector of Italy. Their study was based on three possible scenarios: a) 40% decoupling of payments, b) 50% decoupling of payments and c) 100% decoupling of payments. According to their results, if the first scenario was applied, a 50% decrease of tobacco production was expected. The second and third scenarios would have a more significant impact on the tobacco production of the main tobacco growing regions of Italy (up to 95%). In their study, a reorganization of farms is proposed either by expanding the other crops in their production plan (mostly wheat) or by introducing alternative crops in it.

The measurement of tobacco farms efficiency and the development of efficient farms are of great significance, especially since the latest reform of CAP. Karagiannis and Sarris (2005), Using the parametric approach, estimated technical and scale efficiency of tobacco farms in Greece during the period 1991 - 1995. They concluded that technical efficiency is lower than scale efficiency (69% and 93%, respectively) and thus the greater portion of overall inefficiency is attributed to the fact of producing below the production frontier.

Galani et al. (2007) estimated technical and scale efficiency of tobacco farms in Greece, using the non-parametric approach, in the period 2000 - 2002. They found that overall technical efficiency is 65%, pure technical efficiency is 74% and scale efficiency is 88%. According to the results of their research, there are ample possibilities for improving technical efficiency through input reorganization. Yet, the main conclusions of their research are derived from the potential profitability improvement of farms after the input reorganization. Tobacco farms could reduce their relative high production expenses by input reorganization and this reduction could increase significantly the profitability of farms, raising the proportion of profitable farms, at the same time.

The present study compared to previous ones, takes into account the differences that may be observed between the farms with Eastern and American-type tobaccos as well as between the different regions of the country. According to our knowledge, this is the first attempt of contemporaneous investigation of efficiency and optimal production plans, separately for the eastern and American type tobaccos for each tobacco growing region. It is explored whether the tobacco sector remains in the efficient and optimal production plans of each region. In the cases of substitution, alternative crops that maximize the gross margin of farms are suggested. In addition, an *ex ante* evaluation of the impact of decoupling of payments on the efficiency of farms of the main tobacco growing regions of Greece is attempted.

The specific goals of this research in the aforementioned context separately for the tobaccos of Eastern and American-type and for the main tobacco growing regions of the country are:

- To explore whether the tobacco farms use their inputs in the most efficient way.
- To determine the average efficiency of farms and investigate whether the scale of operation affects the efficiency.
- To explore the impact of payments upon efficiency and (ex-ante) evaluate the consequences of farms functioning in a competitive environment.
- To explore the potentiality of improvement of farm income and gross margin based on the optimal farms (efficient peers) of each area.
- To develop new optimal and effective production plans that will assist farms to cope with the competitive conditions introducing by the new CAP and finally.
- To explore whether the cultivation of tobacco is economically feasible in various areas of Greece, based on the alternative options for each area.

METHODOLOGY

Data Envelopment Analysis (DEA) and Linear Programming (LP) are the methods that have been used for the purposes of this research.

DEA is the methodology applied in order to estimate the relative efficiency of farms that operate under similar conditions and use the same number of inputs to produce identical outputs (Cooper et al., 2000). Their difference lies solely on the quantities of inputs and outputs. It is a non-parametric approach and its mathematical formulation is as follows:

Objective function: $$\text{Max } \theta_j = \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \quad (1)$$

Subject to: $$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1, \ (j = 1, 2, \ldots, n) \quad (2)$$

$$u_r \geq 0, \ (r = 1,2,\ldots,s) \quad (3)$$

$v_i \geq 0$ (i = 1,2,…,m) (4)

Where n = number of farms, j = the farm whose relative efficiency is being measured, m = number of inputs, s = number of outputs, x_{ij} = quantity of input i in farm j, y_{rj} = quantity of output r from farm j, u_r = weight for output r, v_i = weight for input i, θj = relative efficiency of farm j.

