Assessment of the farming transformation in a rural region of Sétif province in Algeria

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Jel Classification: Q20, R11

Abstract

The main aim of this paper is to elaborate a typology and to assess the transformations of agricultural activities in the northern part of Sétif province in Algeria. During the nineties, the country experienced a period of insecurity and terrorism, which seriously disrupted the socio-economic situation of the farming system. The study area is predominantly rural; it includes nine municipalities and is one of the areas affected by this scourge. After a decade of instability, normal conditions were recovering again with the launch of a national program of agricultural aid in 2000, namely "Plan National de Développement Agricole" *(PNDA). This change will impact farming dynamics. The analysis of agricultural practices through nonlinear methods, namely the CATegorical Principal Components Analysis (CATPCA), aims to assess the behavior of farmers across time, which will be used as a decision-making tool for assessing and reorienting the government agricultural aid programs. The results showed two typologies: the first one consists of large-scale farming combining field crops (cereals) under rainfed regime and livestock; the second one consists of small farms practicing intensive irrigated crops such as arboriculture and market gardening. However, the economic performance of farms seems to be associated with two different criteria: the size of the farm and farming system as arboriculture and market gardening.*

***Keywords**: farming transformation, PNDA program, economic performance, Algeria.*

Résumé

L'objectif principal de cet article est de dresser une typologie et de faire une évaluation des transformations des activités agricoles dans la partie nord de la Wilaya de Sétif – Algérie. Au cours des années quatre-vingt-dix, le pays a vécu une période d'insécurité et de terrorisme qui a sérieusement bouleversé la situation socioéconomique de l'appareil productif agricole ; la zone d'étude est majoritairement rurale, inclut neuf communes et fait partie des zones touchées par ce fléau. Après une décennie d'instabilité, les conditions de vie normales sont de retour, avec le lancement d'un programme national de subvention agricole en 2000, à savoir le Plan National de Développement Agricole(PNDA). Ce changement de situation aura des impacts sur la dynamique des activités agricoles. L'analyse des transformations des pratiques agricoles à travers des méthodes non linéaires, à savoir l'analyse en composantes principales catégorielle (ACPC), vise à évaluer le comportement des agriculteurs à l'échelle temporelle et permet de fournir un outil de prise de décision pour la réorientation et l'évaluation des programmes gouvernementaux d'aide agricole. Les résultats ont fait ressortir deux typologies : la première typologie est composée de la grande exploitation combinant les grandes cultures pluviales (céréales) et l'élevage, la deuxième est constituée de petites exploitations pratiquant les cultures intensives irriguées, telles que l'arboriculture et le maraîchage. Cependant, la performance économique des exploitations agricoles semble être associée à deux critères distincts, à savoir la taille de l'exploitation et l'activité agricole pratiquée telles que l'arboriculture et le maraîchage.

Mots-clés: transformations agricoles, Plan National de Développement Agricole, performance économique, Algérie.

1. Introduction

The nineties or "*the black decade in Algeria*", according to Bozarslan (2005), refers to the conflict that started in 1991 between the Algerian government and various Islamist groups for political reasons. The northern part of Sétif (Algeria) was a victim of these political events. It experienced a hard period of terrorism and insecurity that led to greater social and economic upheaval affecting the rural society practicing agriculture in impoverished mountainous areas, where many people had changed their farming activities or had left their land to settle in cities or rural villages (Bessaoud, 2006). This had probably a huge effect on the farming system and the household incomes.

In 1999, a new law granted amnesty to most Islamist fighters, which prompted a return to normal life. As a result, violence declined significantly, with the return of peaceful life in the affected areas. This means a new onset for the agricultural sector. Furthermore, through the National Agricultural Development Plan (PNDA: Plan National du Développement Agricole) launched in 2000, the Algerian government aimed at developing agricultural production and productivity, modernization of farms through substantial investments and the use of appropriate sustainable natural resources (Laoubi, 2010). Huge funds were allocated by the government through financial and technical aid to farmers, where 2.3 billion Euros were granted during the period 2000-2005 (Habibi, 2008). Indeed, agricultural extension is an essential tool for rural development (Oakley and Garforth, 1985), as it facilitates both the adoption and the adaptation of technology to local conditions (Anderson and Feder, 2003).The theories that have occasionally been made regarding the setting of economic activities allow a deeper understanding of the relations and interdependencies that determine the installation of various economic activities in space, aiming at the social and economic development of different regions (Lambrianidis, 1992; Kostov and McErlean, 2006).

In similar cases, several statistical methods were used to carry out spatial-temporal analysis, but also the usefulness of a newly developed multivariate statistical tool such as the categorical principal component analysis (CATPCA) (Leunda *et al*., 2009) which was tested to assess the spatial-temporal transformations of agricultural practices in differ-

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ent municipalities of the northern part of Sétif, from the black decade until now.

On this basis, changes are put into effect regarding the spatial distribution of economic activities, according to the new economic conditions under formulation and the various tools used for their implementation (regional development incentives, financing policies, taxation) (Barnes *et al*., 2007).

