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Full Length Research Paper

Citrus farming in Algeria: Farmers' behavior towards research and extension agenda

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The objective of this paper was to assess the behavior of Algerian citrus farmers with respect to agricultural research under the current extension and research system. Surveys were conducted at technical institute, extension service, and among 75 randomly selected stratified citrus farmers using closed structured questionnaires in 5 selected municipalities in the Blida province. The results of farm-level data analysis showed that identical management and farming practices in citrus farms resulted in variable production. The difference in production was found to be mainly due to the variety of citrus types planted. This fact, in addition to the socio-economic farmers' constraints, suggests that the techniques adopted were non-profitable and highlights the failure of extension activities. At extension level, the socio-economic condition of the agents made them unable to fulfill their extension role. In addition, the agents' lack of experience, training and specialization, financial resources and demonstration plots, hindered the implementation of the extension programs. Furthermore, the agents have no relationships with technical institutes or with agricultural research results. Work and experiments in the experimental stations of technical institutes that led to innovative results were not promoted. As consequences, farmers and sellers of agricultural products are still the primary sources of agricultural information. This first academic study conducted may contribute to implementing appropriate strategies and policies that achieve the development of more viable farming practices in the Algerian citrus orchards.

Key words: Citrus farming, extension and research, agricultural development, Algeria.

INTRODUCTION

Algeria has traditionally been a citrus exporter; however, the structural and organizational instability of the agricultural sector (Laoubi and Yamao, 2009; Bessaoud, 2002; CNES, 2000) has resulted in contrasting trends in agricultural production, with yields that have not progressed since independence (CNES, 2000). In order to up-grade the Algerian citrus farming system and to enhance Algerian agricultural practices in the context of regional trade integration and WTO accession, in 2000 the Algerian government launched the National Agricultural Development Program (PNDA). The PNDA evolved to include a rural dimension in 2002 and became the National Agricultural and Rural Development Program PND- AR). The new agricultural policy objectives aimed for the development and modernization of farms, the intensification and the expansion of irrigated areas, the development of agricultural production and productivity through substantial investments and the appropriate and sustainable use of natural resources. The PNDA was accompanied by supporting measures such as supervision, follow up, evaluation, and technical guidance from extension services.

More than ever, with the implementation of the PNDAR, the agricultural extension program is considered to be an important component of agricultural development, with particular interest from the Ministry of Agriculture and Rural Development.

Indeed, agricultural extension is an essential tool for rural development (Oakley and Garforth, 1985), as it facilitates both the adoption of technology and the adaptation of technology to local conditions (Anderson and Feder, 2003). The adoption of new technologies and new production approaches in farming activities is becoming crucial for countries to meet the challenges of

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rapidly expanding populations and decreasing availability of agriculturally productive land (Umali and Schwartz, 1994). The new agricultural technologies and knowledge are typically developed and validated by research scientists, and the task of extension agencies is to promote the adoption of these technologies by farmers, thereby increasing agricultural productivity (Belay and Abebaw, 2004).

In Algeria, since 1985, several actions and measures have been undertaken regarding agricultural extension. A ministerial Circular No. 1065 of 31/12/1985, has set up a system extension and organizational structure integrating all stakeholders. Executive Decree No. 95-99 of April 1st, 1995, which established a National Institute for the Extension (INVA). Decree No. 96-97 of April 13, 1996, which provided status recognition for extension agents, and as consequence devoted the extension as an important function in agricultural development.

Besides, the Algerian research sector experienced in recent years a remarkable revitalization through the enactment of law and a five year policy program on the scientific research and technological development (Law No. 11/98 in 22/08/1998). This law has brought more to the functioning of the research by the introduction of innovations in management in terms of flexibility and autonomy, and strengthening the research institutions in terms of financial resources, infrastructure and scientific potential. Efforts have been made to strengthen and reorient research programs so that they meet agricultural sector concerns and support needs arising from various development programs (PNDA and PNDAR). These new political orientations and a better analysis of the farmers' needs led the technical institutes to develop a certain number of tools (observations, economic bulletins and participative methods) which contributed to widening their field of competences and activities.