Two restrictions are imposed in order to solve the problem: the weights can not be negative {(3) and (4)} and relative efficiency is less than or equal to one (θj≤1) (2) (Ray, 2004). In turn the fractional programming problem can be transformed into a linear programming problem:

Objective function: $\text{Max} = \sum_{r=1}^{s} u_r y_{rj}^{\sim} \sum_{i=1}^{m} v_i x_{ij}$ (5)

Subject to: $\sum_{r=1}^{s} u_r y_{rj}^{\sim} \sum_{i=1}^{m} v_i x_{ij} \leq 0$, (j = 1, 2,…, n) (6),

$$\sum_{i=1}^{m} v_i x_{ij} = 1 \quad (7),$$

While (3) and (4) still hold.

The objective is to maximize function (5), but because of the restriction (7), the aim is to maximize the following function:

Objective function:

$$\text{Max } \theta_j = \sum_{r=1}^{s} u_r y_{rj} \quad (8),$$

Subject to: (3), (4) and

$$\sum_{r=1}^{s} u_r y_{rj} \leq 1 \quad (9)$$

The relative efficiency of farm j is θj and θj≤1 is the imposed restriction. Farm j is efficient when:

$$\sum_{r=1}^{s} u_r y_{rj}^{\sim} \sum_{i=1}^{m} v_i x_{ij} = 0 \rightarrow \sum_{r=1}^{s} u_r y_{rj} = \sum_{i=1}^{m} v_i x_{ij} \rightarrow \sum_{r=1}^{s} u_r y_{rj} = 1 \rightarrow \theta_j = 1$$

On the contrary, when $\theta_j < 1$ farm j is inefficient.

The final conversion in the DEA model is related to the decrease of the restrictions. It is well known that for each primal problem a corresponding dual problem can be expressed using the same data. The solution of either the primal or the dual problem gives the same information concerning the efficiency. The dual problem is formed by corresponding a new dual variable to every restriction of the primal problem. The mathematical expression of the dual model, which is used as it's subjected to fewer restrictions compared to the primal problem, is the following:

$$\begin{aligned} &\min_{\theta,\lambda} \theta \\ &st \quad -y_j + Y\lambda \geq 0 \\ &\quad \theta x_j - X\lambda \geq 0 \\ &\quad \lambda \geq 0 \end{aligned} \quad (10)$$

Where: x_j is the vector of inputs used by the *j* farm, y_j is the vector of outputs produced by the *j* farm, X is the matrix of inputs of all farms in the sample, Y is the matrix of outputs of all farms in the sample and λ is a vector of weights.

Overall Technical Efficiency (OTE) refers to Constant Returns to Scale (CRS) (Charnes *et al.*, 1978) and can be separated into "Pure" Technical Efficiency (PTE) and Scale Efficiency (SE). PTE refers to Variable Returns to Scale (VRS) (Banker et al., 1984) and can be measured if the following restriction is added in the model:

$$\sum_{j=1}^{n} \lambda_j = 1, \quad \{\lambda j \geq 0 \ (j = 1, 2, \ldots, n)\} \quad (11)$$

This restriction ensures that each inefficient farm is being compared with farms of similar size. Scale Efficiency for each farm is measured by the ratio OTE / PTE. A farm with SE = 1 operates in optimal scale, whereas a farm with SE<1 has a sub-optimal size and it either overproduces or under produces compared to its size. To determine whether scale inefficiency can be attributed to increasing or decreasing returns to scale, the Non-Increasing Returns to Scale model (NIRS) can be applied if restriction (11) in the Variable Returns to Scale model is substituted with the following one: $\sum_{j=1}^{n} \lambda_j \leq 1$ (12). If $\theta_{CRS} = \theta_{NIRS} < \theta_{VRS}$ there are increasing returns to scale and if $\theta_{CRS} < \theta_{NIRS} = \theta_{VRS}$, decreasing returns to scale. Relative efficiency measured on the basis of the Constant Returns to Scale model is θ_{CRS}, θ_{NIRS} is for the Non-Increasing Returns to Scale model and θ_{VRS} for the Variable Returns to Scale model, respectively.