In most rural areas, the household form is already dominant. It is for this reason that in the chosen theoretical approach, the family production unit is taken as a reference unit (Campagne, 1999). However, as shown by Darré (1989) and Deléage (2004), farm practices are negotiated within the group of professionals and with other partners.

In the mountainous region of Sétif, the family farm is the most dominant form (MADR, 2009), which induces complex socioeconomic relations governing the agricultural sector. The change in farming systems can be approached as essentially a land process where farmers are the main protagonists (Ansaloni, 2006). However, Colson *et al*. (1998) consider that technical change in production systems is intimately linked to the system for allocating aid.

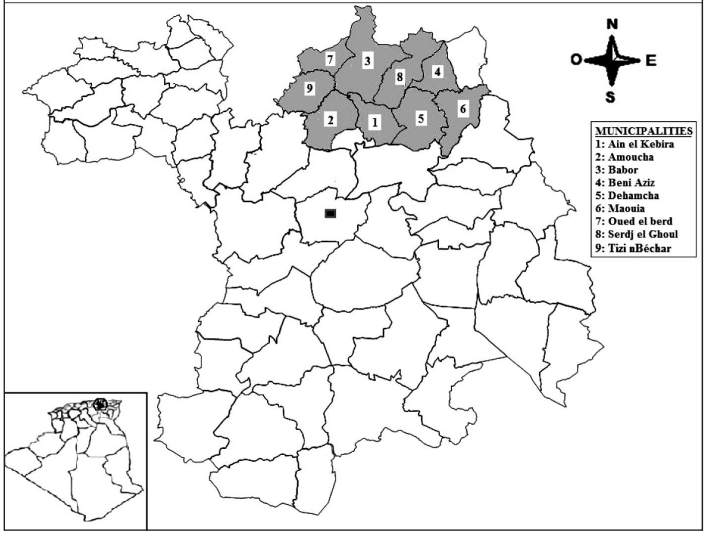
This paper attempts (i) to build a farming typology in the northern part of Sétif; (ii) to highlight the main farming transformations occurring in the dominant activities after the hard socioeconomic conditions lived during the black decade; (iii) to assess the effect of the PNDA program on the economic performance of farms and farming changes, through the analysis of the farmer's choice to adopt new agricultural practices or to hold old ones; and finally to bring proposals relating to technical and organizational level for the local development policies.

2. Materials and Methods

2.1. Study area

The study area is situated in the northern part of Sétif province, including nine municipalities: *Babor*, *Ain el Kebira*, *Serdj el Ghoul*, *Tizin'Bechar*, *Amoucha*, *Oued el Bered*, *Dehamcha*, *Maaouia* and *Beni Aziz*. Covering an area of 758.67 Km^2 , about 11.58% of the total area of the province, this region is characterized by favorable rainfall conditions and by the abundance of water resources acting positively on agricultural development. However, its geographical and socioeconomic conditions are very hard, with rough terrain, isolation, lack of infrastructure and uncomfortable roads, effects of insecurity and massive exodus that occurred during the last decade, thus presenting major impediments to the agricultural development in this area.

Figure 1 - *Location of the study area within Algeria and Sétif province.*



2.2. Sampling and data analysis

It is through the farm study and implementation that most decisions determine the success or failure of government aid programs and agricultural development projects; hence the need to diagnose this organization level is paramount. Our investigation, carried out in 2011, focused on a sample of 125 farms spread over nine municipalities. The sampling model adopted was a stratified random design (Tittonell *et al*., 2005; Blood and Birniea, 2008) which provided observations for each stratum group with a rate of 5% for each municipality. A face-to-face questionnaire was developed with the head of household, including a series of questions describing the socio-economic environment, farming activities transformations, motivations and problems hindering agricultural development (Table 1). Each study focused on socioeconomic assessment that requires a good measurement of this concept, which can be difficult to establish. There are some problems directly linked to the subjective nature of socioeconomic data. Individual attitudes cannot be observed directly, but are usually obtained from subjective survey questions. When dealing with such subjective variables, some problems (e.g. cognitive dissonance) can arise and affect the meaningfulness of the data (Bertrand and Mullainathan, 2001).

Thirty-one (31) variables were obtained from the questionnaires, including 18 quantitative and 13 categorical variables; the categorical variables were divided into 5 nominal, 3 binary and 5 ordinal. The ordinal variables were scored according to 5-point Likert scale: 1 (slight), 2 (low), 3 (moderate), 4 (high), 5 (very high), as for education level and water resource capability variables. However, the economic performance of the farm was directly assessed by the head of the household during the interview according to 3-point Likert scale: 1 (low), 2 (moderate), 3 (high). Economic performance assessment is too subjective, so the farmer should give his statement based on the importance of the farm financial outputs allocated to household needs.

2.3. Methodological approach

The set of variables obtained from the survey will be analyzed by a nonlinear statistical analysis, namely CATegorical Principal Analysis (CATPCA); it will be used iteratively to analyze the various aspects addressed throughout this article.