Nevertheless, despite these efforts, to date in Algeria, no academic study has been undertaken to evaluate the linkages between agricultural research and citrus farmers. Also, many questions have arisen regarding the dissemination of the innovations developed by agricultural research among the citrus farmers, including what methods are being used to share innovations among citrus farmers and what impact these innovations have on citrus production and productivity.

Hence, the objective of this study is to assess the behavior of Algerian citrus farmers with respect to agricultural research under the current extension and research system.

METHODOLOGY

Description of the study area

The study was carried out in five municipalities of Blida province, namely, Larbaa, Boufarik, Chebli, Mouzaia, and Oued El Alleug. The province is located in the northern part of Algeria, at a distance of 50 km south west of Algiers, the capital city. The total population, total area, and total agricultural area of the province are 947,278 inhabitants, 1.478,62 km^2 and 132,953 ha, respectively. The climate in the province is generally Mediterranean, characterized by cool, moist winters and hot and dry summers. The average yearly temperature varies from 11.5°C in the winter to 33°C in the summer. The average annual rainfall is around 600 mm; Irrigation water in the province is supplied from the Bouroumi Dam and by groundwater. Citrus orchards in Blida province cove-r an area of 16,422 ha, which represent 26% of the total citrus area in the country (63,296 ha). At the province level, it represents 55% of the total orchard area and 29% of the total utilized agricultural area. The citrus production in the province represents 33.3% (2,298,150 ql) of the country's total production (6,894,670 ql) (MADR, 2007). Therefore, Blida province represents an important source of citrus in Algeria.

Extension in the province

Extension in the province is ensured by the collaboration of various agricultural institutions, such as DSA (direction of agricultural utilities), agricultural subdivision, chamber of agriculture, and technical institutes. The number of extension workers in the province is 38, covering over 25 municipalities. The extension methods currently are accomplished in three ways. Close outreach is the most intensive extension method, with 1,762 sessions, and represents more than 95% of extension sessions. This method is based on individual contact or with groups of farmers through technical seminars (59 sessions, with an average of 26 farmers per day), presentation days (24 sessions with an average of 30 farmers per session), advice visits, and supervision by a network of contact farmers. Of the 1,667 advice visits, 520 were to citrus farmers, with an average of 86 farmers visited per subject. Subjects include setting an orchard and better use of methods of citrus farming practice such as pruning, treatment of trees, and irrigation. The second method of outreach is achieved through scientific and technical events. Five major meetings were held throughout the year, with the participation of technical institutes and the DSA. The themes of the events include training for young investors, biological control, micro-irrigation, and project development. The third extension outreach is accomplished through radio and television.

In addition, interveners and educational materials are also used in extension outreach. The ITAF (Technical Institute for Fruit Trees and Vineyards) is the leading technical institute that operates and leads extension sessions on the setting, managing, and maintaining of citrus orchard based on experimental reports and brochures. The INPV (The National Plant Protection Institute) deals with issues of protection of different crops, such as the curative treatment of diseases in crops. The extension methods at this level are mainly based on the demonstration plot, information days, and tours using slides and brochures from ITAF.

Data collection and analysis

Both secondary and primary data were collected in order to address the objective of this study. Secondary sources included brochures and annual activity reports kept at the ITAF institute. This information would allow us to better understand the technical itinerary of the citrus farming system, and thus to assess the impact of research on the citrus farmers. Primary data were collected both at farm and extension agents' levels. At the farm level and given the lack of a comprehensive list of citrus farmers in the selected municipalities at all levels (agricultural subdivision, DSA, chamber of agriculture), we constructed a list of all farmers from the five municipalities at the chamber of agriculture of Blida (Table 1).

Using a method of stratified random sampling, we divided the farm list data base (Table 1) into strata by land ownership and farm

Table 1. Distribution of farms in the 5 municipalities of Blida province.