Efficiency is measured against feasible frontiers hence the improvement of each inefficient farm is also feasible through better management of inputs. It should be mentioned though that the evaluation is done taking as a benchmark existing technology which is accessible at present to farm units and any currently available but not yet applied technology is not taken into account (Lansink and Reinhard, 2004).

This methodology was originally proposed by Farrell (1957) and has been reformulated in a mathematical way by Charnes et al. (1978) and Banker et al. (1984). DEA has been applied to the agricultural sector to measure, amongst other things, efficiency in horticulture (Iraizoz et al., 2003), in the cotton sector (Shafiq and Rehman, 2000), in the dairy sector (Manos and Psychoudakis, 1997; Fraser and Cordina, 1999), in the sheep sector (Fousekis et al., 2001; Theocharopoulos et al., 2007a), in pig farms (Sharma et al., 1999; Lansink and Reinhard, 2004; Galanopoulos et al., 2006) and in sustainable farming systems (Lansink et al., 2002; Theocharopoulos et al., 2007b).

In this study the input oriented model was used and the measure of input efficiency indicates by how much inputs must be reduced by an inefficient farm, given the level of output. Efficient farms are feasible-models of each tobacco growing area and are of special interest on behalf of farm management. The improvement of every inefficient farm based on the efficient peers is feasible. This is very important since most farmers, during the decision-making process

of farm management, aim in the choice of a production method that minimizes the production cost.

The Linear Programming method (LP) was applied in order to find the (economically) best alternative combination of crops. It is a mathematical method which optimizes a function under specific restrictions. The function is linear as the used restrictions. In the present study a maximization of gross margin is attempted, that is the economic result taking into account the fixed capital of each case (Papanagiotou, 2005).

The mathematical expression of the problem is the following:

$$\sum_{j=1}^{n} c_j x_j = Z = \max \quad (13)$$

$$\sum_{j=1}^{n} \alpha_{ij} x_j \leq b_i \quad (14)$$

$$x_j \geq 0 \quad (15)$$

Where x_j = hectares of the crop j, c_j = gross margin per unit of the crop j, α_{ij} = quantity of the production factor i needed by the crop j, i = number of production factors, j = number of crops, b_i = available quantity of production factor i.

Equation 13 is the function that has to be maximized. Equation (14) is the restrictions or the available quantities of each production factor. Equation (15) expresses the values of x that should not be negative.

Data description and model specification

The present study is focusing on 2 different groups of tobacco farms:

1.) Farms with Eastern-type tobaccos from 3 different areas of the country:

a) Xanthi-Rodopi in Thrace.
b) Pella-Pieria in Central Macedonia.
c) Aitoloakarnania in Western Greece.

2.) Farms with Virginia tobaccos from 2 different areas of the country:

d) Aitoloakarnania in Western Greece.
e) Phthiotida in Central Greece.

The collection of primary data was made with the use of a questionnaire and personal interviews in the farmers during the period of June - October, 2006, referring to techno-economical data of the cultivating period 2005 - 2006. The sample is comprised of 1181 tobacco farms, of which 846 cultivate Eastern-type tobaccos and 335 Virginia tobaccos. Based on the primary data of farms, the following models were specified:

Model 1: This model is comprised of four inputs: human labour measured in hours, land expressed in hectares, annual expenses of variable capital (in euros) and annual expenses of fixed capital (in euros) and two outputs: gross revenue without subsidies (in euros) and farm's subsidies (in euros).

Model 2: This model is comprised of four inputs: human labour measured in hours, land expressed in hectares, annual expenses of variable capital (in euros) and annual expenses of fixed capital (in euros) and one output: gross revenue without subsidies (in euros).

