Rev. Agr. Acad., v. 5, n. 1, Jan/Fev (2022)

Revista Agrária Acadêmica

Agrarian Academic Journal

doi: 10.32406/v5n1/2022/102-116/agrariacad

Typology of agricultural farms in the South-East of Algerian Sahara: the case of Zelfana oasis. Tipologia de fazendas agrícolas no sudeste do Saara argelino: o caso do oásis de Zelfana.

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Abstract

In Algerian Saharan, oases are characterized by the fragility of the ecosystem and degradation of microclimate, which covers most of the Algerian oasis, where the climate change is adversely affecting the society of the developing countries because their livelihoods rely mainly on climate-dependent activities, whether agricultural or economic. Zelfana is one of the thirteen oases that encompass the region of Ghardaia (Algerian Sahara); it is part of the territory of the Châamba. This oasis characterized for the past two decades by phoenicicole farms knows strong socio-economic and cultural mutations that have strongly influenced the agricultural sector for several decades. The main purpose of the paper aims to understand this diversity and define the characteristics of the farms, which rely on a structural typology for Treatment data by MAC - Multiple Correspondence Analysis under SPSS. After that, we determine the number of classes corresponding to the types of agricultural farms. Based on the most discriminating variables, we cleared the characteristics of each farm type. From this study, we determined the more discriminating variables include the professional identity of the farmer, the importance of farms, seniority, location, size of the farm, and the dominant culture. Clustering indicates five types of farms, namely: ancient irrigated farms (small gardens and Palm grove (CAPER)), the improved farms, small new farms, and at last the medium and large farms.
Keywords: Oasis. Ecosystem. Agricultural. From. Typology.

Resumo

No Saara argelino, os oásis são caracterizados pela fragilidade do ecossistema e degradação do microclima, que cobre a maior parte do oásis argelino, onde a mudança climática está afetando negativamente a sociedade dos países em desenvolvimento, porque seus meios de subsistência dependem principalmente de atividades dependentes do clima, seja agrícola ou econômica. Zelfana é um dos treze oásis que abrangem a região de Ghardaia (Saara argelino); faz parte do território da Châamba. Este oásis caracterizado nas últimas duas décadas por fazendas phoenicicole conhece fortes mutações socioeconômicas e culturais que influenciaram fortemente o setor agrícola por várias décadas. O objetivo principal do trabalho visa compreender essa diversidade e definir as características das fazendas, que contam com uma tipologia estrutural para tratamento de dados por MAC - Análise de Correspondência Múltipla no SPSS. Depois disso, determinamos o número de classes correspondentes aos tipos de fazendas agrícolas. Com base nas variáveis mais discriminatórias, limpamos as características de cada tipo de fazenda. A partir deste estudo, determinamos que as variáveis mais discriminatórias incluem a identidade profissional do agricultor, a importância das fazendas, antiguidade, localização, tamanho da fazenda e a cultura dominante. A agregação indica cinco tipos de explorações, nomeadamente: as antigas quintas de regadio (pequenas hortas e palmeiral (CAPER)), as explorações melhoradas, as pequenas quintas novas e por último as médias e grandes explorações.
Palavras-chave: Oasis. Ecossistema. Agricultura. From. Tipologia.

1. Introduction

In the Algerian desert, agriculture experienced an inclusive recovery during the second half of the twentieth century, through the different agricultural policies of the State and successive Agricultural development programs. The launch of the agricultural land ownership program (APFA) in 1983 resulted in the development of thousands of hectares across the different Saharan Regions; thereby creating a new agricultural dynamic is reflected in the emergence of new production systems. Since independence (1962) to today, various agricultural policies programs that have been implemented in Algeria, were characterized by the absence of continuity (Hadeid et al., 2021; Zenkhri et al., 2015). Distinguish the decade 1960s by the experience of self-management and the policy of partial transformation of the productive apparatus. The decade of the 1970s was that of an institutional intervention heavy of the State in the management of the sector and of the agrarian reform.

The State intervention has also contributed to promoting agricultural development in the Sahara region (Hamamouche et al., 2018), through the initiation of investments in agriculture since the 1970s, the date of the implementation of the agrarian revolution, which allowed recovery of the agricultural sector. In the years of eighty the agricultural sector has made of breaks and has tried to ensure a transition to a market economy. In addition to the political will to liberalize the agricultural sector through the nationalization of land (Hamamouche et al., 2015).Though all this, the state policy has been sought to improved national food security, developing certain priority agricultural sectors and land (Bessaoud et al., 2019).This has contributed to the challenges of food security and sustainable development at different levels (Bouarfa et al., 2020).