Type	EAC[1]						EAI[2]		Private		FP[3]	Total
Size (ha)	<5	5 - 10	11 - 15	16 - 20	21 - 25	>25	<5	6 - 10	<5	>5		
Larbaa	20	25	12	15	9	8	7	0	11	6	-	113
Boufarik	21	30	15	13	9	7	10	4	9	7	-	125
Chebli	13	20	23	20	13	10	9	1	21	7	-	137
Mozaia	68	59	13	10	11	2	10	3	7	1	2	186
Oued El Alleug	19	34	30	24	10	7	40	3	15	8	2	192

1: EAC: Collective state farm, 2: EAI: Individual state farm, 3: FP: Pilot farm. Field survey, 2008-2009.

size, and we then randomly selected the farms from within each stratum. This ensured a sufficient number of observations for each strata group.

Therefore 75 farms (10% of the total population) were selected from the five municipalities, and the size of the sample selected from each group is shown in Table 2. The 75 farms include 55 EAC (collective state farms), 8 EAI (individual state farms), 10 Private (private farms), and 2 PF (pilot farms) (Table 2).

Surveys were conducted on the selected 75 farms between October 2008 and January 2009. A well-structured questionnaire developed with the assistance of the agricultural subdivision and in collaboration with the researchers of INRA (National Institute of Agricultural Research), was used to interview face to face with the heads of the EAI and private farms and the heads or representtatives of the collective EAC farms. The questionnaire included quantitative and qualitative questions. Topic areas included the farm and its socio-economic environment, the practices of citrus farmers, the farmers' interest in information, and the relationship between farmers and extension agents.

At extension level, survey has been conducted face to face with communal extension agents in the five selected municipalities (one agent from each municipality) using a well structured questionnaire, including qualitative and quantitative questions about their social conditions, extension programs, and the choice of themes and diffused topics presented by the organization.

The collected data from the survey was entered into a computer and analysis was done using the SPSS package (version 15.0). Descriptive statistics including frequencies, percentages and means were used to summarize the information. Tabular technique was used to classify the data and derive meaningful findings by using arithmetic means and percentages.

RESULTS AND DISSCUSSION

Socioeconomic characteristics of the farmers

The socioeconomic characteristics of respondent farmers are presented in Table 3; indicating that the average age of 75 farmers is 50 years old, and over 80% of farmers have an age above 40 years old. Young farmers under 30 years are mainly people who have replaced their father who left farming for retirement at a very advanced age. Table 3 also shows that 60 citrus farmers (82.3%) are literate (can write and read), but most of them are very poorly educated. Sixteen of the farmers (20%) have a significant education level (technician, engineer or accountant), and six of them (8%) specialized in agriculture. Only two farmers have received training abroad due to personal initiatives. Table 3 also reveals that about 74% of our sample is represented by collective state farms (EAC), and 36% of them (27 EAC farms) are fragmented. It should be mentioned that, for some EAC farms, the fragmentation is illegal. In addition, in terms of farming system, polyculture is the dominant farming approach in our sample and few farms practice only citrus farming. Nearly 30% of all farms have less than 5 ha of citrus. On most EAC farms (30 farms that is, 55%), the citrus area is grown on less than 10 ha. Only the pilot farms have areas devoted to citrus that are larger than 100 ha. With respect to farming experience, we note that 46 farmers (61.4%) have over 20 years experience in citrus farming, though 29 farmers (38.6%) have less than 20 years of experience. The less experienced group is mainly composed of the beneficiaries of the reorganization of public sector land (Decree no. 87-19 of 8th December, 1987), private individuals who have recovered their land and youth who have replaced their parents.

Table 3 also indicates that 70 farmers (93%) are working full time at the farm. For 56 farmers (75%), citrus production represents the largest share of their income (over 56%). The rest of their income comes from either other agricultural activities such as orchards or vegetable farming, wheat farming, livestock, or non-agricultural activities. Additionally, of the farmers, 57 (76%) use permanent labor, such as employees in large private farms and pilot farms, however, in large collective state farm (EAC), permanent labor used in citrus farming comes exclusively from the family members.

