



## Typology of farmers in mountainous areas of northern Tunisia

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**Summary** - The Pastoral systems in the mountainous regions of northern Tunisia are undergoing profound transformations related to the changes that are both on the social organization, economy and cultural practices. As part of study areas Zaghouan, Siliana and Beja, we review cropping systems in mountain areas and especially among small farmers. The field survey about the practice of crop rotation in the mountainous areas of Tunisia and the types of operators, showed that the profiles supported the practice of rotation among farmers are practicing this profession for a decade, married, over 40 years and having level of primary education or more. The environment for the rotation is represented by a farmer residing on the premises owner of its operations and whose main activity is agriculture, located within 10km of a weekly market, and browsing a paved road or semi paved. The model mixed farming to livestock (cattle, sheep or both), with topography sloping plain or with soil type clay or sandy, a surface area of over 10ha profile is favorable to the practice of rotation. This occurs in 25,7 - 16,4 and 15,4% respectively in Beja, Siliana and Zaghouan. The multivariate analysis provided a better understanding of the nature of links between the different production parameters in a given region, showing that the farmers from the regions mentioned above, are characterized by a knowledge of the rotation type growing up respectively from absent, low to medium.

**Keys words :** cropping systems / small farmers / mountainous regions / practice of crop rotation / typology of operators / multidimensional analysis

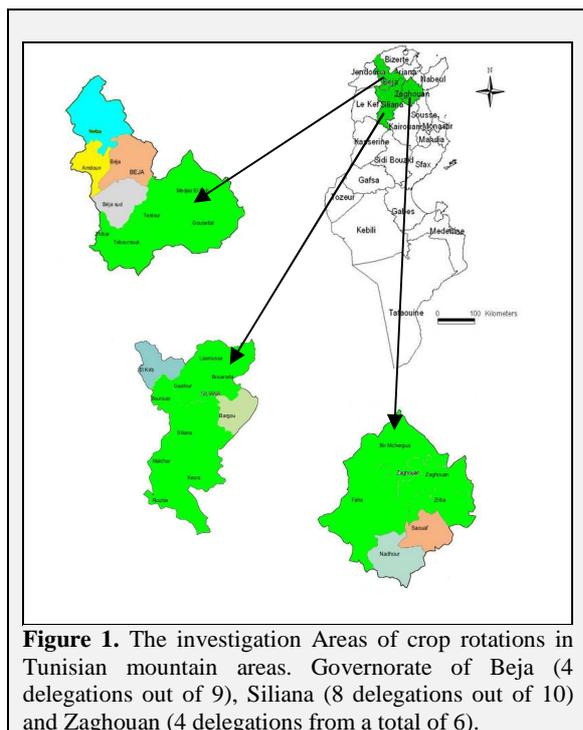
### 1. Introduction

Forage crops are important in the development of Tunisian agriculture. Indeed, the introduction of forage production systems in our main objective is to increase and improve animal production especially in meat and milk. As a result, a restoration and an increase in fertility bio-organic soil is observed in the crop rotation to feed component (Floret et al. 2000).

This study provides primary purpose, the design of a typology of farmers practicing rotation in three governorates Beja, Siliana and Zaghouan (Figure 1). The qualitative and quantitative variables related to the various farms are put into games and act as basic functions in this design. The latter will then be

able to define or limit the possibilities of adoption first, then an adaptation of forage crops in sustainable production systems in the studied areas.

The introduction of a new agrarian technology is still in an environment requiring the establishment of a set of several factors: social, cultural, economic, and ecological. Any new technique, which induces substantial expenditure requires to be adapted and adopted by producers, a study showing profitability. The typology of farmers sought may constitute grounds for an intensification of production in agro-pastoralists. Allowing to know the characteristics and limitations of the production and actions to be taken for possible improvement.



**Figure 1.** The investigation Areas of crop rotations in Tunisian mountain areas. Governorate of Beja (4 delegations out of 9), Siliana (8 delegations out of 10) and Zaghouan (4 delegations from a total of 6).