Zelfana is one of the thirteen oases that encompass the region of Ghardaia (Algerian Sahara); it is part of the territory of the territory of the Châamba[1]. In the last thirty years, this oasis was known for various phenomena in agriculture transformation in rural areas and rural development problems that most of us often see in recent years. It has for two decades been characterized by a unique production system commonly known as the oasis system, this system is known in traditional palm groves in family farms of small size (Zenkhri et al., 2014). The increase of agricultural land has been at a modest rhythm for a century, it is only densified for a century. The oasis map has hardly changed and it has only become denser (BRL Engineering, 1999). Since independence to today, various agricultural land development programs in the Sahara region, have made significant development, especially in Zelfana oasis. We can often distinguish between old palm groves and new agricultural development lands in these regions (Bouammar & Bekhti, 2008). In addition to the reform policies in agriculture since the 1970s, which have continued to change it continuously to find a suitable combination to improve economic productivity and social anchor, especially for rural landscapes (Rouabhi et al.,2016). Indeed the development of agricultural land began in 1983, as part of the law relating APFA; 83-18 (JORA n°1373, 1983), and executive Decree 97-483 concerning the concession of agricultural land (JORA n°83, 1997), encouraged by the availability of massive water resources and soils suitable for development has created a spectacular agricultural dynamic and it has recovery to the agricultural sector in the Zelfana region.

The region of Zelfana has, for centuries been characterized by a unique production system, commonly known as oasis system, this system is common in traditional palm groves in family farms of small size. However, the policy adopted in the agricultural sector since the 70's in access to land and water has allowed changing the agricultural landscape of Zelfana.

[1] - *The Châamba tribes arrived in the north of Africa with the last invasion of Hilalis during the 11 th century. This is an Arab tribe, first settled in the Metlili region, where it was famous with for raising livestock and for its nomadic life.*

The objective of this research is to identify the different types of farms in the Zelfana region and the surrounding extensions. No detailed studies about the agricultural development and land granted up to now. On the grounds that it is a newly established area.

In this paper, we will present the study area, the approach for building typology including the variables used for conducting surveys. In a second step, we present the results of the statistical analysis through the identification and characterization of the different types of farms.

2. Context and methodology

2.1. Location and characteristics of the study area

Zelfana is located in the wilaya of Ghardaia 60km far from the capital of the wilaya, is located 660 km south of Algiers (Addoun & Hadeid, 2019; 2020). It is limited to the north by the Guerrara town, in the south by Metlili Châamba in the West by the municipality of El-Atteuf, and finally, to the East by the wilaya of Ouargla (see Fig. 1). Zelfana is a young town, established following the administrative division since 1984. Previously, it was part of Metlili; it is currently the Daira constituency, which is a distance of 67km. The area of this town is mostly occupied by oasis agriculture and palm trees groves (Addoun, 2021).

A brief, history of the region of Zelfana; it is a crossroads linking the Southeast to the Southwest and the center. During the nomadic period, Zelfana was also a meeting place, and the passage of nomadic tribes coming from Metlili (67 km), Ghardaia 65 km, and Ouergla which is far from the capital of the town of Zelfana about 135 km.

The region of Zelfana also called the “city of Hammamet” has, for half a century been characterized by a unique production system, commonly known as the “oasis system”. It was created from nothing said ex-nihilo (Bisson, 1989), this system was known in traditional palm groves in family farms of small size, it was created during the colonial period include the policy of *CAPER*[2], this system is used in the traditional palm in small family farms (Zenkhri et al., 2014).

We chose Zelfana region as a case study because of its marked agricultural attraction in space and in terms of the presence of the ancient oases, and the irrigated perimeter. Zelfana is well known for its high number of dense palm groves in its northern part and many agricultural farms , which is an important source of livelihood for farmers and local families.

[2] - *CAPER: Fund for accession to ownership and Rural Exploitation, which from August 1957 undertook its first projects in the Sahara. This policy was to materialize through the creation (decree of March 26, 1956). The objective was to access small farmers to immediately exploitable plots of land*.

