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Competitiveness and Policy Analysis of Potato Production in Oued Souf region: A Policy Analysis Matrix (PAM) approach

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Abstract:
Potato cultivation is one of the most important manifestations of agricultural intensification of Oued Souf. Which necessitated the continuation of this boom by study and analysis. The study used the Policy Analysis Matrix (PAM), one of the most important quantitative analysis tools in this field. To arrive at a set of indicators that assess the role of government policies and accurately determine the comparative advantage and competitiveness of the potato crop in the region.
Keywords: agricultural intensification, policy analysis matrix, comparative advantage, competitiveness.
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Introduction

Oued Souf (Algeria) is an agricultural region despite its desert character. In addition to its national leadership in the production of some crops such as dates and tobacco, the success of the experiment of cultivating peanuts and the intensification of its production in the eighties of the last century, and the signs of the success of the experiment of olive cultivation and production in recent years. The experience of growing potatoes at the beginning of the nineties of the twentieth century, and the expansion and intensification of its production year after year, is truly unique, not only in terms of the expansion of cultivated areas, but even of the continuous increase in the yield of production per hectare. Thus, El-Oued occupies the first place nationally in the volume of production of this crop.

This study will deal with knowing the role of government policies in this agricultural boom in the region, and more precisely the potato crop. Research efforts have been made to create concise, easy-to-measure, and understandable criteria for analysing the impact of agricultural policies on agricultural products. From here arose a new method of agricultural policy analysis, which is the Policy Analysis Matrix of (Monke & Pearson, 1989). The study addresses the main problematic involved in the following fundamental question:

What is the level of comparative and competitive advantage of the potato crop in Oued Souf?

This study included the following hypotheses:

- Potato yield in Oued Souf region has a comparative advantage;
- Potato yield in Oued Souf region has high competitiveness;
- Government policies have played an encouraging and stimulating role for potato production in Oued Souf region.

The importance of this study is demonstrated by knowing the tools and methods of quantitative analysis of an important and strategic sector, namely the agricultural sector. Specifically, assessing and knowing the success of the agricultural policies adopted on the agricultural boom in Oued Souf, especially the potato crop.

1- Theoretical basis:

The policy analysis matrix is a quantitative mathematical, analytical method and used to analyse comparative advantage by measuring the impact of government intervention policies and market distortions on the vertical commodity system or commodity chains from farm to final consumption and export point (Saad, Zhang, & Xia, 2019). (Monke & Pearson, 1989) published their first research using the Policy Analysis Matrix (PAM) in 1989, while

(Picazo, & Estruch,, 2008) used the policy Analysis Matrix to study the profitability of the rice crop in Spain. While (Mohanty & Jagadan, 2003) used a policy analysis matrix to determine the state policy intervention in the cotton crop. Also (AL-Fllujy & Mudh, 2012) used the Policy Analysis Matrix to investigate the impact of state intervention on the fisheries sector in Iraq. On the other hand, (Soejono, Maharani, & Zahrosa, 2020) used the Policy Analysis Matrix to analyse the comparative and competitive advantages of Pronojiwo snake fruit in Indonesia and his farming development strategies to be competitive in the international market.

The PAM is an approach to the analysis of two accounting identities: i) private profit, defining profitability as the difference between revenues and costs; and, ii) social profit, which evaluates the effects of divergences (policy distortions and market failures) as a result of the difference between the parameters observed in the domestic market (private prices) and indices and indicators that would exist if the divergences were removed (social prices) (Monke & Pearson, 1989). The structure of the PAM is comprised of a double entrance accounting system composed of two identities (Table 1).