This methodology is applied on the farm level, so in model 1, subsidies that are no longer (after the new CAP) connected with the type and volume of production, are expressed as a separate output. On the contrary, in model 2, subsidies were not included in the output in order to evaluate the 'real' efficiency of farms in the market, and to explore their impact on the efficiency of farms. The two models were overall solved 2362 times (1181*2), varying the data refer to each farm. The values of efficiency derived from the above models ($0 < \theta \leq 1$) were expressed as percentage (%).

With the application of the aforementioned methodology, the improvement of every inefficient farm through input reorganization is feasible, that was initially made, based on the model of Variable Returns to Scale (VRS). This model gives the input decrease at a certain level of outputs and the improvement that can be achieved without altering the scale of operation. In a next stage, input reorganization was performed with the model CRS, where input reduction at a certain level of outputs and improvement of efficiency can be achieved if the scale of operation is altered at the same time.

The present production plan of the average tobacco farm is referred to the sample of farms in each area. In addition, the indices, for the year 2005, of the agricultural structural policy of corresponding country regions were used for the construction of the necessary matrix. In particular, this was performed for the calculation of the gross margin and the other essential techno-economical data (for the problem restrictions), referring to, competitive to the tobacco, alternative crops. Subsidies were not included in the gross margin, since the aim was to find the optimal production plan in the new competitive conditions of the reformed CAP. The restrictions of this model refer to the same production factors used in the DEA method. Regarding the alternative, to tobacco, crops, forthcoming opportunities in the market of each area were located and the potentiality of an important number of (alternative to tobacco) crops to be introduced in the production plan was explored.

DEA and LP, based on the aforementioned models specification, were applied in order to explore whether the optimal production plan remains the same or is altered when farms operate technically efficient and also when they operate at the same time at an optimal scale of operation. In this way, it was possible to develop efficient and optimal production plans for the farms which cultivate tobacco of Eastern-type and for the farms which cultivate tobaccos of the variety Virginia.

EMPIRICAL RESULTS AND DISCUSSION

The application of model 1 showed that the average technical efficiency of the farms with Eastern-type tobaccos is low, varying among the three studied areas between 48.7 and 70.6%. This means, that inputs should be reduced by about 30 - 50%, depending on the area, in order farms to become technically efficient in the given production technology and output level. This input reduction can be accomplished without altering the farm's scale of operation. Average scale efficiency of farms with Eastern-type tobaccos, are 73, 48 and 80.8% for the three samples of farms, respectively. Consequently, farms can be further save inputs provided the size adjustments. To be specific, inputs can be additionally reduced by 27, 52 and 19.2% respectively, as long as farms do the proper size adjustments for a given technology and output level (**Table** 1).

Comparing the average scale and technical efficiency

Table 1. Average technical and scale efficiency[1] of tobacco farms.

Type of Tobacco - Region	Efficiency	Model 1		Model 2	
		Mean	St. Dev.	Mean	St. Dev.
I.A.	Technical	48.7	21.8	43.7	21.6
	Scale	73.0	23.2	35.9	22.7
I.B.	Technical	51.3	23.1	47.8	22.5
	Scale	48.0	26.4	34.2	28.4
I.C.	Technical	70.6	23.4	68.2	22.8
	Scale	80.8	18.3	69.5	21.4
II.D.	Technical	55.1	22.0	45.1	22.4
	Scale	78.4	21.7	56.1	26.3
II.E.	Technical	81.3	21.5	78.6	21.3
	Scale	75.7	23.8	65.2	28.5

Source: Results of the research 1 in percentages (%).

Table 2. Returns to scale of tobacco farms.