## 2. Materials and Methods

### 2.1. Identification and selection of study areas

Socio-economic surveys and studies of development projects in agricultural areas specific to small and medium farmers have been developed in three governorates of Beja, Siliana and Zaghouan. This is justified by the fact that farmers on these areas have approximately the same conditions and constraints. The contribution of the general direction of agricultural production in the Ministry of Agriculture and the environment and the three regional commissionerhip of agricultural development was necessary for the conduct of investigations. The exploratory missions previous investigations have shown that the majority of farms are small to medium-size with a low rate of large farms like firms for development and agricultural development. These were therefore excluded from this study. The sampling of operators applied and type random way, based on the reflections of Norman (1988). To do this, we identified in all these areas the names of the producers of land from small to medium size (less than 30ha). A random selection was then performed allowing the names of those selected for the systematic investigation. According to the study areas, the sampling rate varied between 58 and 79% for the sake of representation. As a result, 782

farmers were concerned by the survey, including 253 in Beja, 269 in Siliana and 260 in Zaghouan.

The survey items are among 47 being subdivided into three groups:

- Profile of the farmer: area, name of the farmer, age and education level, seniority in the field
- Nature of operations: location, size, topography, agricultural vocation
- Cultural practices: crops grown, plantings, rotation, extension means

### 2.2. Stages of statistical analysis

The counting of the surveys was followed by a statistical analysis in 3 steps:

Step 1: Conduct of the study univariate descriptive and easy to describe all the data for all operators.

Step 2: Restructuring of the data in the sense of a group of values in consistent terms and cut quantitative variables in modal classes. The information used was recorded on two terms (either positively or negatively depending on the objective) and for each variable. A bivariate study of all variables and groups of variables was thus achieved.

Step 3: Conduct of the MCFA (multiple correspondence factor analysis) on groups of variables: a complete contingency table was constructed from several variables. The aim is to highlight the factors that influence the practice of rotation. The classification of the results was performed by the segmentation technique. This allows you to view the junction of the variables in a hierarchical manner. The unit is configured to tree branches as possible to the parameters included in the model compared to the target variable. To better understand the correlations between groups of variables, an MCA was performed. This technique of multivariate analysis is best suited to the study data. The multiple correspondence analysis quantifies the qualitative ratings by assigning numerical values to the observations (objects) and methods for the objects belonging to the same modality are close to each other and those of different ways, far apart other. Each object is as close as possible from points of conditions that apply. So, how divided the objects into subgroups homogeneous. This technique is based on the principle of reducing the Euclidean distances between the general factors that may explain



how the targeted variable such as knowledge and practice of the rotation. But, before a significant number of initial variables, a data reorganization was made necessary to identify the contribution of each information in the farm typology.

### 2.3. Statistical treatment of survey data

The processing of data collected by the surveys was carried out by the following software:

- Excel (version 2007): descriptive statistics and graphical construction,
- SPSS (version 16): bivariate study, contingency table and complete segmentation of groups of variables.
- Statistica (version 7): Multiple correspondence factor analysis (MCFA).

## 3. Results

### 3.1. Descriptive study and crossing of variables

#### 3.1.1. General information on the operation

The survey crop rotation specific to mountain areas of Tunisia received a total of 782 farms distributed almost equally between the three northern governorates in the Tunisian dorsal Beja, Siliana and Zaghuan. A Beja, 4 delegations from a total of 9 were affected by the investigation. The number of respondents was higher at the Delegation of El Bab Medjez (104), followed by Testour (65), then Goubelatt (55) and finally Teboursouk (29). In Siliana, 8 delegation were surveyed on the 11 that make up the governorate. The Delegation of Siliana has absorbed a total of 58 investigations, then Bou Arada and Kesra (45 each), and finally others (15-30). Regarding the governorate of Zaghuan, 4 delegations were the subject of several investigations among 6. The number of respondents was higher in El Fahs (117), followed by Bir M'chergua (99), Zaghuan (29) and finally Zriba (15).

#### 3.1.2. Study of the Profile of respondents

The gender distribution of respondents shows that the sex ratio is in favor of males (0,97). In 75% of cases, farmers are over 40 years. Those under 40 represent 25% of the total. The managers whose age between 40 and 60 comprise the highest frequency (44,9%). By joining the group over 60 years, the frequency increases to 74,9% or three quarters of farmers surveyed. The majority 90% of farmers surveyed are married. More than 38% of

respondents are classified as illiterate. The rest were trained between the primary school, secondary, and tertiary. Agricultural training is poorly represented (less than 2%). The majority of farmers about 89% engaged in farming for over 10 years.