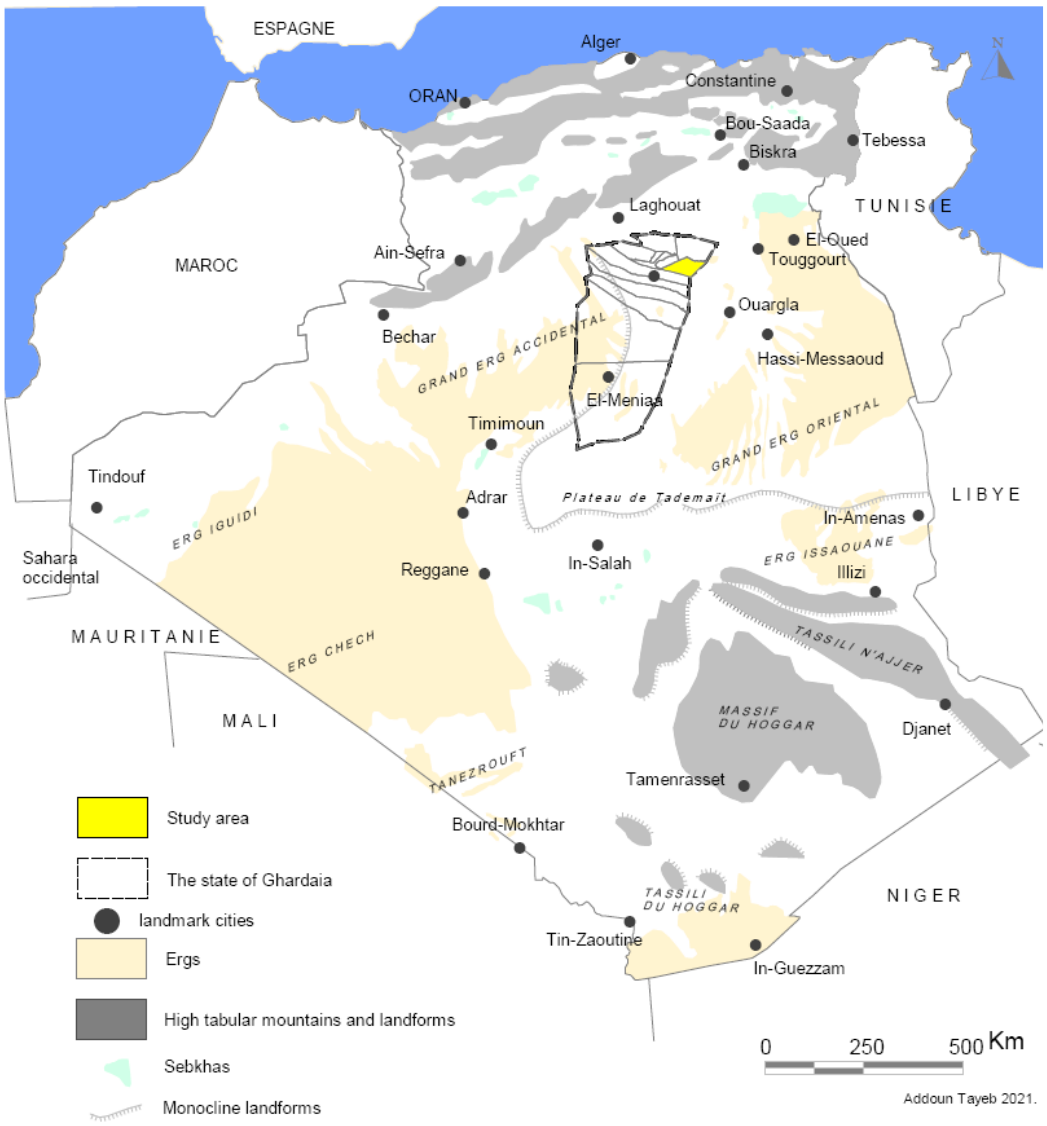

Figure 1 - Location of the region of Zelfana

The climate of Zelfana is typical of the Saharan desert, with a tendency to aridity. Weather changes and rain fall show up mainly in late fall and winter. As, with a mild winter, which is characterized by low precipitation, whereas the summer is characterized by intense evaporation, high temperatures (ONM, 2019).

The average annual temperature is 22.52°C. The warmest and the coldest months are: August with an average temperature of 36.8°C and January with an average temperature of 7.6°C.

Most precipitation in this region occurs during the winter, although some winters are practically dry. Total annual precipitation is 48 mm, December is the rainiest month (6.44 mm), and June is the driest (0.14 mm). Moisture in Zelfana is low, generally below 50% of all year, ranging from 20 % in July to 65% in December.

2.2. Materials and methods

In order to achieve the study purpose, we used an approach taking into account the specificity of Zelfana region; farms and the agricultural exploitation as well as the socio-economic profile of the farmers.

A semi-open questionnaire was conducted in various agricultural areas. The sample included 90 farms spread over six agricultural zones of *Zelfana; Zelfana El Oued, El Hessei, Gouifla, Fedj Naam, Sidi M'hamed Bouragba, and Nakousset*. Taking into account the total number of farms in the area study, the number of surveyed farms is apportioned to each zone according to a sampling rate of 20 %.

2.2.1. Choice of typology

Our choice of typology consist to identify the groups of rather similar farms between them for presenting the same operating characteristics and, thereby, to be indebted for the same development action modes (Capillon et al., 1988). In a second step , two methods are suggested; the first method built the typology of production systems starting situations and farmer's projects (Faci, 2019; Brossier and Petit, 1977). The second method built the typology based on the classification of different variables of farms in the Zelfana oasis to understand the first level of characterization of the diversity of farms. Also, this classification depends on the so-called structure classification variables (Ababsa, 2007).