Distribution of citrus varieties in the sample case study

Although some varieties of citrus are more prevalent in some municipalities than in others, the differences are not significant. The orchards are generally composed of plantations of different varieties combined together. From the analysis of the data presented in Table 4, old orchards are composed of different proportions of varieties that are more or less equal. There is a concentration of early variety citrus trees, such as Thomson representing 55% and Washington representing 16%, in new plantations. Also, there are low proportion of late

Table 2. Distribution of selected sample of farms by size, type, and municipality.

Size (ha)	EAC						EAI	Private	FP	Total
	<5	6 - 10	11 - 15	16 - 20	21 - 25	>25				
Larbaa	2	2	1	1	1	1	1	2	--	11
Boufarik	2	3	1	1	1	1	1	2	--	12
Chebli	1	2	3	2	1	1	1	3	--	14
Mouzaia	7	6	1	1	1	-	1	1	1	19
Oued El Alleug	2	3	3	2	1	1	4	2	1	19
Total	14	16	9	7	5	4	8	10	2	75

Field survey, 2008 - 2009.

citrus varieties, which ensure welding with summer fruits and a consistent sup-ply for the processing industry.

Agricultural information and extension in the sample case study

Agricultural information is a determinant of farmers' adoption of new farming practice and agricultural technology, and thus, achieving agricultural development goal. The survey results indicate that 90% of farmers believe that information is necessary and useful while 10% of the farmers say that information is not important. With regard to the amount of time spent obtaining information, most farmers (70%) declared that they spent a lot of time looking for information through discussions with other fellow farmers and sellers of agricultural product. While a small portion (10%) declared that they spend a lot of time looking for new information at technical institutes by contacting experts and associations abroad. Conversely, the remaining 20% of the farmers declared a total disinterest for new information because they are focused on solving immediate problems, such as land ownership constraints, and the scarcity of water resources. With regard to the relationship with the extension agent, in our study 100% of the farmers declared that they know the extension agent in their municipality. The frequency and the rate of contact vary, as needed, from 0 to 20 visits per month. For extension sessions, 100% of the farmers said that the meetings are rare, and the attendance is selective. Furthermore, the farmers said that the extension sessions were important and more frequent before 1987, and that in recent years, the extension program is limited to visits by extension agents. With regards to extension agent's evaluation, the results of the survey highlight the following characteristics:

1. The years of experience for 4 of the 5 agents are 9 years, except for the agent in Oued el Alleug, who has 29 years of experience.
2. The reason for the agent doing the extension work varies from one agent to another. Two of them became extension agent as a result of administrative assignments (Boufarik and Larbâa), while the other agents are in this career by choice.
3. Every agent acquired extension training without any specialization, except for the Oued el Alleug agent. The five agents have received intensive training programs during the last five years; however, according to the agents, the quality of these programs were low due to a lack of means.
4. In regard to extension agent coverage relative to the number of farmers and the agricultural area, Table 5 shows that there is a significant gap between extension agents. In comparing our data to other statistics reported in the "Manual of extension of the national center for agricultural educational," the national average is 1 extension agent per 800 supervised farmers, higher than the average in our sample. However, in terms of the agricultural area covered, the average for the Blida province is 1 agent per 1,728 ha, which indicates that the agents in our sample cover a larger area than the average. Therefore, we can state that there are no standards of supervision, as neither the number of farmers nor the agricultural area were taken into consideration in the appointment of the agents. The agents' work is based solely on the administrative boundaries of the municipalities.
5. In regard to the extension programs and innovation adoption, since 2000, the extension agents' work has been limited to the supervision of the PNDA beneficiaries. The extension programs cover subjects such as setting and planting citrus trees, pruning and fructification, management of citrus farming, irrigation using water saving technologies, and maintenance of an irrigation system. The spread of innovation was conducted by the extension agents in the majority of cases; however, sometimes specialists were involved. One agent has demonstration plots and a service vehicle (Mouzaia). The most used extension method is the group session, followed by individual methods. The agents argue that the group approach is the most effective because it has a time-saving advantage. However, the extension agents faced constrains in disseminating the innovations among farmers. In fact, the agents are relatively young (average year 39 years old) and are agricultural technicians who had acquired extension training without any specialization

Table 3. Distribution of farmers according to their personal socio-economic characteristics.