First: To make farm typologies by highlighting the most discriminative variables involved for a better construction of these typologies and assessment of the relevance of the analysis model.

Second: An analysis of the dynamics of agricultural activities observed during two periods; the first period is before 2000 (*black decade*), the second one is after 2000, date of the PNDA program launching; through the assessment of demarcation of the old and current agricultural practices within the same farms, and to see whether PNDA has been involved in farming shifts.

Third: To highlight the association between high economic performance and agricultural activities recently introduced, in other words, to point out new activities that adapt well and act positively on the farm economic performance. At the same time, it should be also noted that the conservative systems (farms which had not changed practices), also may had high economic performance. It is then confirmatory to say, in these cases, that the need to preserve old practices is a necessity, where conservative farms perform well by developing a good level of adaptation.

Fourth: To make an assessment of constraints to agricultural development in the study area and to evaluate the PNDA program in terms of benefits and failures in order to provide future guidelines and recommendations.

2.4. Statistical analysis

The CATPCA was performed by SPSS v18, which is a type of factor analysis adapted for use in social and behavioral science research due to the often nonnumeric nature of survey responses (Meulman *et al*., 2004). CATPCA aims at the same goals of traditional Principal Component Analysis (PCA) and Multiple Correspondence Analysis (MCA), it is suited for variables of mixed measurement level that may not be linearly related to each other (Linting *et al*., 2006; Manicera *et al*., 2010), it can be thought of as a method of dimension reduction. The method reveals relationships among variables, cases, and variables and cases. So, the use of this analysis is appropriate for our categorical variables set describing the economic, biophysical, social and technical factors that influence the whole economic activity of the farm household (Maseda *et al*., 2004; Meert *et al*., 2005; Tittonell *et al*., 2005; Pardos *et al*., 2008; Blazy *et al*., 2009). Recorded variables were selectively chosen so they characterize farms regarding all mentioned aspects of the farming system (Rouabhi *et al*., 2012).

The purpose of this analysis is to reduce an original set of variables into a smaller set of uncorrelated component representing most information found in the original variables. This technique is very useful when the large number of variables prevents effectively the interpretation of the relationships between objects. By reducing the number of dimensions, several components can interpret rather a large number of variables. The principal component analysis includes standard linear relationships between numeric variables. On the other hand, the approach of optimal coding allows variables to be encoded at different levels. Qualitative variables are optimally quantified in relation to the specified number of dimensions. As a result, non-linear relationships between variables can be specified.

3. Results and Discussion

3.1. Description of the farming environment

Socio-economic conditions

The majority of farmers had a long agricultural experience of about 25 years. However, 58% of farmers have a mean age exceeding 50 years and 32% a mean age between 30 and 50 years. The education level was low as mentioned by Zoghbi (1993), so, about 47.2% of farmers have never attended school and 15.2% have a basic education level. This low education level may prevent the extension of new production techniques that may modernize farms under the PNDA program. However, farmers aged less than 30 years were about 10%, which means that agricultural activity is monopolized by aged landowners; so the employment of young people in the farming activities is almost inaccessible in rural areas (Bessaoud, 2006).

Farmers' motivations and attitude towards PNDA program

Farmers attitude was mostly fitting with respect to their attachment to agricultural activity. About 91.20% of farmers had no intention to leave their activity; this attitude was similar among the farmers for all municipalities. Proportion of innovation investments made after 2000 approached 46.4%. However, farmer's motivation towards government aid programs was substantially weak and 56.8% of farmers did not join the PNDA program. This could be caused by poor awareness of farmers, complicated administrative procedures, bureaucracy, weak financial sector that can be also an obstacle to investment (Haid, 2012).

Structures of farming system

The small scale farming was the dominant typology, where the average Utilized Agricultural Area (UAA) was about13.10 ha, most of which (10.20ha) under rainfed regime against 2.96 ha of irrigated crops. The mean of operating wells was about 0.35, i.e. 35% of farms were equipped with well. This rate was relatively high if compared to the general rate of the province which was about 0.15 (MADR,2009).The well pumping depth was relatively low with a mean of 3.19 m, which means abundance of water resources, which is contradictory with the modesty of the amount of irrigated areas. That can be explained by recourse of farmers to rainfed crops, such as field crops (cereals) that counted 9.94 ha of 13.10 ha of the total UAA representing a rate of 75.87%. Large-scale animal production was always hindered by natural constraints such as a lack of pastoral areas and the extreme temperatures; as a result, the breeding activity was summarized in household farming scale with a mean of around 3 cows, 17 sheep and 8 hives per farm.