However, the descriptive typology is based on a set of qualitative and quantitative variables that can be used for qualitative purposes, essentially based on the nature and modalities of organizing and means of production. As shown in Fig. 2, the overall methodological frame work is structured as follows:

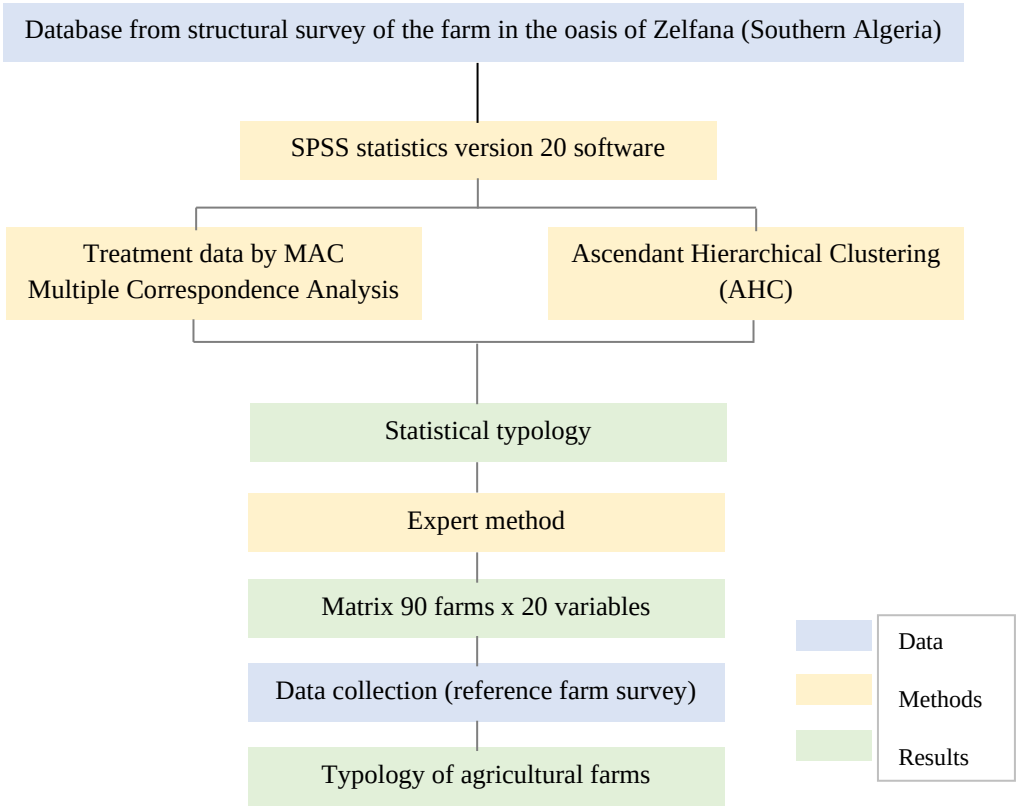

Figure 2 - Methodological approach (Source: *Author's work*)

2.2.2. Pre-investigations and investigations

Our approach is based on surveys; the survey unit is "the farm", and the questionnaire is semi-open. Pre-surveys were conducted in the various agricultural areas of the region where we have identified five categories of farms for which, we attributed, to start, the names that most commonly used: the Ancient Oasis Palm Grove of the colonial period (*CAPER*), farms of Agrarian Revolution called Pilot farm(*RA*), Perimeters(*APFA*), Smallholders and New perimeters(medium and large farms). These different categories have already been the object of identification the evolution of agricultural of Zelfana.

For investigations, we selected a sample of 90 farms, 20 variables. The variables used are; level and professional identity of the farmer, farm size and area, seniority, location and legal status of the farm, age, dominant culture, variety, the importance of agriculture, alignment and age of palms, equipment of irrigation, and drainage.

2.2.3. Treatment of data

This step focuses on a series at Treatment of data was carried out by statistical software namely SPSS version 20 (statistical Package for Social Sciences), a matrix 90 farms x 20 variables, was submitted to the Multiples Correspondence Analysis (MCA) for a first analysis data. The most discriminating variables were the basis for classification by the method of Ascendant Hierarchical Clustering (AHC), which determines the number of classes through the diagram. Finally, the k-means analysis allowed synthesized all the surveys elements to characterize each type of farming and to identify the spatial pattern farming practices of dominant activity.

3. Results and discussion

3.1. Variance analysis

The examination of Table 1 shows that Cronbach's alpha near to 1, indicates the reliability of the model, which by the summary and the diagram of the eigen values (Fig. 3), shows that all the factors that we have entered, identified two-axis where the first represents 45,423% of the variance and the second 31.318% totaling together 76.73% which is satisfactory for our study.

Table 1 - Accounted inertia derived from the MCA

Dimension	Cronbach's Alpha	Variance Accounted For		
		Total (Eigenvalue)	Inertia	% of Variance
1	0,937	9,085	0,454	45,423
2	0,885	6,264	0,313	31,318
Total		15,348	0,767	
Mean	,915	7,674	0,384	38,371