Variable	Frequency	Percentage
Age (years)		
≤30	2	2.7
31 - 40	12	16
41 - 60	44	58.7
> 61	17	22.6
Education		
No formal education	4	5.33
Primary education	48	64
Secondary education	8	10.67
Tertiary education	15	20
Tenancy status		
Private	10	13.33
Farm pilot	2	2.67
EAC*	55	73.33
EAI*	8	10.67
Farm size (ha)		
≤5	28	37.33
5 - 10	20	26.67
10 - 25	21	28
>25	6	8
Farming system (farms)		
Citrus	3	4
Citrus and orchards	29	39
Citrus and wheat	17	22
Citrus and livestock	18	24
Citrus and vegetable	8	11
Irrigation source		
Groundwater	64	85.3
Surface water	11	14.7
Farming experience (years)		
≤10	7	9.3
11 - 20	22	29.3
21 - 50	46	61.4
Occupation		
Agriculture only	70	93
Agriculture and business/services	5	7
Structure of labor use (farms)		
Permanent labor	57	76
Seasonal labor	18	24

Field survey, 2008 – 2009. * EAC and EAI: These are farms belonging to the state and were distributed to individual (EAI) and collective farms (EAC) involving at least three members with usufruct rights (Decree no. 87-19 of 8th December 1987).

Also, agents declared that they have no relationship with technical institutes or with agricultural research results. Furthermore, the lack of transportation, office equipment and demonstration plots hinder the implementation of the extension programs itself, and often they are financed by farmers. There is also a lack of professional and improvement training on new techniques, such as drip technology, which makes the process of extension difficult.

The level of use of the farming techniques by citrus farmers

To assess the level of techniques used by citrus farmers, we opted to look at a variety of methods. This is described by the percentage of farmers who adopt the techniques, taking into account land ownership status. The municipality is not taken into consideration, as practices are relatively homogeneous across the 5 municipalities studied. Table 6 indicates the percentage of farmers using different techniques, and analysis of the data reveals the following observations:

a) All of the techniques are performed at EAC farms (except for the sprinkler), with varying percentages. Some techniques are not used as often, and these are generally considered by farmers as secondary and not important. However, land ownership constraints hinder the investment in EAC farms.
b) The private sector appears to be most willing to practice various techniques. Indeed, all techniques analyzed are performed at private farms (except plastic film mulching), and in larger proportions than on the EAC farms.
c) Only the techniques that are considered a priority for citrus farming are practiced at most EAI and pilot farms. Even though the techniques are well known, especially by technicians at pilot farms, financial constraints at the 2 pilot farms requires managers to do only the necessary farming operations.

Based on this analysis, we developed a typology of different techniques used, and ranked them according to the degree of utilization.

1) Weakly used techniques: Techniques weakly used are those that are represented by less than 10% of users. These techniques include the fractioning of nitrate fertilizer, chemical weeding, sprinkler irrigation, foliar fertilizer, green manure application and plastic film mulching. These techniques are very poorly adopted by farmers because of a lack of financial means or their ignorance of the technique's usefulness.
2) Techniques used moderately: Moderately used techniques represent 40 to 50% of users. These techniques include nitrogen fertilization, sub-soiling, drip irrigation, organic fertilizers and biological control. Most of these

Table 4. Distribution of citrus varieties by age (%).

Varieties (%)/ Years	<5 years	6 - 15 years	16 - 30 years	31 - 50 years	>50 years
Thomson Navels	55	49	37	--	10
Clementine (seedless)	3	12	12	--	18
Lemon (4 seasons)	5	15	29	--	10
Clementine	--	12	9	25	9
Washington Navels	16	8	5	--	3
Double fine	--	--	--	25	8
Portuguese	2	--	--	--	10
Valencia	6	--	--	25	10
Mandarin	2	--	4	--	10
Lemon (seedless)	2	4	4	--	2
Sanguine	5	--	--	--	-
Melange	--	--	--	--	3
WilKing	3	--	--	25	3
Hamlin	--	--	--	--	1
Pomelo	--	--	--	--	2
Tangerine	1	--	--	--	-
Satsuma	--	--	--	--	1

Field survey, 2008-2009.