Table 1 - *Descriptive statistics of the variables found significant for the typologies construction*

Variables	Mean±SEM	Max
Utilized Agricultural Area (UAA)	13.10±1.19	90
Irrigated area	2.96±0.34	16
Non irrigated area	10.20±1.07	90
Number of wells by farm	0.35±0.05	3
Well pumping depth (m)	3.19±0.50	25
Arboriculture area (ha)	1.08±0.15	9
Field crops area (cereals)	9.94±1.07	90
Market gardening area	0.82±0.20	16
Cattle breeding [Number of cows]	3.46±0.58	50
Ovine breeding [Number of sheep]	17.38±2.94	200
Beekeeping [number of hives]	8.11±1.68	150
Farmer accumulated agricultural experience (years)	25.81±1.33	71

3.2. Typology construction

Several iterative CATPCAs had been conducted, where ten variables were dropped from analysis because of their weak variance-accounted-for (VAF) which was less than 0.01. These variables may not be suitably contributing to the principal components. As a result, only 13 numerical and 0.8 categorical variables remained with strong contribution and utilized to build the typology. Variables shown in bold (Table 2) load positively well on the first dimension. At the same time, the second dimension presents a positive loading of *Arboriculture* and *market gardening*. Dimension 1 seems to reflect concern for large-scale farming with rainfed cultivation. Dimension 2 seems to reflect concern for small-scale farming with irrigated crops.

Table 2 - *Factor loadings based on a categorical principle components analysis for 13 items*

Variables	Acronyms	Dimension	
		1	2
Arable area (AA)	AA	**1,020**	0,041
Utilized Agricultural Area (UAA)	UAA	**0,979**	-0,031
Irrigated area	irrig	**0,621**	0,474
Non irrigated area	Non_irrig	**0,947**	-0,167
Number of wells by farm	Well	0,459	0,119
Arboriculture area	Arboriculture	0,304	**0,524**
Fodder area	fodder	**0,548**	0,048
Field crops area (cereals)	Field_crop	**0,947**	-0,193
Market gardening area	Gard	0,024	**0,681**
Cattle breeding [Number of cows]	Bovine	0,430	-0,100
Ovine breeding [Number of sheep]	Ovine	0,263	-0,156
Rate of ground water level fall	Grd_wat_lev_fall	0,425	0,150
Farmer accumulated agricultural experience	Farmer_experience	0,330	-0,130

When using Likert-type scales, it is imperative to calculate and report Cronbach's alpha coefficient for internal consistency reliability for any scales or subscales. The Model Summary displays the internal consistency coefficient for each dimension, which were both higher than 0.8 (Table 2). It should also be noted that a high value for Cronbach's alpha (>0.8) indicates good internal consistency of the items in the scale (George and Mallery, 2003). The explained variance for each set of item is to be assumed as the ratio between eigenvalue and the number of items. On the first axis, the contribution of the set of numeric variables is more effective with an eigenvalue of 5.33, explaining 41% of variability. While the second dimension is more representative of the nominal variables, with an eigenvalue of 3.21, explaining 40.12% of variability. If considering the overall relevance of the model with two axes, with respect to two sets of variables, the model has an average representation of the variability, the first dimension accounts for 32.14 % of the variance, while the second one accounts for 20.61%.

Table 3 - *CAPTCA model summary.*

Dimension	Cronbach's Alpha	Variance Accounted For (VAF)		
		Multiple Nominal Variables	Non Multiple Variables	Total (Eigenvalue)
1	0,89	1,42	5,33	6,75
2	0,81	3,21	1,12	4,33
Total	0,93[1]	2,31[2]	6,45	8,76[3]

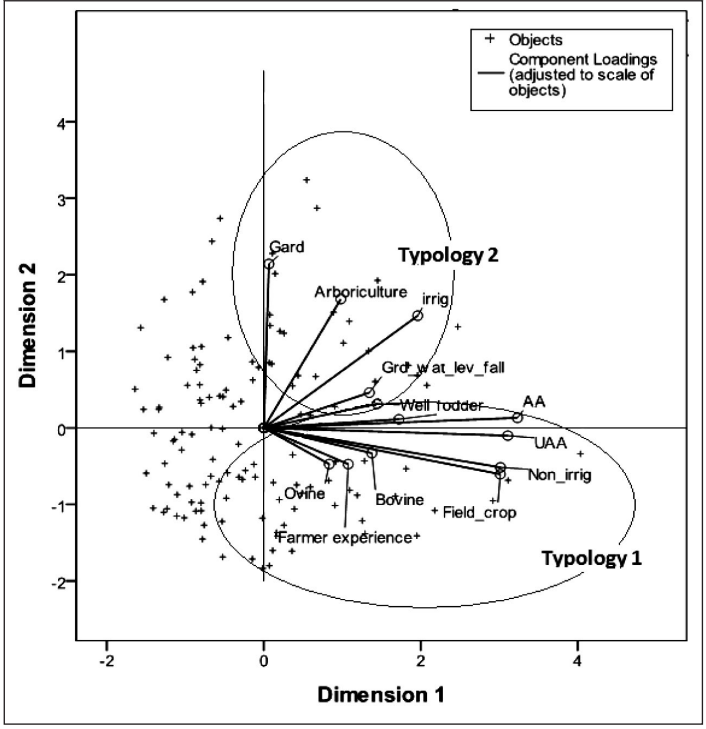
The screening of objects and variables via CATPCA analysis shows two major typologies (Fig. 2).