Source: Author's own elaboration

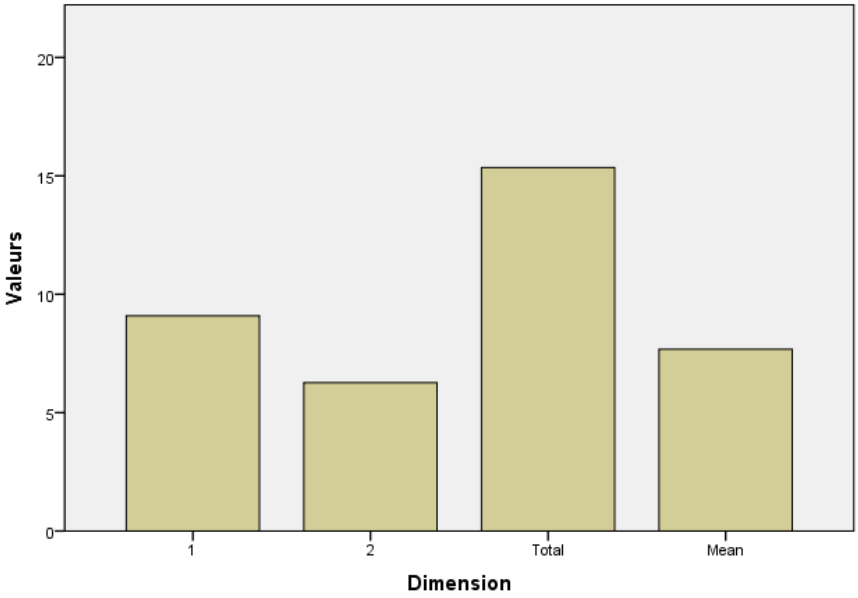

Figure 3 - Variance Accounted for total (Eigenvalue)

Knowing that for the same axis, the more the measure of excellence for the variable is significant, the more it contributes to the formation of this axis and its meaning; the results of our MCA are as follows:

Or the first axis, we notice a significant contribution of the variables related to the identification of farms; the identity farmer (0.955), the legal status (0.166), seniority (0.188), and location of the farm (0.774), followed by the dominant culture (0.063). On the same axis also appears the contribution of variables; the size of farm (0.558), the second product (0.137) place of farm (Fig. 4).

Concerning the second axis, the strong discriminating variables are the identity of the farmer (0.971), the Age of the farmer (0.927), and the localization of the farm (0.439) (see Fig. 4 and Tab. 2).

Figure 4 shows the importance of discriminatory variables on the first axis and that the identity of the variables of the farmer, the age of farmer, and "place of localization", are variables that distinguish on the two axes. It is noteworthy that the variables related to the farmer such as age and level, do not contribute to the formation of axis and, the only professional identity of the farmer can be distinguished.

The results showed that the majority of the farms are of advanced medium age (38%) and (38%) had size farms between (1 -2 hectares), shows the distribution of farmers according to personal and socio-economic characteristics. The majority (38%) of the farmers are more than 45 years, (28%) were 35 years while under 31% were between 35 and 45 years. (85%) of the farmers had a family size between 5 and 8 members and 15 % had a family size less than 4 members About 50% of households lived in extended families (housing for grandparents).

Table 2 - Discrimination measures

	Dimension		Mean
	1	2	
Age_farmers	,927	,821	,874
Age_plam	,928	,859	,894
Alignment_palm	,562	,395	,478
Breeding	,071	,104	,087
Dominant_culture	,179	,063	,121
Domin_produc	,230	,101	,165
Prod_Marken	,006	,008	,007
Farm_size	,909	,558	,734
Identify_famer	,971	,955	,963
Legal_status	,357	,166	,262
Seniority	,656	,188	,422
Locatistion	,439	,774	,607
Num_palms	,799	,293	,546
Proximity	,892	,419	,656
Second_produc	,003	,137	,070
Income	,061	,129	,095
Irrigation_drainage	,040	,029	,034
Level_farmes	,878	,069	,474
Type_workforce	,045	,172	,108
Infrastructures	,132	,024	,078
Active Total	9,085	6,264	7,674
% of Variance	45,423	31,318	38,371

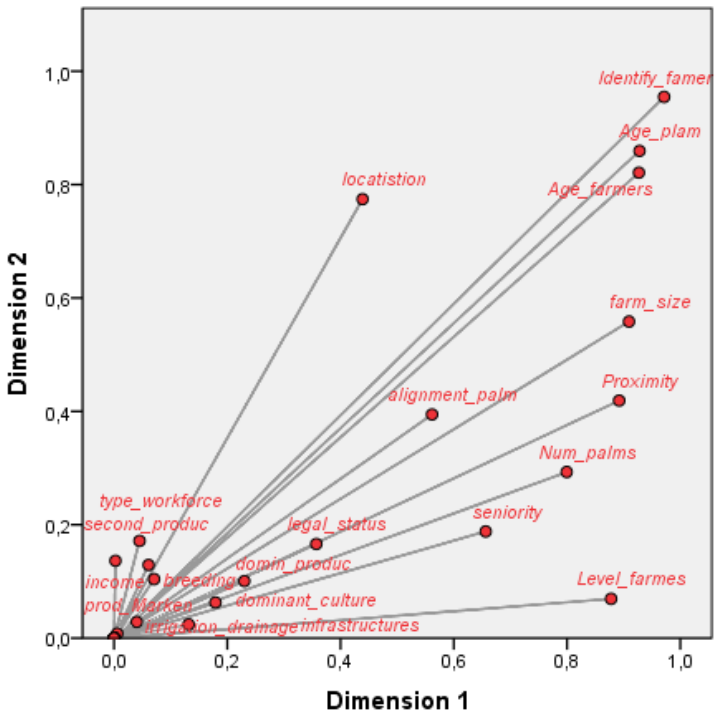

Figure 4 - Discrimination measures (Source: *Author's work*)

The graph below confirms the existence of multiple links between farmer's answers of especially for strong discriminatory variables that this type of formation occurs when there are exactly multiple links between the answers (Fig. 5).