Table 1. The accounting structure of the Policy Analysis Matrix

	Revenue	Costs		Profit
		Tradable Inputs	Domestic Factors	
Private Price	**A**	**B**	**C**	**D** (1)
Social Price	**E**	**F**	**G**	**H** (2)
Divergence	**I** (3)	**J** (4)	**K** (5)	**L** (6)

(1) Private Profits (D = A – B – C) / (2) Social Profits (H = E –F – G)
(3) Output Transfers (I = A - E) / (4) Input Transfers (J = B – F)
(5) Factor Transfers (K = C –G) / (6) Net Transfers (L = D – H or L = I – J – K)

Source: (Monke & Pearson, 1989)

From the PAM structure indicators can be obtained that allow us to conclude whether or not a determined agricultural system is competitive and has comparative advantages. For this investigation only the first row of the matrix was used (private budget), that is, the analysis at private prices. Therefore, from this row the information that can be obtained is as follows: production costs at private prices (CP=B+C); gains at private prices (D=A-B-C); ratio of private profitability (RRP=D/(B+C)); ratio or efficiency of the private cost (RCP=C/(A-B)), value added to private prices (VAP = A-B / A) (Rebollar-Rebollar, Morales-Hernández, Hernández-Martínez, Guzmán-Soria, & Rebollar-Rebollar, 2011).

To find out comparative and competitive advantages based on the PAM matrix, the formulation is as follows:

a. The Domestic Resource Cost Ratios (DRC) (Elsedig, Mohd, & Fatimah, 2015)**:**

The Domestic Resource Cost Ratios (DRC) provides a measure of the level of comparative advantage achieved by the selected system:

$$\text{DRC} = \frac{Social\ Cost\ of\ Non\ Tradable\ Inputs\ (G)}{Social\ Revenue\ (E) - Social\ Cost\ of\ Tradable\ Inputs\ (F)}$$

Decision criteria:

- DRC <1 means that economic activity is economically efficient in the use of domestic resources or that economic activity has a comparative advantage so that domestic fulfilment is more profitable with an increase in domestic production. Domestic resource investment is beneficial to agricultural production's contribution to international revenue and comparative advantage;
- DRC> 1 means that economic activity is not economically efficient in the use of domestic resources or that economic activity causes comparative losses.

b. The Financial Cost Benefit ratio (FCB) (Mustafa & Quddus, 2012)**:**

The Financial Cost Benefit ratio (FCB) is the value of the domestic factors against the difference between the revenue minus tradable input:

$$\text{FCB} = \frac{Private\ Cost\ of\ Non\ tradable\ Inputs\ (C)}{Private\ Revenue\ (A) - Private\ Cost\ of\ Tradable\ Input\ (B)}$$

Decision criteria:

- FCB <1 it means that the system is profitable;
- FCB > 1 it means that the systems utilize more value of Domestic factors than the Value added, then the system is not profitable;
- FCB = 1 means that the economic activity provides a normal profit or the activity is at a break-even point.

c. The Nominal Protection Coefficient (NPC) (Quddus & Mustafa, 2011):

The Nominal Protection Coefficient (NPC) measures the level of protection for the tradable output by looking at the ratio of revenue at private prices to revenue at social prices:

$$\text{NPC} = \frac{Private\ Revenue\ (A)}{Social\ Revenue\ (E)}$$

Decision criteria:

- NPC <1 it indicates that the main output is undervalued at its private price, resulting in a transfer of wealth from the production system to the economy;
- NPC > 1 it indicates that the system benefits from protection.

d. The Effective Protection Coefficient (EPC) (Zheng, Lambert, Wang, & Wang, 2013)**:**

The Effective Protection Coefficient (EPC) compares the value added at private prices to value added at social prices. This gives us a combined index of the level of trade distortion on both tradable inputs and outputs, and provides a more accurate measure of the level of protection than the NPC:

$$\text{NPC} = \frac{Private\ Revenue\ (A) - Private\ Cost\ of\ Tradable\ Input\ (B)}{Social\ Revenue\ (E) - Social\ Cost\ of\ Tradable\ Inputs\ (F)}$$

Decision criteria:

- EPC <1 it means that the system generates less value added at market prices than it would at social prices, i.e. government does not provide effective protection.;
- EPC > 1 it means that the selected system is protected.

e. The Profitability coefficient (PC) (Souza, Revillion, Waquil, Belarmino, & Lanfranco, 2017)**:**

The Profitability coefficient (PC) measure policy reflection on the profitability of the system:

$$\text{PC} = \frac{Private\ Profits\ (D)}{Social\ Profits\ (H)}$$

Decision criteria:

- PC <1 it means that the economy benefits from net transfers from the system;
- PC > 1 it means that the system benefits from net transfers from the economy.