The first dimension characterizes large scale farming under rainfed cultivation combined with cattle farming, mentioned to be the classical typology for the semi arid local conditions (Benniou and Aubry, 2010). Four variables, namely UAA, AA, Non irrigated area (*Non_irrig*) Field crops area (*Field_crop*) contributed most to the first component; however variables characterizing the breeding farming (*Bovine* and *Ovine*) contributed less. Indeed the second dimension was more represented by irrigated area (*irrig*), market Gardening (*Gard*) and arboriculture (*arboriculture*) representing the average scale farming practicing irrigated cultivation associated with beekeeping. This typology still characterizes mountainous and forest regions with uneven topologies in the northern part of Sétif (Boukemmoum and Boucheloukh, 2011).

The spatial distribution of old activities over the study area seemed to have a specific distribution (Figure 3a) where some activities were clustered according to the area potential; however, socioeconomic conditions such as financial weakness of farms and psychological attachment of farmers to their old activities, leads to a low PNDA program membership. There was a close relationship between annual crops (*an_cultiv*) and mixed crop-livestock (*Cp-Lvstck*) in the vicinity of *Ain el kebira, Amoucha and Maaouia* municipalities, the second clustering of old activities was formed by poultry farming (*Poult*) and livestock breeding (*Lvstock*) nearby *Oued el Berd*, *Serdj el Ghoul* and *Beniaziz* municipalities. The third aggregation was formed by market gardening crops (*Gard*) and beekeeping (*Api*),

[1] otal Cronbach's Alpha is based on the total Eigenvalue.
[2] Mean over dimensions.
[3] Because there are Multiple Nominal variables, total *Eigenvalue is not the sum over dimensions*

Figure 2 - *Characterization of the main typologies observed in the study area*

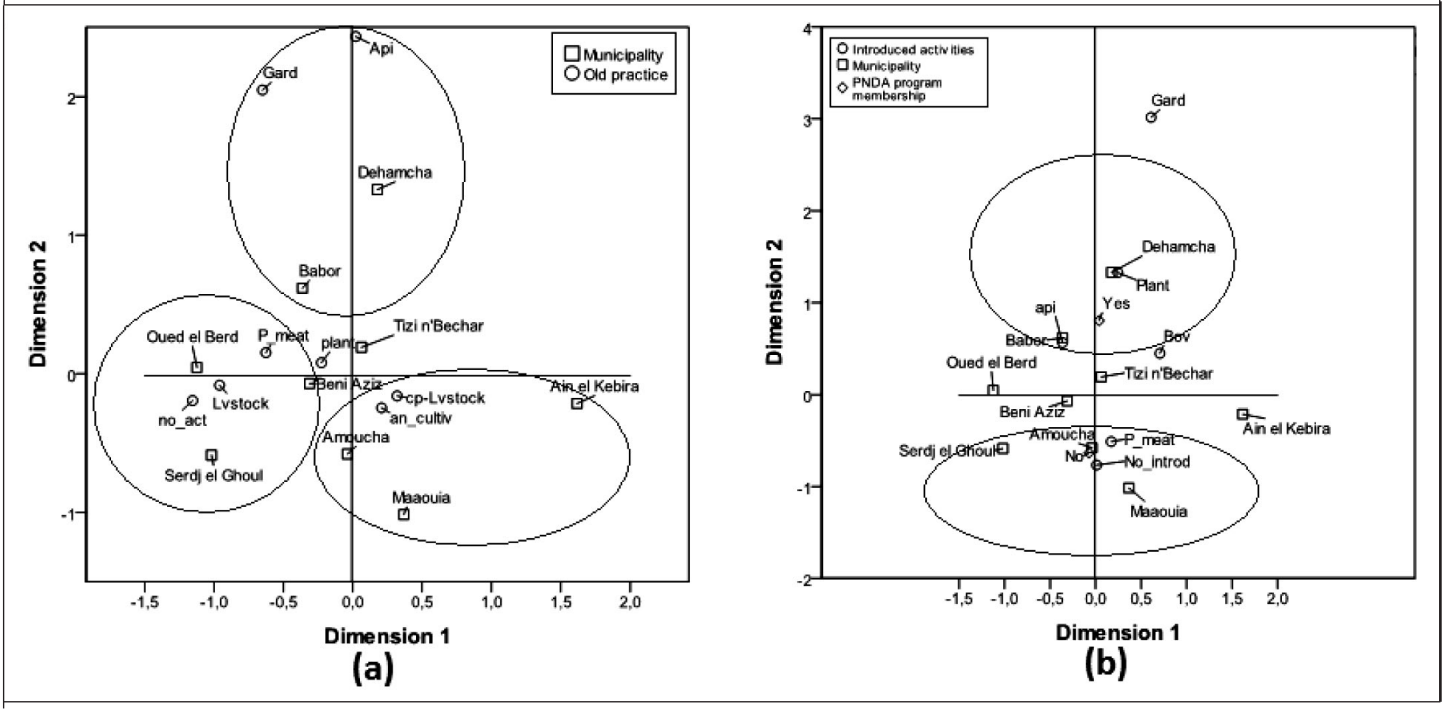


where *Babor* and *Dehamcha* municipalities were the most represented.