Table 5. Number of farmers and the agricultural area supervised by the extension agents.

Municipality	Number of farmers	Agricultural area (ha)
Larbaa	500	6,640
Boufarik	200	3,500
Chebli	313	5,175
Mouzaia	365	5,572
Oued El Alleug	300	5,202

Field survey, 2008-2009.

techniques are known by farmers, but they are not practiced by all. This is due to a lack of equipment for sub soiling, the non-availability of nitrogenous fertilizers on the market due to security issues in the region, a lack of information or wariness regarding the use biological control, the lack of livestock farming for organic manure, and the advanced age of orchard trees that do not allow drip irrigation.

3) Techniques widely used: Widely used techniques are those used by 92 to 100% of farmers. These techniques include harrowing, phosphorus and potassium fertilization, weeding, irrigation and pruning. These techniques are known by all farmers and are crucial to the farming of citrus. However, the degree of compliance with standards for these techniques differs among farmers, especially based on their income. Most of these techniques are passed on from one generation to the next, without knowledge of their effectiveness.

In addition, with regard to the results analysis, a number of observations should be made in respect of the current farming practices:

1) As regards harrowing, only 11 farmers (20%) reported that tillage was done properly.

2) As regards fertilization, the amount of nitrogen provided is insufficient for 90% of the farmers, and the nitrogen fertilization is improperly prepared, without taking into account the needs of the tree. In addition, there is a problem in spreading the fertilizer, which is done by hand around the base of the tree by 85% of farmers.

3) As regards organic fertilizer, despite 55% of the farmers made an application of organic fertilizer, but the quantities were low. For most of the farmers, the manure comes from their livestock.

4) Pests and diseases are a major concern for farmers. The citrus pests are relatively large in number, and the impacts on production are important for the quality of the harvest. A proper treatment requires the monitoring of various developmental stages of the parasites by specialists, although this is not the case with farmers. In our sample, 80% of the farmers used other farmers or

Table 6. Percentage of farmers adopting farming techniques.

Farm type	EAC		EAI		Private		FP		Total	
Technique	**No.**	**(%)**	**No.**	**(%)**	**No.**	**(%)**	**No.**	**(%)**	**No.**	**(%)**
Harrowing	55	100	2	100	10	100	2	100	75	100
Sub-soiling	18	33	5	60	8	80	2	100	33	44
Fertilizer (PK)	54	92	6	75	10	100	2	100	72	96
Fertilizer (N)	40	72	3	37	6	60	2	100	51	68
Fraction (N)	2	3	-	-	4	40	1	50	7	9
Foliar Fertilizer	2	3	-	-	4	40	-	-	6	8
Green manure	1	2	-	-	2	20	-	-	3	4
Organic fertilizer	32	58	3	37	5	50	1	50	41	55
Biological control	20	36	4	50	4	40	2	100	30	40
Plastic film mulching	1	2							1	1
Weeding	55	100	8	100	10	100	2	100	75	100
Weeding (Chemical)	1	2	-	-	2	20	-	-	3	4
Irrigation	55	100	8	100	10	100	2	100	75	100
Sprinkler	-	-	-	-	1	10	-		1	1
Drip	14	25	4	50	8	80	2	100	30	40
Pruning	55	100	8	100	10	100	2	100	75	100

Field survey, 2008-2009.

Table 7. Parasites in citrus orchards (by %).

Municipality/Pests	Leaf miner (%)	Medfly (%)	Aphids (%)	Cochineal (%)	Sooty mold (%)
Larbaa	50	61	44	10	18
Boufarik	50	27	66	15	25
Chebli	70	60	35	14	0
Mouzaia	70	13	13	15	0
Oued El Alleg	65	38	06	15	22
Total (%)	61	40	33	14	13

Field survey, 2008-2009.

product sellers to identify parasites. Most of the parasites encountered during our investigation are shown in Table 7.