3. Methodology and Materials:

This section presents the method used in the economic analysis of potato production systems in Oued Souf using the Policy Analysis matrix (PAM) and the data collection and analysis procedures adopted in this research. The variables and data collected were defined based on the definition of the accounting analysis categories and indicators that the Policy Analysis Matrix (PAM) allows, in accordance with the procedures suggested by (Monke & Pearson, 1989), and (Santos Alves, Belarminob, & Padula, 2017).

3.1 Data collection:

Primary and secondary data were used for this study. The primary data were obtained from different processors through observation and interview using a structured questionnaire. Data collected included inputs requirements, market prices for inputs and outputs, transportation cost and returns. The secondary data were sourced from Food and agricultural organisation FAO, the World Bank and the United Nations Conference on

Trade and Development UNCTAD, the data included production subsidy, import and export tariff and the exchange rate.

Agriculture in El Oued despite its desert character, and Oued Souf region in particular, witnessed an expansion of cultivated areas and a historic intensification of some crops, which made El Oued a pioneer at the national level in the production of several plant crops, such as potatoes, dates, tobacco and groundnuts, in addition to a promising future in the cultivation and production of olives and the production of grain. Over the years, potato production in Oued Souf has hit a high pace, beating the national leadership by a wide margin (2016 ،مخزومي).

Since the study population, represented by the farmers of the Oued Souf area for potato crop, is characterized by a great degree of homogeneity because it contains the same natural and demographic characteristics, in addition to the fact that most of the areas and holdings are classified within the category of smallholdings (less than 50 hectares), which made researchers mainly based on primary data that was collected through a simple random sample of 150 potato farmers in the 2019/2020 agricultural season (see Appendix 1.).

3.2 Potato technical coefficients in Oued Souf:

After sorting and classifying the data contained in the questionnaire for this study, it was possible to develop Table 2, which shows the technical coefficients of the potato crop, i.e. the need per hectare of production requirements, and the achieved productivity.

Table 2. Potato technical coefficients 2019/2020

Input	Production factors	Quantity / ha
Tradable	Seeds (kg)	3050
	Chemical fertilizer (kg)	380
	Pesticides (liters)	3
Domestic factors	Land preparation	25
	Irrigation	90
	Crop care	28
	Manual harvesting	60
	Working capital	34000
	Ground Preparation (Machine Hour)	18
	Mechanical harvesting (Machine Hour)	12
	Electricity	21000
	Windbreaks	780
	Manure	3800
Productivity (kg)		28500

Source: authors calculation based on questionnaire data

Due to government intervention policies in support of some crops, the prevailing market prices do not represent social prices (shadow prices), and

since social prices cannot be found directly from the local market, border prices have been reported to, which are the prices of imported goods converted into local currency, which gives approximate numbers of social prices, by calculating Farm gate Import Parity Prices, according to the equation:

$$\text{FIPP} = \text{BP}_{cif} \times \text{ER} + \text{HCP} + \text{TCBM} + \text{IC} - \text{TCFM} - \text{TPC}$$

BP_{cif}: Border import price / ER: exchange rate / HCP: handling costs
TCBM: Transport costs from the border to the market / IC: Insurance costs
TCFM: Transport costs from the farm to the market / TPC: Total Processing costs

Table 3. Farm gate Import Parity Prices of potato in Oued Souf 2019/2020

Export price per ton, fob	323
Transport and insurance Costs up to the port (borders)	137
Import price, CIF	460
Equilibrium exchange rate (DZ / USD)	120
Import price in dinars, CIF	55200
Handling costs from the port to the main warehouses	2250
Total Processing costs	5520
Import Parity Prices	51930
Transport costs from the farm gate to the main warehouses	700
Farm gate Import Parity Prices	51230

Source: authors calculation based on questionnaire data

The export price per ton was determined according to the statistics of the Food and Agriculture Organization (FAOSTAT, 2020). While the transport and insurance cost up to the port, was determined depending on the data of the World Bank (World Bank, 2020), and (United Nations Conference on Trade and Development, 2020). Transport costs from the port to the main warehouses, and transport costs from the farm gate to the main warehouses, were based on the average costs prevailing with the transporters in the region.