The impact of PNDA program was different from one municipality to another; it had a significant effect on the investment ability and economic performance of farms. At the same time, the PNDA program promoted some agricultural activities at the expense of other. CATPCA analysis showed an association between PNDA program membership and introduced activities. Thus, the PNDA program focused much more on arboriculture (*Plant*) and beekeeping (*Api*) relatively to *Dehamcha*, *Babor* and *Tizin'Bechar* municipalities, taking into account the specificities and the potentialities of these areas and the accumulated know-how inherited from old practices that can also bias the trend. There was a strong relationship between farmers who had not introduced new activities and those who had not participated in PNDA program; hence, this means that the financial ability plays a paramount role in the adoption of new investments in these rural areas where the majority of farmers lived on subsistence farming. Indeed, the role of the PNDA program is to provide technical assistance and encourage farmers to undertake new adequate investments in order to improve their economic status. While PNDA program was less efficient and unable to promote fairly cattle breeding and poultry farming in other municipalities as in *Amoucha , Serdj el Ghoul and Maaouia* (Figure 3b), this explained a weak flexibility in the operating mechanisms of PNDA program, particularly, with investments in living matter (live cattle).Generally, several factors have prevented the implementation of development programs, including hasty preparation of aid programs, land ownership constraints, lack of investments, reduced water availability, lack of loyalty among farmers to farm organizations, low levels of education and agricultural training, lack of extension services support, marketing channel constraints, bureaucracy and the slow speed of the grant agreement process (Laoubi and Yamao, 2012).

The anchoring capability for recently introduced activi-

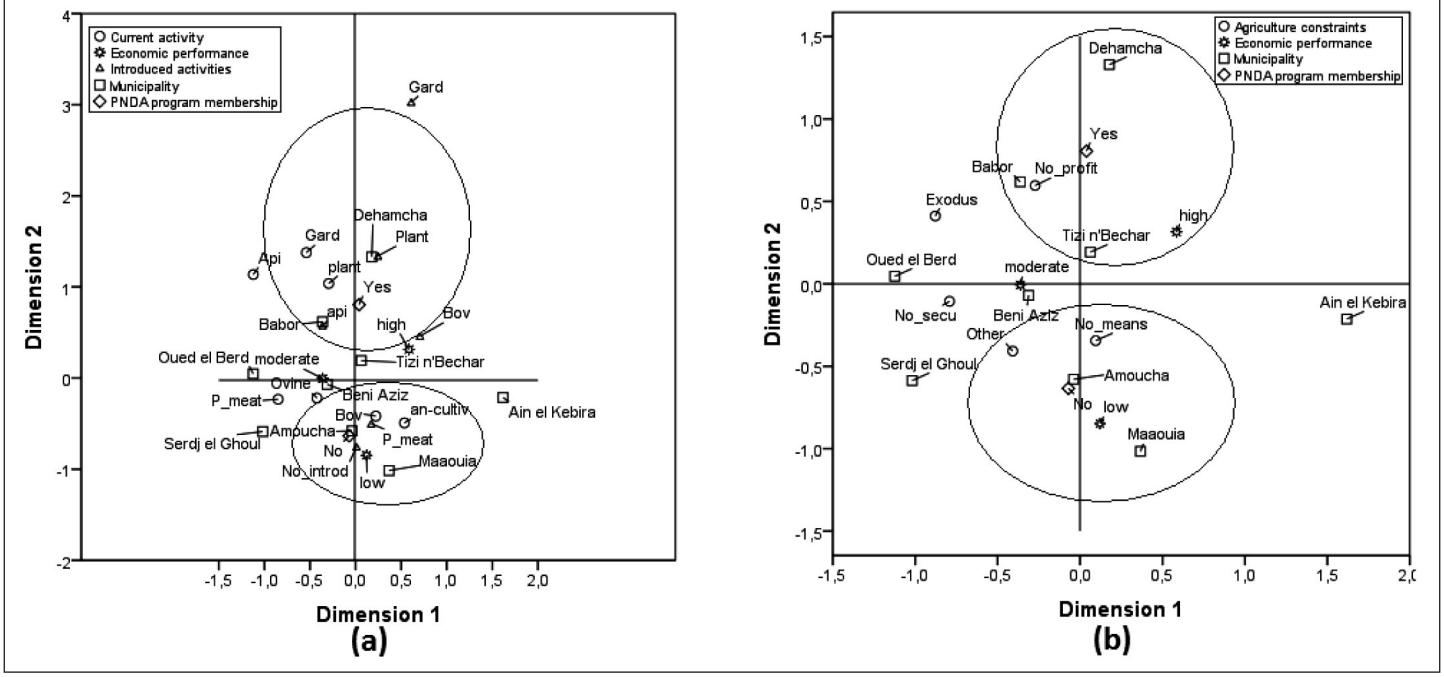
Figure 3a -*Distribution of the old activities.* - Figure 3b - *Distribution of the introduced activities and PNDA program membership*