Type of Tobacco	Returns to Scale	Model 1		Model 2	
		Frequency (No)	Percentage (%)	Frequency (No)	Percentage (%)
I	Constant	47	5.6	23	2.7
	Decreasing	62	7.3	26	3.1
	Increasing	737	87.1	797	94.2
	Total	846	100.0	846	100.0
II	Constant	32	9.5	17	5.1
	Decreasing	33	9.9	11	3.3
	Increasing	270	80.6	307	91.6
	Total	335	100.0	335	100.0

Source: Results of the research.

of farms with Eastern-type tobaccos, the following results come up: a) overall inefficiency in the area A is ought to 2/3 on the non-rational input management and only 1/3 is due to scale inefficiency, b) overall inefficiency in area B is ought a little more to the scale inefficiency rather on the non-rational input management and c) overall inefficiency in area C is 60% due to a non-rational input management and 40% to scale inefficiency.

Regarding farms which cultivate Virginia tobacco, the application of model 1 showed that the average technical efficiency is quite different between the two areas of the country having the values of 55.1 and 81.3% respectively. This means that inputs should be decreased by 44.9 and 18.7% respectively, in order to have efficient farms, for a given production technology and output level. This input reduction can be obtained without altering the farm's scale of operation. Average scale efficiency of farms is a little higher than 75% and it is similar for both areas, in contrast to technical efficiency. Consequently, further input reduction (22 - 24%) can be obtained if the appropriate scale adjustments are made for a given technology and output level (Table 1). Comparing average scale and technical efficiency, it is concluded that the overall inefficiency in area D is 2/3 due to non-rational input management and 1/3 is ought to scale inefficiency, but in area E, overall inefficiency is mainly ought to scale inefficiency (56.5%).

Model 2 measures the "real" efficiency of farms, as the subsidies are not included in the analysis. From the comparison with the corresponding results derived from the model 1, useful remarks are made regarding the impact of subsidies on the farms efficiency and an ex ante evaluation of the consequences of farms functioning in a pure competitive environment is made. When subsidies are not taken into account, average technical efficiency is decreased between 2.4 and 5% at the three farms groups with Eastern-type tobaccos, and by 2.7 and 10% at the farms groups with Virginia tobaccos. Furthermore, scale efficiency, when subsidies are not taken into account, is reduced between 11.3 and 37.1% at the farms

Table 3. Farm income and gross margin of farms with Eastern-type tobaccos in the current inefficiency level, in the case of technical efficiency (VRS models) and in the case of both technical and scale efficiency (CRS models)[1].

Region-Model	Economic Result[2]	Current	VRS Improvement	CRS Improvement
A: Model 1	Gross Margin of Tobacco	13059.4	14010.1	14137.7
	Gross Margin of Farm	13584.8	17144.3	17801.0
	Farm Income	8699.4	13307.9	14179.5
A: Model 2	Gross Margin of Tobacco	5095.5	6161.8	6520.0
	Gross Margin of Farm	4563.6	8433.0	9760.9
	Farm Income	- 321.9	4703.3	6513.3
B: Model 1	Gross Margin of Tobacco	13338.6	13920.0	14152.5
	Gross Margin of Farm	17672.9	19237.2	19754.5
	Farm Income	14525.0	17564.0	18569.1
B: Model 2	Gross Margin of Tobacco	2708.5	3344.3	3626.6
	Gross Margin of Farm	5314.3	6992.9	7615.9
	Farm Income	2166.4	5407.4	6613.6
C: Model 1	Gross Margin of Tobacco	13725.4	14166.1	14340.6
	Gross Margin of Farm	16840.5	18140.2	18555.3
	Farm Income	11681.5	14033.9	14821.0
C: Model 2	Gross Margin of Tobacco	1263.8	1742.7	2005.1
	Gross Margin of Farm	3066.6	4463.8	5095.2
	Farm Income	- 2092.5	474.0	1709.3

Source: Results of the research 1 on the basis of the efficient peers derived from DEA methodology 2 in euros.

Table 4. Farm income and gross margin of farms with Virginia tobacco in the current inefficiency level, in the case of technical efficiency (VRS models) and in the case of both technical and scale (CRS models)[1].