4.PAM calculation of Potato in Oued Souf:

Table 4. shows the elements of the first row of the policy analysis matrix for the potato crop, that is, cost, revenue and profit calculated in private prices (market prices).

Table 4. Potato production factors and revenue at private prices

Input	Production factors	Quantity/ha	Unit price	Production factor cost
Tradable	Seeds	3050	78	237900
	Chemical fertilizer	380	70	26600
	Pesticides	3	6500	19500
Total cost of tradable inputs at private prices				284000

Domestic factors	Land preparation	25	1200	30000
	Irrigation	90	600	54000
	Crop care	28	1200	33600
	Manual harvesting	60	1500	90000
	Working capital	34000	/	34000
	Ground Preparation	18	1500	27000
	Mechanical harvesting	12	1500	18000
	Electricity	21000	/	21000
	Windbreaks	780	15	11700
	Manure	3800	45	171000
	Land	1	80000	80000
Total cost of domestic inputs at private prices				570300
Private revenue (A)		28500	41	1168500
private profitability (D)				314200

Source: authors calculation based on questionnaire data

Table 5. shows the elements of the second row of the policy analysis matrix for the potato crop, that is, cost, revenue and profit calculated in social prices.

Table 5. Potato production factors and revenue at social prices

Input	Production factors	Quantity/ha	Unit price	Production factor cost
Tradable	Seeds	3050	66	201300
	Chemical fertilizer	380	56.4	26600
	Pesticides	3	7200	21600
Total cost of tradable inputs at social prices				249500
Domestic factors	Land preparation	25	1200	30000
	Irrigation	90	600	54000
	Crop care	28	1200	33600
	Manual harvesting	60	1500	90000
	Working capital	34000	/	34000
	Ground Preparation	18	1500	27000
	Mechanical harvesting	12	1500	18000
	Electricity	56040	/	56040
	Windbreaks	780	15	11700
	Manure	3800	45	171000
	Land	1	80000	80000
Total cost of domestic inputs at social prices				605340
Social revenue (E)		28500	51.230	1460055
Social profitability (H)				605215

Source: authors calculation based on questionnaire data

If the markets are in perfect competition and the economy is in general equilibrium, then prevailing prices represent social prices. Because these conditions are not available in the market and the Algerian economy due to the government's intervention policy in supporting the agricultural sector, market prices do not represent equilibrium prices, and since social prices cannot be found directly from the local market, which gives approximate figures for social prices, border prices have been used. The social prices of seeds were based on the Farm gate Import Parity Prices of Dutch seed potatoes, while the social prices for fertilizers, medicines and pesticides were based on World Bank data.

As for the prices of local resources, the same special prices were adopted for work due to the difficulty of moving labour in agriculture to an alternative activity in the short term. The same operating hours for mechanization were also adopted as a shadow price, and private prices were adopted as social prices for both land, manure, and windbreaks due to the availability of large areas that could be agricultural reclamation in the region, whose poor sandy land relies heavily on manure from animal and poultry waste.

As for electricity, the average price of the International Energy Agency was adopted in its statistics on energy fees and prices for the Organization for Economic Cooperation and Development (OECD) countries (International Energy Agency, 2019).

Based on the results of Table 4. and Table 5. we can construct Table 6. which represents the Policy Analysis Matrix per hectare of the potato crop calculated in dinars / hectare.

Table 6. Policy Analysis Matrix of Potato in Oued Souf 2019/2020

	Revenue	Costs		Profit
		Tradable Inputs	Domestic Factors	
Private Price	1168500	284000	570300	314200
Social Price	1460055	249500	605340	605215
Divergence	-291555	34500	-35040	-291015

Source: authors calculation based on questionnaire data

The policy analysis matrix provides a direct set of indicators to assess the efficiency and comparative advantages of the system, and it can be summarized in Table 7.