ties in the farming system would be explained by the position and the approximation of modalities on the graph (Fig 4a),i.e. if every introduced activity is near to the same old activity. That is, this introduced activity became dominant, expressing a good fitting with the local socioeconomic conditions. For example, according to the second dimension, a good anchoring of Arboriculture (*Plant*), and market gardening (*Gard*) was observed with high PNDA program membership (*Yes*) in the vicinity of *Dehamcha* municipality, which was characterized by market gardening (*Gard*) and beekeeping (*Api*) in the period before 2000 (Figure 3a). The same situation is observed according to the first dimension, where bovine breeding (*Bov*) became a dominant activity combined with annual cultivation (*An_cultiv*) in the vicinity of *Amoucha* municipality with no PNDA program membership (*No*). Agricultural systems are dynamic, since farmers and consumers are continuously responding to changes in crop and livestock outputs, food prices, input prices, resource availability. This volatility is largely due to factors that farmers have no or little control over such as weather conditions, outbreaks of disease and pests (Halam *et al*., 2012). To provide farmers with some protection against external shocks, agriculture has historically accessed programs of subsidy payments. Any attempts to influence farmer behaviors must therefore acknowledge the social, environmental and economic cultural context of farming. Clustering of introduced and current activities will be more useful, by combining with the economic performance modalities (high, moderate and low).Therefore, the first cluster of arboriculture was associated with high economic performance, but the second aggregation of bovine breeding is less associated with high economic performance. This means that the cattle have a difficult adaptation in these areas because of lack of mastery over livestock, noting that a significant number of inexperienced investors who are engaged in milk production, encouraged by the government policy aimed at promoting national milk production through incentive prices and to reduce the import bill which was around $800 million in 2010 according to the National Inter-professional Milk Office. In *Dehamcha* municipality the choice of introducing arboriculture and market gardening fitted best, because the majority of farmers had high economic performance. However, the choice of bovine breeding fitted less in the vicinity of *Amoucha*, and *Maaouia*. While moderate economic performance was weakly represented by both dimensions, *Maaouia, Amoucha* and *Serdj el Ghoul* municipalities were characterized by a low economic performance which was strongly associated with low PNDA program membership and weak anchorage of cattle breeding. PNDA program should respond to the expectations of farmers by first making the best decision tools for investment that would be able to improve economic performance and secondly by providing best farming conditions to strengthen farmer's commitment and settlement. In tandem, development policies should incorporate other aspects, namely the promotion of handicraft and services business (Bessaoud, 2006); provide amenities such as roads and rural housing, rehabilitation of the natural environment, recovery and sustainable management of natural resources (FAO, 2012). Among the agricultural constraints observed in the northern part of Sétif, the insecurity impact is still present in the minds of farmers, especially

Figure 4a - *Relationship between PNDA program membership and economic performance according to the anchorage of activities.*

Figure 4b - *Relationship between PNDA program membership and economic performance according to major agricultural constraints.*



those living in distant parts and mountainous municipalities as *Babor*, *Oued el Berd* and *Serdj el Ghoul* and who considered that rural exodus and insecurity as responsible for the abandonment of agriculture. However, we noted also that the PNDA program included technical and organizational failures; in some municipalities, where farmers scored a high economic performance with high PNDA program membership and had no feeling of insecurity as in *Dehamcha* and *Babor*, farmers believed that the major constraints to agriculture were due to the lack of farming profitability (Figure 4b). So, if the actions of PNDA program have less profitable targeted activities, via improving land tenure and expanding UAA, the results might have been better. However, municipalities with low PNDA membership rate such *Beni Aziz* and *Amoucha*, farmers thought that the major agricultural constraints were of technical nature, where most farmers suffered from lack of mechanization. Unfortunately, the PNDA program did not include support for acquisition of agricultural equipment, which was a major impediment to the development of Algerian agriculture, where the degree of mechanization is lower than the worldwide rate (Houmy and El Himdy, 2013) and the index of mechanization is 0.27 HP/ha, half of standards recommended by the FAO (0.55 HP/ha) (Chabane, 2010). Thus, PNDA program should be amended by structuring investment actions, by helping farmers to acquire farm equipment (tractors, tillage and irrigation equipment) and assisting them to promote livestock buildings in order to accommodate the growing number of bovine livestock observed in this region.