Model	Economic Result[2]	Current	VRS Improvement	CRS Improvement
I.I.: Model 1	Gross Margin of Tobacco	20289.1	21759.8	21986.7
	Gross Margin of Farm	26692.9	29978.4	30465.4
	Farm Income	17306.0	23691.2	24921.2
I.I.: Model 2	Gross Margin of Tobacco	- 744.4	1135.5	1575.1
	Gross Margin of Farm	3250.8	7405.9	8316.5
	Farm Income	- 6136.1	1844.9	3918.6

Source: Results of the research on the basis of the efficient peers derived from DEA methodology 2 in euros.

groups with Eastern-type tobaccos and by 10.5 and 22% at the two farms groups with Virginia tobaccos (Table 1).

These results show that tobacco farms, in the new competitive environment, can further decrease inputs with a certain level of gross revenue, mostly by proper size adjustments. Subsidies mainly alter the scale efficiency and constrain the potentiality of farms to decrease input and production expenses via adjustment in the scale of operation.

Analysis of the two models demonstrated that the majority of farms are operating under increasing returns to scale (Table 2). This result can be attributed mainly to the small size of Greek farms and it is in agreement with the results of most studies in the agricultural economy of the country. Consequently, besides rational input management, the scale of operation should also be increased, in order for the farms to decrease significantly their production cost. The percentage of farms operating under increasing returns to scale is high and is also changing for farms with Eastern-type tobaccos from 87.1% in model 1 - 94.2% in model 2. Regarding farms with Virginia tobaccos, the corresponding percentage is 80.6% in model 1 and is increased to 91.6% in model 2. This fact implies that the absence of subsidies not only

Table 5. Current, optimal and optimal-efficient production plans of the average farm with Eastern-type tobaccos in the region A.

Crop	Current	Optimal[1]	Optimal[2]	Optimal-efficient
	(ha)	(ha)	(ha)	(ha)
Tobacco Eastern-type	1.706	1.843	1.768	1.789
Soft wheat	2.912	0.000	0.000	0.000
Durum wheat		2.843		2.897
Sunflower	0.000	0.000	2.918	0.000
Other crops	0.068	0.000	0.000	
Total	4.686	4.686	4.686	4.686
Gross Margin (€)	4563.6	6440.8	6491.2	17419.9

Source: Results of the research.
[1] the specific subsidy for energy crops (45 €/ha) is not included in the LP model.
[2] the specific subsidy for energy crops (45 €/ha) is included in the LP model.

Table 6. Current, optimal and optimal-efficient production plans of the average farm with Eastern-type tobaccos in the region B.

Crop	Current	Optimal	Optimal-Efficient
	(ha)	(ha)	(ha)
Tobacco Eastern-type	1.552	0.000	1.990
Soft wheat	0.696		
Durum wheat			0.000
Peach	0.579		
Maize	0.265		
Alfalfa	0.168	0.437	1.374
Oregano	0.000	2.175	0.000
Mentha (Mint)		0.752	
Other crops	0.104	0.000	
Total	3.364	3.364	3.364
Gross Margin (€)	5314.3	20308.5	25305.1

Source: Results of the research.

increases the scale inefficiency but also changes the type of returns to scale of some farms from constant and decreasing to increasing. Consequently, while these farms, with the subsidies, are operating in an optimal or in a greater than the optimal size, in a pure competitive economic environment are operating in a smaller from the optimal size, so they should proceed to a size increase in order to achieve reduction of production cost.

The farm income and the gross margin of farms with Eastern-type tobaccos are presented on (Table 3), in the case of current inefficiency level, in the case of technical efficiency and in the case of both technical and scale efficiency. According to the results of model 1 (including the payments in the outputs), the farm income can be increased depending on the area, from 20 - 53% and the gross margin from 8 - 26%, with the achievement of technical efficiency in input management. If farms, also, make the proper size adjustments, then farm income can be further increased almost by 6% and the gross margin from 2.3 - 3.8%, depending on the area.