Table 7. Policy Analysis Matrix Indicators of Potato in Oued Souf 2019/2020

Indicator	Equation	Value
Financial Profitability (FP)	[D = A - B - C]	314200
Financial Cost-Benefit Ratio (FCB)	[C / (A - B)]	0.64
Social Profitability (SP)	[H = E - F - G]	605215
Domestic Resource Cost (DRC)	[G / (E - F)]	0.5
Social Cost-Benefit Ratio (SCB)	[(F + G) / E]	0.58
Transfers	[L = I- J - K]	-291015
Nominal Protection Coefficient (NPC)	[A / E]	0.8
Effective Protection Coefficient (EPC)	[(A - B) / (E - F)]	0.73
Profitability Coefficient (PC)	[D / H]	0.52
Producers Subsidy Ratio (PSR)	[L / E]	-0.20
Equiv. Producer Subsidy (EPS)	[L / A]	-0.25

Source: authors calculation based on questionnaire data

We can summarize the most important results of Table 7. in the following points:

- The results indicate that the value of the Financial Cost-Benefit Ratio (FCB) at private prices is equal to 0.64, which is smaller than one. This indicates that the potato production system in Oued Souf is considered competitive;
- The value of the Domestic Resource Cost (DRC) is 0.5, which is smaller than one, which indicates that the potato production system in Oued Souf has a comparative advantage, that is, it uses fewer local resources than the added value;
- The value of the Social Cost-Benefit Ratio (SCB) at social prices equals 0.58, which is smaller than one, indicates that the potato production system in Oued Souf has a comparative advantage, and it is a more appropriate indicator since it takes into account the full cost of production instead of only local factors;
- The Nominal Protection Coefficient (NPC) of 0.8, which is smaller than 1, indicates that the system is not benefiting from protection. Also, the value of Effective Protection Coefficient (EPC) equals 0.73, which is smaller than one, indicates that the system does not benefit from the total level of protection, taking into account the impact of policies on the

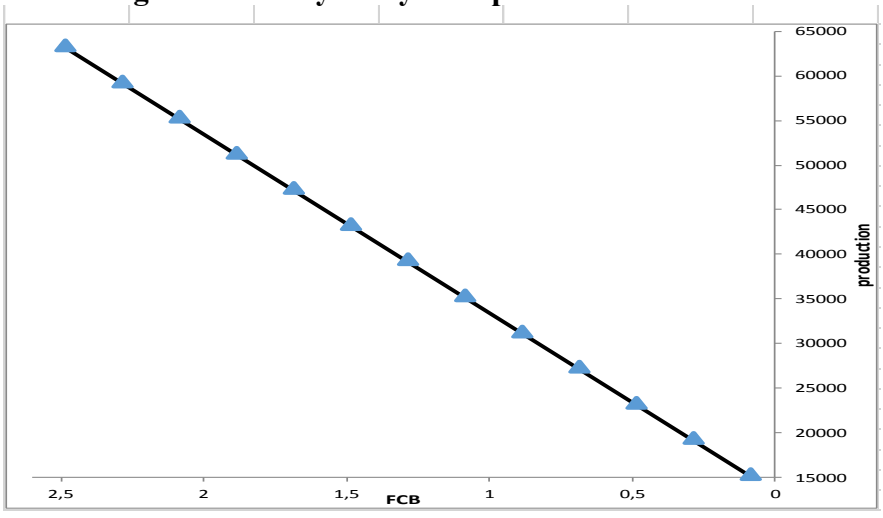
private value of tradable products and supplies;

- The Profitability Coefficient (PC) equals 0.52, which is smaller than one, indicates that the economy benefits by net transfers from the system. Also, the value of transfers is negative (-291015DZD), which means that there are transfers from the system to the economy with this absolute value;
- The value of the Producers Subsidy Ratio (PSR) equals -0.20, and since this value is negative, this means that both the production and the production factors of the potato in the Oued Souf do not enjoy any real support, but rather an adverse price policy that impedes farmers. Also, the value of the Equiv. Producer Subsidy (EPS) is equal to -0.25, which means that there is no support for the producer but rather a support for the consumer with this amount.