The leaf miner is widespread across all municipalities (61% of the orchards surveyed), but it is most commonly found in orchards in Chebli and Mouzaïa. Medflies infect 40% of the orchards, but they are more prevalent at Larbaa and Chebli. Aphids are also widely represented in 33% of the identified orchards, but they are mostly found in the orchards of Boufarik (66%) and Larbaa (44%). The development of parasite colonies resulted from ineffective pest and disease control techniques. One reason for partial or total ineffectiveness of the treatments is the misuse of products, such as the use of a product at the incorrect time or improper application. The products may also be ineffective or obsolete, or farmers may only be applying products to part of the plots. Biological control is another technique used by 40% of the farmers against the leaf miner, but the results remain insignificant given that 60% of the farmers do not apply the treatment, which led to the regeneration of the population.

5) As regards irrigation, groundwater is used to irrigate 85% of the citrus area, and four irrigation systems were identified in the study area.

Spate irrigation: This system, which began in the late 1990s due to lack of security, is used by 20% of farmers in our sample.

Basin system: This system includes filling a basin with water around the tree, where the soil must be perfectly leveled. This system is used mostly by our farmers (85%).

Sprinkler: This method was used prior to 1998 on a private farm from Larbaa; this farm has since been converted to drip technology.

Drip: The drip system is used by 40% of our farmers on young citrus plantations. However, it should be noted that this system is poorly managed by farmers. During our investigation, the farmers declared that their plots were irrigated sufficiently. However, some remarks must be

Table 8. Distribution of average yield/ha/municipality for all varieties.

Municipality	Larbaa	Boufarik	Chebli	Mouzaia	Oued El Alleug	Average
Yield (ql/ha)	165	170	175	100	90	140

Field survey, 2008-2009.

made regarding the validity of these statements:

i) Five farms did not have the first irrigation, which should have occurred during late June to early July. This was due to a lack of equipment for leveling the ground, which delayed the start of irrigation.
ii) Of the citrus farmers, 20% irrigate every 4 to 6 weeks, which is a considerable length of time, regardless of the soil type.
iii) Alternating between two different irrigation systems (basin irrigation and drip) in the same plots due to a lack of knowledge occurred in 13% of the farmers.

6) As regards pruning, some observations may be made:

i) In some major production units, pruning is performed over a longer time period than is desirable because pruners are not available locally in sufficient numbers.
ii) Delays in harvest are often imposed by the farmers due to marketing difficulties. These delays shorten the window of time that is optimal for pruning.
iii) For 85% of the farms, pruning is affected by inadequate funds to provide the paste for healing pruning wounds, which leads to poor care of the trees.
iv) Pruning is done only on very small surfaces to avoid a drop in citrus production for the year.
v) Pruners often have a low level of qualification due to the non-specialization of most of the citrus farmers.
vi) The EAC farms are generally composed of a sufficient group of farmers who assume the full use of equipment and the accomplishment of different tasks. This situation is unlike some EAI and private farms that use pruners from the EAC, which delays pruning to less favorable times.

Yields in citrus farms

The performance data were estimated by the citrus farmers. As a consequence of the farming practices in our sample, the average yield for all varieties of all combined age groups of trees amounted to 140 ql/ha. From Table 8, we noticed that the best yields are obtained in Chebli, with an average yield of 175 ql/ha. This is closely followed by both Boufarik and Larbaa, with average yields of 170 and 160 ql/ha. Lastly, the municipalities of El Oued Alleug and Mouzaia have average respective yields of 100 and 90 ql/ha. However, these yields are found to be below average when com-pared to those provided by the agricultural statistics of Blida province, which is 181 ql/ha (MADR, 2007). The average yields by variety and municipality are analyzed in Table 9.

The performance analysis of the different varieties shows that the best yields are obtained with lemon, with an average yield of 210 ql/ha, and the best productions are obtained at both Larbaa and Boufarik, with 300 ql/ha. Navels rank second, with the Washington Navels leading in yield, with 158 ql/ha. Washington Navels are followed closely by Thomson Navels, with an average of 142 ql/ha. The best yields are still recorded in Boufarik and Chebli. The Valencia variety was ranked in 4th place with an average yield of 103 ql/ha. The best performance was recorded at Boufarik, with an average of 250 ql/ha. The lowest yields were recorded for Clementine, with an average of 50.4 ql/ha.