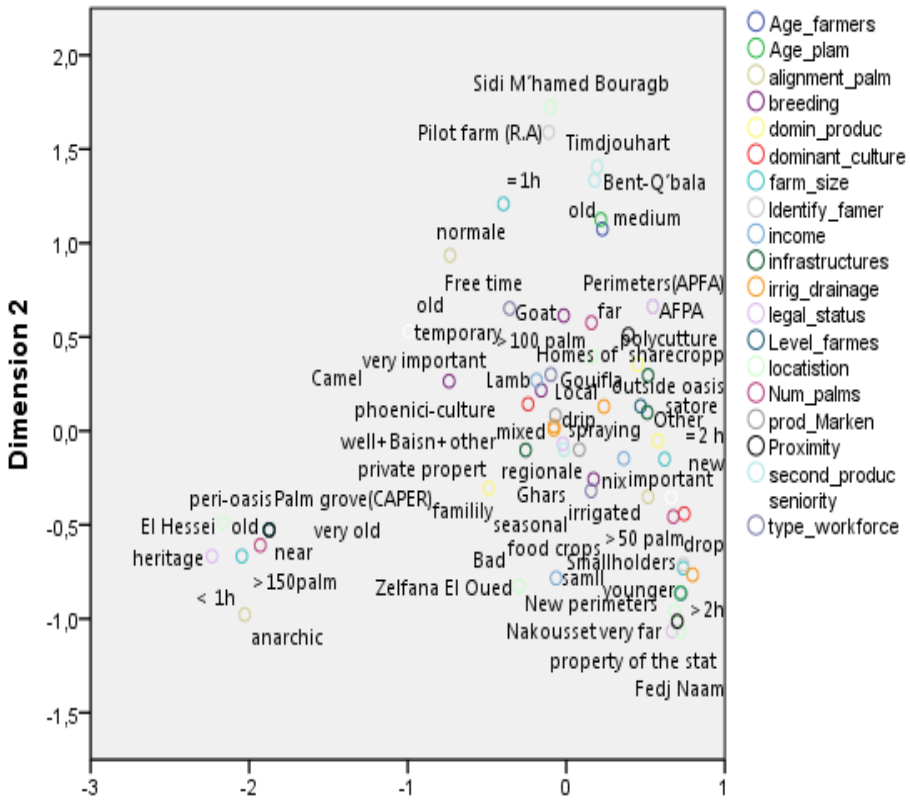

Figure 5 - Main typologies observed in the area study (Source: *Author's own elaboration*)

Figure 5 shows clearly the farms of very small sizes and medium and large farms. Also, the same configuration appears for the variable "located of farms", the outside oasis and circum-urban farms are opposed to farms outside and far from the cities in the six agricultural zones of Zelfana.

Another variable that is most important for farming, the graphic opposes the farmers for whom farming is the only actor to those having other functions in parallel. While we noticed, for example (15%) engaged in farmers having agriculture and the rest (85%)as a secondary activity where the farmer is trying to take advantage but the risk of neglect, sell his farm or just give up at any moment. Clearly, it would be futile to inject funds into the agricultural sphere if in parallel we do not act on the development of man (Bouammar, 2010). This is considered the first actor who must deal with agricultural development in his environment.

3.2. Characteristics of farm types

Table 3 provides results of Correlations Transformed Variables by SPSS, we applied the method of classification *k-means* where the figure (Fig. 6) "Cluster Membership" determines the allocation of individuals by cluster and shows that the five type farms include the following categories:

• The type concerning the only category of the ancient oasis in the palm grove (CAPER), also called tradition oasis, this type is due to the presence of water source, which contributed to the development

of the oasis significantly through the ages (Ahmed & Abdedayem, 2017). Also, this type was establishished only in the southeast of Algeria during the colonial period and its goal was to facilitate the access of small farmers to lands agricultural exploitation;

• The type of farms named farms of agrarian revolution also, called Pilot farm (RA);

•The type perimeters (APFA) it was created by the state, so-called agricultural perimeters as part of the (APFA); are located near the traditional palm groves (Côte, 2002);

• The type of the small farms attributed by Concession (Law of land concession1997) (JORA n° 83, 1997);

• The type of the new farms this last contains the medium and large farms where are regrouped the medium-sized, the large farms and agricultural enterprises, has been programmed in the arid and semi-arid regions (Steppe and Sahara) to replace traditional agriculture that operates in difficult (scarce labor, dried foggers, etc.) and less profitable environments (Hadeid et al., 2021).