5.Sensitivity analysis of potato productivity in Oued Souf:

Sensitivity analysis aims to determine the relationship between the various indicators of the policy analysis matrix and a selected number of different variables to study the role of these variables on the results of the policy analysis matrix and that the results are based on an accurate scientific basis (Mamza, Salman , & Adeoye, 2014). The indicators that can be taken as a reference in the sensitivity analysis of potato are the Financial Cost-Benefit Ratio (FCB), the Domestic Resource Cost (DRC), the Effective Protection Coefficient (EPC), and the Producers Subsidy Ratio (PSR).

Fig.1. Sensitivity analysis of potato based on FCB

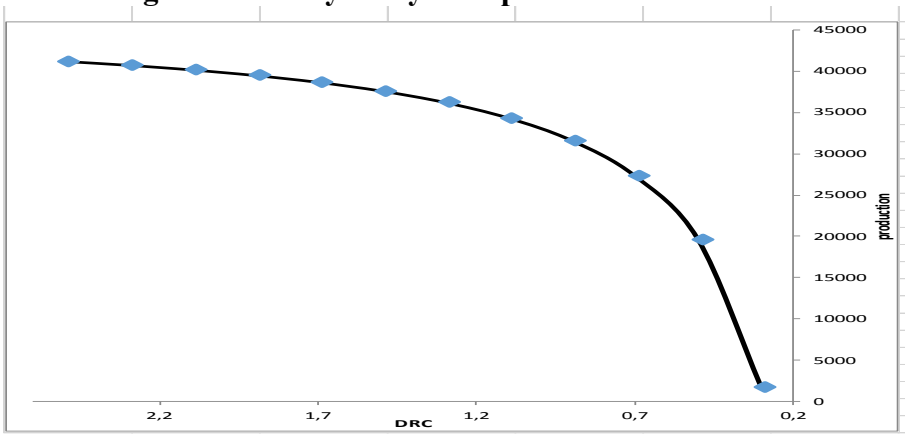


Source: Sensitive add-ins for Excel 2013

There is a positive linear relationship between productivity and the Financial Cost-Benefit Ratio (FCB). The increase in FCB by 0.2, leads to

increasing productivity by more than 4003 kg/hectare.

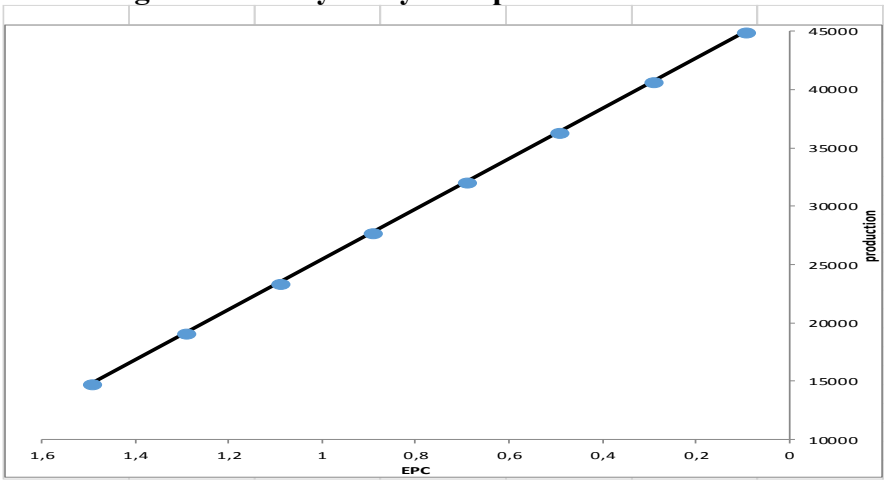
Fig.2. Sensitivity analysis of potato based on DRC



Source: Sensitive add-ins for Excel 2013

Note that the relationship between productivity and the Domestic Resource Cost (DRC) is non-linear. Whereas, the percentage change in productivity resulting from the increase in DRC between 0.7 and 1.3 is more than the percentage change in productivity resulting from the increase in DRC between 1.5 and 1.9, then the rate of increase weakens until it is almost non-existent whenever the value of the indicator increases, and the trend becomes horizontal.