According to the results derived from the application of model 2 (excluding the payments from the outputs), for the average farm with Eastern-type tobaccos, the farm income, with a technically efficient input management, has a positive value varying from 474 - 5407 €, depending on the area, while it can be 1709 - 6614 € if farms also make scale adjustments. The gross margin of average farm is increased, depending on the area, from 31.6 - 84.5% if technical efficiency is achieved, and in addition from 8.9 - 15.7%, if scale efficiency is achieved, as well. Correspondingly, the gross margin of tobacco sector is increased, depending on the area, from 20.9 - 37.9% and in addition by 5.8 - 15.1% with scale adjustments (Table 3).

The corresponding results for farms with Virginia tobaccos are presented on (Table 4). According to the results of model 1 (including the payments in the outputs), the farm income and the gross margin of average

Table 7. Current, optimal and optimal-efficient production plans of the average farm with Eastern-type tobaccos in the region C.

Crop	Current	Optimal	Optimal-efficient
	(ha)	(ha)	(ha)
Tobacco Eastern-type	1.122	0.000	0.755
Olive	0.608	1.308	1.308
Alfalfa	0.390	0.000	0.000
Maize	0.290		
Barley	0.000	0.641	0.392
Oregano		0.506	0.000
Other crops	0.045	0.000	
Total	2.455	2.455	2.455
Gross Margin (€)	3066.6	8411.3	8959.5

Source: Results of the research.

Table 8. Current and optimal-efficient* plans of the average farm with Virginia tobaccos.

Crop	Current	Optimal[1]	Optimal[2]	Optimal[3]
	(ha)	(ha)	(ha)	(ha)
Tobacco Virginia	2.038	0.000	0.000	0.000
Olive	0.731			
Alfalfa	0.692			
Maize	0.520		1.612	
Citrus (Mandarin)	0.275	0.650	0.000	0.771
Spinach		0.940		1.270
Lettuce		0.550		0.870
Cabbage		0.479	2.644	0.592
Capsicum (Pepper)		0.000	0.000	0.243
Asparagus				0.510
Other crops				0.000
Cultivated land	4.256	2.619	4.256	4.256
Unused land	0.000	1.637	0.000	0.000
Available land	4.256	4.256	4.256	4.256
Gross Margin (€)	3250.8	25161.3	24495.6	44104.9

Source: Results of the research.*Furthermore, the same optimal plans derived by the LP application with the elimination of technical and scale inefficiency (CRS κα VRS models).[1] Optimal plan under the existing restrictions.[2] Optimal plan under the additional restriction of the cultivation of whole available land.
[3] Optimal plan under the assumption of duplicating the available labour.

farm can be increased by 36.9 and 12.3%, respectively, provided a technically efficient input management. An additional increase of 5.2 and 1.6%, respectively, can be accomplished with the proper size adjustments. The relative increase of gross margin of tobacco sector is 7.2% and an extra 1% with scale adjustment.

According to the results from the application of model 2 (excluding the decoupled payments from the outputs), for the average farm with Virginia tobacco, the farm income from negative becomes 1845 €, provided a technically efficient input management. Additional increase up to the value of 3919 €, can be achieved with the proper size adjustment. Correspondingly, the gross margin of the average farm is increased from 3251 - 7406 € and 8317 € respectively. The gross margin of tobacco sector from negative becomes 1136 and 1575 € respectively (Table 4).

Finally, the present production plan, the optimal production plan with the inefficiency in the production process and the optimal production plan for the average tobacco farm that is technically efficient are presented on the (Tables 5-7), for the three main areas of the country

with Eastern-type tobaccos. The corresponding results for the farms with Virginia tobaccos are presented on (Table 8).