Table 3 - Correlations transformed variables

Dimension										
	Age_farmers	Age_plam	Alignment_palm	Breeding	Dominant_culture	Domin_produc	Prod_marken	Farm_size	Identify_famer	Legal_status
Age_farmers	1,000	,999	,613	,215	,334	,493	,094	,871	,976	,477
Age_plam	,999	1,000	,616	,199	,344	,486	,088	,872	,977	,481
Alignment_palm	,613	,616	1,000	,162	,392	,191	-,006	,837	,713	,510
Breeding	,215	,199	,162	1,000	,108	,035	,067	,270	,244	,154
Dominant_culture	,334	,344	,392	,108	1,000	,141	-,001	,402	,390	,217
Domin_produc	,493	,486	,191	,035	,141	1,000	,068	,380	,450	,176
Prod_marken	,094	,088	-,006	,067	-,001	,068	1,000	,110	,098	-,059
Farm_size	,871	,872	,837	,270	,402	,380	,110	1,000	,924	,600
Identify_famer	,976	,977	,713	,244	,390	,450	,098	,924	1,000	,533
Legal_status	,477	,481	,510	,154	,217	,176	-,059	,600	,533	1,000
Seniority	,698	,702	,844	,316	,464	,206	,109	,850	,822	,449
Locatistion	,594	,598	,447	,331	,212	,166	-,077	,655	,596	,522
Num_palms	,880	,882	,621	,129	,295	,439	,095	,849	,883	,474
Proximity	,981	,982	,567	,177	,286	,472	,041	,842	,958	,521
Second_produc	,063	,060	-,039	-,093	-,054	-,011	-,160	,031	,059	,117
Income	,275	,271	,132	-,008	,183	,245	-,142	,189	,233	-,065
Irrigation_drainage	,142	,140	,237	,004	,169	,276	,142	,221	,163	,069
Level_farmes	,973	,973	,544	,174	,284	,510	,067	,833	,951	,532
Type_workforce	,151	,142	,231	,331	,171	-,067	,030	,234	,185	,153
Infrastructures	,349	,344	,172	-,035	,147	,312	,015	,288	,330	,159
Dimension	1	2	3	4	5	6	7	8	9	10
Eigenvalue	9,085	1,734	1,493	1,243	1,116	,937	,826	,702	,638	,586

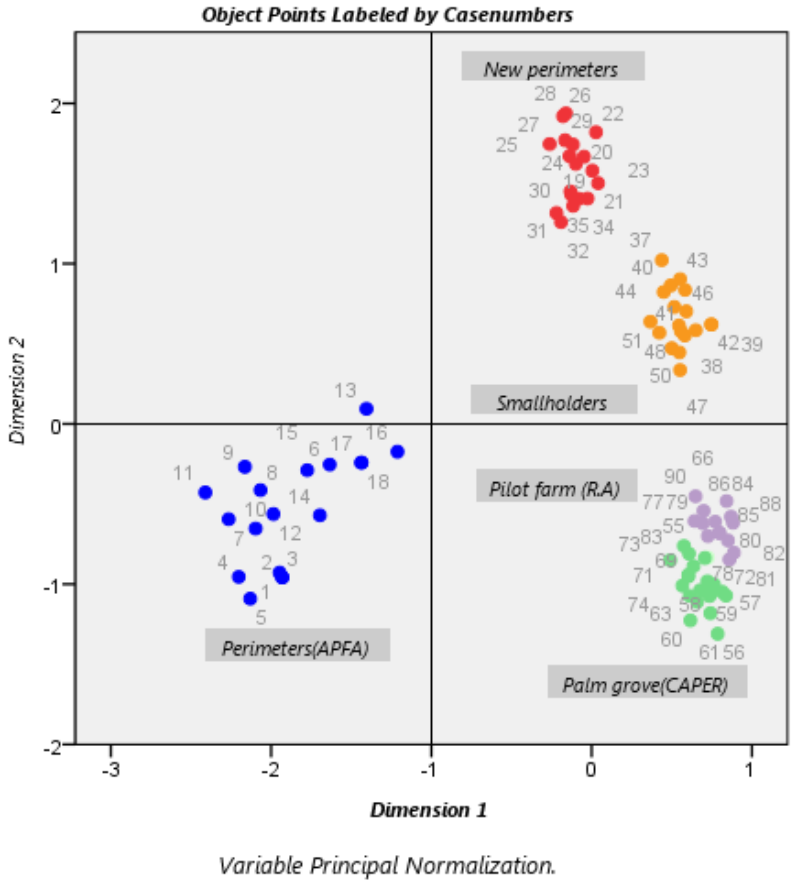

Figure 6 - Types of farms in the oasis of Zelfana (Source: *Author's own elaboration*)

3.2.1. The ancient oasis the palm grove (CAPER)

This type concerns the category of the ancient oasis of the palm grove (CAPER); of the colonial period. It was an effective start for local agriculture because of the policy CAPER was to be achieved through the creation (Decree of 26 March 1956), which undertook to first times in the Sahara during the colonial period when the goal was to give way to small farmers in the plots of land immediately exploitable. They have heterogeneous and very small parcel (1/2 ha) a hectare in size average. However, farmers have attached importance to this ancient oasis, due to the abundance of water and the number of palm trees it contains.