4. Conclusion

Farm typology research has become popular as a way of segmenting farmers into groups to assist in developing targeted farm extension programs. Reorientation of development policies must take into account the temporal variability and trends of farmers and threats that compromise production activities. The typology analysis of the study area shows two different groups; the qualities of the head of the household shows a low education level and advanced age rates which could adversely affect the farm performance. Agricultural practices, particularly those relying on mobile investment such as livestock (cattle, sheep, and poultry) have been changed during the last decade. This change was due to the combination of PNDA program and the insecurity experienced during the black decade, while the agricultural practices that are based on crops (arboriculture, gardening and field crops) were not really affected by this change. The advent of PNDA program is supposed to have given a financial and technical support to rural populations. It would be more appropriate to introduce new activities and to consolidate the old ones, where PNDA program has been well involved in the promotion of activities, expressing a good fitting with the local socioeconomic conditions, such as market gardening and arboriculture. This agricultural shift had a positive impact on economic performance such as in the municipalities of *Babor* and *Dehamcha*. However, the adoption of some agricultural activities seem to have a negative association with the economic performance, implying a poor adaptation to local conditions, such as livestock. Therefore, these actions should be classified by the PNDA program to be less considered in relation to other subsidy actions. However, some shortcomings of the PNDA program need to be noted. First, PNDA neglects the human factor. Hence, it should be noted that with no professional qualifications or an acceptable level of farmers' education, it would be obsolete to speak about agriculture development; second, poor awareness program among farmers, where the membership rate of 43.2% was moderately and relatively low to expectations; third, PNDA program has neglected investment in structural and mechanized agriculture.

In short, the analysis allowed us to make some recommendations regarding the PNDA program based on area specificities and to redirect the axes of PNDA program at a geographical scale (as a municipality level). Hence, the study area was divided into two categories of farmers, regarding the requirements and development needs in the context of PNDA program. The first class requires technical support with great importance allocated to consolidate the old practices as irrigated cultivation, beekeeping and to improve land tenure as for *Babor* and *Dehamcha* municipalities; the second class requires support for investment as the basic means of production (buildings, mechanization) to promote cattle and poultry breeding as for *Amoucha*, *Ain el Kebira* and *Beni Aziz* Municipalities.

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Appendix

Table 1 -V*ariables used for the description of typologies of farms over the studied area.*

Category	Variables			acronym	Units
Socio–economic conditions	Municipality [nominal]			Mun	
	Age of farmer [scale: 1 (age<30 years) , 2 (30<age<50 years), 3 (age>50 years]			age	
	Education of the head of the household [scale: from 1 (no instruction) to 5 (higher)]			educ	
	Economic performance [ordinal: 1 (low), 2 (moderate), 3 (high)]			Eco_perf	
	Farmer accumulated agricultural experience			Farm_exp	Years
	Old practiced agricultural activities[nominal]	modalities	No activity	No_act	
			Annual cultivation (cereals)	An_cultiv	
			Arboriculture	Plant	
			Beekeeping	Api	
			Integrated crop-range-livestock	Cp-Lvstock	
			Livestock	Lvstock	
			Market gardening crops	Gard	
			Poultry farming (broilers)	P_meat	
			Poultry farming (laying)	P_egg	
	Current (Dominant) agricultural activity [nominal]	modalities	Annual cultivation (cereals)	An_cultiv	
			Arboriculture	Plant	
			Beekeeping	Api	
			Bovine breeding	Bov	
			Market gardening crops	Gard	
			Ovine breeding	Ovine	
			Poultry farming (broilers)	P_meat	
			Poultry farming (laying)	P_egg	
	Introduced agricultural activity [nominal]	modalities	Arboriculture	Plant	
			Beekeeping	Api	
			Bovine breeding	Bov	
			Market gardening crops	Gard	
			No introduced activities	No_introd	
			Poultry farming (broilers)	P_meat	
			Poultry farming (laying)	P_egg	
			Green house cropping	GHC	
	Major constraints leading to abandon agriculture [nominal]	modalities	Lack of economic profitability	No_profit	
			Lack of security	No_secu	
			Exodus	Exodus	
			Lack of production means	No_means	
			Others reasons	Other	
	innovation investments made in the farm after 2000 [Yes (1), No (0)]			Innov_invest	
	PNDA program membership [Yes (1), No (0)]			Gov_prog	
	Intention to leave agricultural activity [Yes (1), No (0)]			Int_leav_agr	
Structure of cropping system	Arable area (AA)			AA	ha
	Utilized agricultural area (UAA)			UAA	ha
	Field crops area (cereals)			Field_crop	ha
	Fodder area			fodder	ha
	Arboriculture area			Arboriculture	ha
	Market gardening area			Gard	ha
Animal breeding	Cattle breeding [Number of cows]			Cow	unit
	Ovine breeding [Number of sheep]			Sheep	unit
	Poultry egg [number of chick]			Poult_egg	unit
	Poultry meat [number of chick]			Poult_meat	unit
	Beekeeping [number of hives]			Hive	unit
Farm water resources capabilities	Water resources capability order scale: [scale: 1 to 5]			Wat_ress_cap	
	Number of water drills by farm			Water_drill	unit
	Number of wells by farm			Well	unit
	Drill pumping depth			Drill_ pum_depth	meter
	well pumping depth			Well_ pum_ depth	meter
	Irrigated area			Irrig	ha
	Non irrigated area			Non_irrig	ha
	Rate of ground water level fall [scale: 1 to 5]			Grd_wat_lev_fall	