This average is far below the aver-age provided by the agricultural statistics of the Blida province, which is 128 ql/ha (MADR, 2007). The lowest yields are obtained in Larbâa at 30 ql/ha. The highest yields are observed in Chebli. Yields in Oued el Alleug remain below those of other municipalities, although no significant difference in the technical farming operations was observed between municipalities. By comparing the yields to those of the national statistics of 1970 (Table 10), we notice a drop in production for all varieties, except for lemon, the production of which has doubled. The fall in production is particularly notable for the Clementine, the production of which has fallen by 50%.

The fall in production for almost all of the varieties was a consequence of an increase in the ages of trees, diseases, and the farmers' inability to treat diseased trees. The scarcity of water for irrigation, particularly in the case of some Mouzaia farmers, has reduced the harvest and, consequently, the farmers' incomes. Furthermore, other factors that might affect low yields are sales at the farm gate, the subdivision of plots between members of the EAC, and security issues in the region. Besides, many farmers are interested in plantations of Thomson variety rather than others when replacing old plantations with new ones within the PNDA program. According to farmers, Thomson is the most productive and most profitable variety (sales price and yields). Thus, it may aggravate the problem of some varieties disappearing.

Conclusion

This first academic study results showed that agricultural extension and research system has failed to play a role in

Table 9. Average yield per variety and per municipality (ql/ha).

Varieties/Municipalities	Thomson (ql/ha)	Washington (ql/ha)	Valencia (ql/ha)	Lemon (ql/ha)	Clementine (ql/ha)
Larbaa	180	160	70	300	30
Boufarik	180	225	250	300	80
Chebli	140	--	160	225	120
Mouzaia	120	150	150	125	45
Oued El Alleug	90	100	85	100	85
Average yield (ql/ha)	142	158	103	210	50.4

Field survey, 2008-2009.

Table 10. Yield comparisons (1970 and 2008-2009 field survey).

Varieties/Years	2007 (ql/ha)	1970 (ql/ha)
Thomson	142	146
Washington	158	165
Valencia	103	143
Lemons	201	108
Clementine	50.4	106
Average (ql/ha)	140	133.6

Field survey, 2008-2009.

various agricultural development programs. At the extension services level, the socio-economic condition of the agents made them unable to fulfill their extension role. In addition, the agents' lack of experience, training and specialization, as well as transportation, financial resources and demonstration plots, hinder the implementation of the extension programs. Furthermore, the agents have no relationships with technical institutes or with agricultural research results. Work and experiments in the experimental stations of ITAF that led to innovative results are not promoted or developed. The results are tested in the station without any assurance of their effectiveness in actual conditions, such as on the farms. The few pamphlets produced to disseminate the results of their work are not accessible to farmers. The institutions that are supposed to transmit information on the new technology have had little impact on the farmers' environment. The lack of coordination between different institutions led to a poor flow of information, and the level of farmers' education do not allow them to select the appropriate technology based on their needs.

At the farm level, the technical results obtained show similarities between the various municipalities, especially in terms of the orchard management and the soil occupation. Identical management and cultivation practices among citrus farms resulted in variable production. However, the difference in production is mainly due to the variety of the citrus planted. This fact suggests that the techniques adopted are not profitable and highlights the failure of extension activities conducted for farmers. However, it should be noted that the socio-economic environment of farmers also hindered all investment and adoption of new farming techniques.

The importance of informal channels in agricultural extension has been shown. This is evident from the fact that farmers and sellers of agricultural products are the primary sources of information. The impact of extension agents' work, extension sessions at the chamber of agriculture and TV ads are very limited. The wariness of farmers towards extension agents and agricultural services has generated reluctance in the adoption of new techniques. However, we found that citrus farmers are interested in the information and are not resistant to change or to the introduction of new, more profitable techniques. Finally, this study suggest that developing the extension system and linking it with agricultural research is an urgent and decisive matter for the improvement in farmers' knowledge and performance to allow them to progress and to revitalize citrus farming. However, the success of modernization cannot be complete if those involved do not have common objectives.

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