Also, this type based on date palms especially the date palm type Deglet Nour and Ghars are very adapted to local conditions, and it was characterized by traditional palm tree varieties, a high density of palm trees (150 trees per ha on average) since they are fragmented in a very small parcel, reflecting the social process of heritage(Hamamouche et al., 2018).

3.2.2. The type of farms the agrarian revolution (RA)

After independence, the state affected the numerous agricultural interrupted programs of the government to ameliorate the situation in the agriculture sector. In doing these, many agricultural programs like the Agrarian Reform (1971), in the mid-1970s, the government adopted socialist policies. These include the destructive "revolution agraire" /"agricultural revolution" that entailed the nationalization of private land and the grouping of peasants into "domaines socialites"/"socialist syndicate" without land title (Bouchakour & Bedrani, 2015).

In addition, agrarian revolution programs are part of a succession of Agrarian reforms and policies implemented over the last forty-five years.

This type of farm is highly discriminated by the variable irrigation. Indeed the water supply is ensured by the capillary rise of the groundwater. The farms are size (1-2 ha). It specializing in cash crops, which are assumed to have a higher value than food crops (horticulture, pulses, and cereals...).

3.2.3. The type perimeters (APFA)

Since 1983, national policy was based on the agricultural development of the steppes and Sahara (Hadeid et al., 2018). This political transition was followed by the launching of the" Accession to the agricultural fundamental property" program (APFA) in1983, which resulted in the enhancement of thousands of hectares in different regions in the South, The acquisition of land ownership through the APFA gave rights holders the possibility of accessing abundant water mobilized through boreholes reaching the deep water table, carried out by the state (Otmane and Bendjelid, 2018). Creating new agricultural dynamics in the Saharan region: this is translated by the emergence of new farming systems.

This type includes small farms created by the Law (APFA) (1983) as a small farm of (1-2 ha) and which are discriminated by the "localization" variable, this first experience of farms is located outside oasis and far from Zelfana area center. This farm (APFA) is characterized by a low density of palm trees (60 trees per ha on average).

This type includes small farms attributed by Concession (Law of land concession1997) are located near the perimeters (APFA), which are intended for the sake of market cultivation, based on average value crops. The farms are size (1-5 ha). It specializing in cash crops, which are assumed to have a higher value than food crops (horticulture, pulses, and cereals...).

3.2.4. The type of the small farms

The existence of small farms around the outside oasis is evidence of the actual transformation of the agricultural sector, and during the last three decades targeted the conquest of new virgin spaces more conducive to agricultural intensification and diversification at high market value (Hamamouche et al., 2018), especially producing date palm and new plantation of phoenix culture. In this oasis of study, date palms have several benefits by enhancing the quality of soil with organic matter, minimize soil drying, and create a favorable microclimate that helps populations to support difficult climatic conditions of desert regions.

3.2.5. The type of the new farms (medium and large farms)

They include medium and large farms. They are significantly discriminated by the professional identity of the farmer, the entrepreneurs, potential traders; and even executives and doctors have seized the opportunity of investment in the sector and benefiting thus the support of the state, are located outside oasis and oriented towards market agriculture, based on high-value crops. Nevertheless, the farmers faced many difficulties in starting their activities; on land ownership, drilling wells, delimited perimeters, and allocated land and bank loans.

4. Conclusion

The agricultural system of Zelfana region, are characterized by different types; the ancient oasis the palm grove and novellas extensions outside oasis. These patterns are found in various regions of southern Algeria, are increasingly threatened, facing serious degradation constant.

Our first results show the different types of agricultural farms in the oasis of Zelfana; it is one of the Saharan regions located in the central north of Sahara Algerian. This small city is influenced by the most socio-cultural and economic mutations that have generated several categories of farms known by the different characteristics, both physical and human. The typology of these agricultural farms depends on structural variables, and the initial investigations revealed five categories of farms in this region across all agricultural areas of Zelfana.

Therefore, The study identified five typological forms named through the use of the MCA (Multiple Correspondence Analysis); that the most discriminating variables related to the human component especially in the professional identity of the farmer and the importance which he grants to agriculture, followed by the legal status, seniority, and location of the farm, the dominant culture, the size of the farm.

Clustering followed by K-means analysis allowed to characterize five farm types named; ancient the palm grove, the type of Agrarian revolution farms which was created to track the development of Bayoud (épiphytie date palm), perimeters (APFA), small farms, and new farms. The last is large-scale farming, which was characterized by the dominance of field crops (horticulture, pulses, and cereals...) conducted under a rain fed regime.

Acknowledgements

We are very grateful to the farmers of Zelfana agricultural perimeter (Zelfana Oasis), who welcomed us and facilitated our field work in their plots.

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Received January 19, 2022
Returned to adjustments on March 9, 2022
Received with adjustments on March 10, 2022
Accepted on March 28, 2022