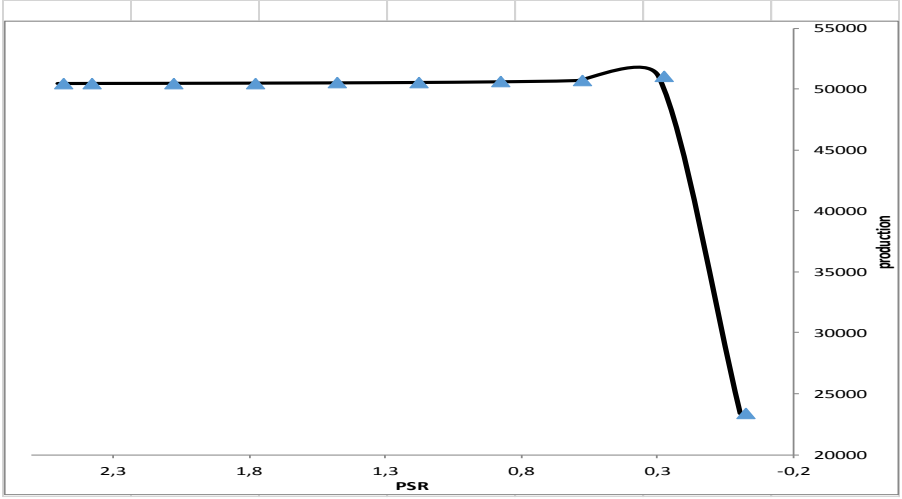
Fig.3. Sensitivity analysis of potato based on EPC



Source: Sensitive add-ins for Excel 2013

There is an inverse linear relationship between productivity and the Effective Protection Coefficient, so that when the value of the coefficient increased by 0.2, the productivity decreased by about 4310 kg/ha.

Fig.4. Sensitivity analysis of potato based on PSR



Source: Sensitive add-ins for Excel 2013

There is a non-linear relationship between productivity and the Producers Subsidy Ratio (PSR). The productivity reaches its highest value when PSR reaches a value of 0.293, then retreats slightly when the value of the indicator equals 0.593, after which the value of productivity remains almost constant no matter how much the value of PSR increases and the trend becomes horizontal

Conclusion

Agriculture in El-Oued, and Oued Souf in particular, witnessed an expansion of cultivated areas and a Historic intensification of some crops, making El-Oued a leading region at the national level in the production of several plant crops, such as potatoes, dates, tobacco, and peanuts, in addition to a promising future in the cultivation and production of olives and cereal production in two periods. Where El-Oued ranks second nationally in the production of dates, and its production of both groundnuts and tobacco is within 40% of the national production, and the national leadership with a large difference in the production of potatoes. This agricultural boom in the region has prompted researchers to try to diagnose and analyse it, and in this context, this study comes as an attempt to quantitative economic analysis using the Policy Analysis Matrix, one of the most important quantitative tools applied in this field, so that the study reaches a set of results that can be summarized as follows:

- The potato production system in Oued Souf region is competitive and has a comparative advantage;
- The potato production system in Oued Souf region does not benefit from

the total level of protection, taking into account the impact of policies on the private value of tradable products and supplies;

- The national economy benefits from net transfers from the potato production system in in Oued Souf region;
- The production and production factors of potato in Oued Souf do not enjoy any real support, but rather an adverse and hindering price policy for farmers, and there is no support for the producer, but rather consumer support in this context.

Based on these results, the following can be recommended:

- Due to its comparative competitive advantage, the government should work to encourage and expand potato cultivation in the region, by facilitating administrative procedures for obtaining agricultural reclamation lands, constructing agricultural paths and connecting electricity, and providing financial support and technical follow-up;
- Based on the findings of the policy analysis matrix, the recommendation is to offer real subsidies to potato farmers in the region so that the producer subsidy ratio (PSR) hits a value of + 0.293 in order to carry production to the maximum value;
- The sustainability of the agricultural expansion of the potato crop in Oued Souf requires the creation of sustainable policy, legal and regulatory frameworks for real estate and agricultural tenure issues;
- Exploiting and employing government intervention and support to direct and encourage farmers in the region on sustainable agricultural practices and the rational and sustainable exploitation of natural resources, especially groundwater.

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