Conclusion and Recommendations

From the results of the present study is concluded that tobacco farms are not using their inputs in the most effective way and they are not take advantage of the sector's know how. The declination from the technically efficient input use is significant, both at Eastern-type and Virginia tobaccos farms. Elimination of inefficiency based on optimal farms (efficient peers) can lead to a significant increase of the farm income and the gross margin of farms. Furthermore, significant differences among the different areas of the country are observed. As a consequence, analysis of the efficiency of the tobacco farms in a regional level gives more accurate results and shows differences that cannot be brought forth with the general efficiency analysis in a national level.

One of the main conclusions of this study is that subsidies seem to confine the ability of farms to reduce their inputs. As a consequence, the excess inputs in the agricultural sector are preserved while at the same time non-appropriate sizes of the tobacco farms are sustained. The finding of increasing returns to scale, both at Eastern-type and Virginia tobacco farms leads to the conclusion that, besides technically optimal management of inputs, an increase of the size of scale of operation is needed in order an additional reduction of production cost to be achieved.

The Eastern-type tobaccos, which in the initial production plan cover 36.4 - 46.1% of the total land of the average farm, remain only to 1 of 3 optimal but not efficient production plans. On the contrary, they remain at all 3 optimal and efficient plans of average farm, with a percentage varying from 31.4 - 59.2% of the total cultivated land. Consequently, if inefficiency is not eliminated, then a substitution of Eastern-type tobaccos with aromatic plants (oregano, mint), energy plants (e.g. sunflower) and grains (wheat, barley) is recommended. The efficiency should be maximized which means optimization of the input/output relation and scale of operation in order the cultivation of eastern type tobaccos to be continued. This leads to new efficient and optimal production plans that include Eastern-type tobaccos while the gross margin of the average tobacco farm becomes the maximum.

On the contrary, tobaccos Virginia do not remain in the optimal production plan. The substitution, with the existing quantity of production factors, will be by horti-cultural plants, citrus trees and other types of trees. However, if the aim of the agricultural policy is the utilization of available lands for agricultural purposes in order not to have, during the reformation process, uncultivated lands, then: a) If the available quantity of the other production factors is constant, corn (or/and alfalfa) and the horticultural plants will be used for the utilization of the available land. In this case, the gross margin will not be so different from the maximum gross margin of the previous case b) If the available labour is increased, then crops of high gross margin and labour demanding (like asparagus) will also be used for the reformation and as a consequence the economic result of farms will be significantly increased.

In terms of policy recommendations, the results of programming and efficiency analysis in a regional level recommend more specific measures than those based on total efficiency in a country level. One of the major goals of the Common Agricultural Policy in the EU is to improve the efficiency in the use of resources. To pursue this goal, findings suggest measures geared towards the improvement of technical efficiency and increase in the size of scale of operation. In the case of Eastern-type tobaccos, this improvement is sufficient for keeping this crop in the production plans. Consequently, in this case, policy measures aiming at the improvement of efficiency must focus on necessary scientific support regarding the efficient use of inputs/outputs. On the other hand, the existing technology which is accessible at present to farms with Virginia tobaccos is not sufficient for keeping this type of tobacco in the optimal and efficient production plans. In this case, the introduction of a new technology is the only way for potential keeping of Virginia tobaccos in the production plans. The new institution of agricultural advisers introduced in the reformed CAP could play an important role in that direction, supported by the network of extension services. However, in the case that the existing technology will not be changed for farms with Virginia tobaccos and efficiency will not be improved for farms with Eastern-type tobaccos, this study propose the kind of crops that should be used in each case for the tobacco substitution (horticultural plants, citrus trees, asparagus, aromatic and energy plants, grains etc).

From the above conclusions and recommendations, it is obvious that the efficiency analysis, separately, for farms with Eastern-type and Virginia tobaccos, provides essential knowledge for policy-makers to implement specific measures in the tobacco sector. Therefore, future research should focus on the "ex-post" analysis of the new CAP on the efficient use of inputs, on the causes of efficiency change on the basis of farm-specific characteristics and on sensitivity analysis on the basis of different alternative scenarios (e.g. for input and output prices).

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