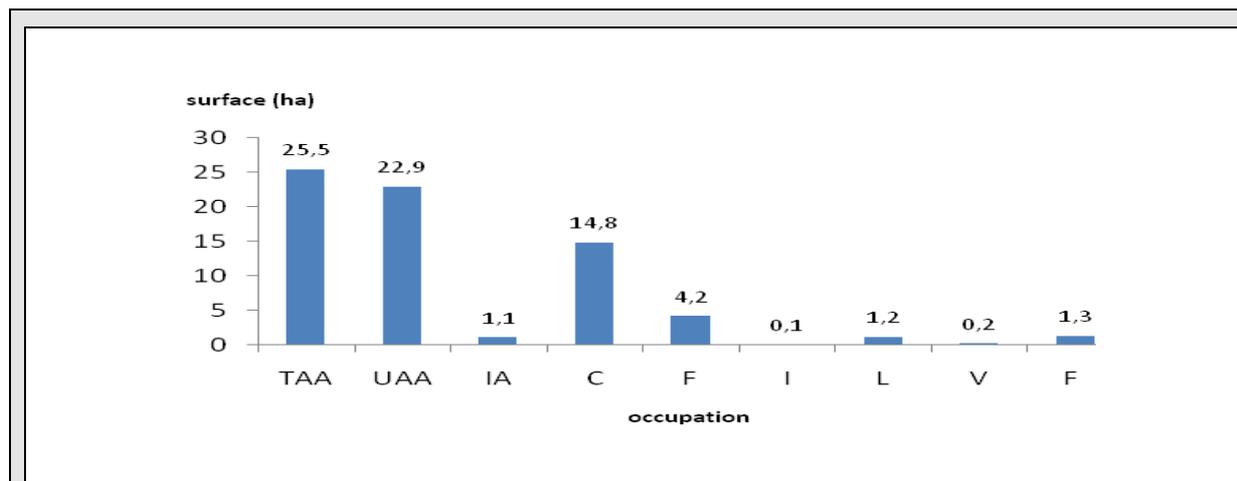
#### 3.1.3. Operation

The farm is shown as property, rental, association or other forms combined. The majority of farmers (74,55%) are landowners; but 14,07% of them are at the same time landlords and tenants. Leased land represents 11% of the total. The majority (58,44%) of farmers living on the premises.

#### 3.1.4. Agricultural activities

92% of farmers surveyed believe that agriculture is a main practice. Agricultural useful area (UAA) represents 90% of the total agricultural area. While the irrigated area is about 4,8% compared to the useful agricultural area. About 64,6% of useful agricultural area is reserved for cereals, followed by fodder (18,4%). The legume acreage does not exceed 5,3% (Figure 2).

The UAA average is about 22,9ha/farmer with a predominance of cereal crops (14,8ha/farmer), while fodder is about 4,2ha/farmer. The majority of farms (34,27%) are slope and 35,42% of them are located in the plains. The texture of the soil of farms surveyed is fine (clay) in 30,56% of cases, however 31,07% of soils are classified as sandy. Calcareous soils are significant as they represent 26,73% of the total. Breeding activity is present in 75,83% of cases. Cattle are the least represented (26,98%).



**Figure 2.** Distribution of average acreage per farmer in the three governorates. For example the total argicole surface average per farmer is 25,5ha, whose 14,8ha exploited in cereal. TAA: total agricultural area, UAA: useful agricultural area; IA: irrigated area; C: cereal, F: Forage Crops; I: Industrial crops; L: legumes crops; V: Vegetable crops and F: Fruit Trees.

### 3.1.5. Crop rotation

To the question, do you have an idea about the practice of crop rotation? the majority (693/782) of respondents said yes (over 88%). Knowledge of the rotation is fairly recent, less than 20 years in 50% of cases. Often, this is an arbitrary classification of evasive answers like, has always been, my ancestors did. Farmers saying they know the rotation are in Zaghouan (99,6%) in Beja (92,9%) and in Siliana (74,0%).

Among 782 farmers with knowledge about crop rotation, the vast majority (93,36%) also claim to know the real benefits of the appropriate rotation to their plots. Farmers practicing rotation (84,1% of total) are much more represented in Zaghouan (98,5%) in Beja (83,8%) and in Siliana (70,6%). The survey found that 53,25% of farmers believe that alternate with the cereal should be either biennial, 36,08% of them the triennial. However, the quadriennial is recommended by (10% of farmers only). Among 658 farmers practicing the rotation, the biennial rotation was observed in 45,14% of cases, the triennial 45,29%, and finally the quadriennial 9,57%. The main objective declared by farmers practicing crop rotation consists mainly in improving yields followed by the prevention against disease. 39,52% of farmers believe that the non-practice of crop rotation is justified primarily by the ignorance of its role in cropping systems. While in 11,29% of cases, the price of products based on Fabaceae seeds found particularly in the market is not competitive and not encouraging for the promotion of

rotation. In most cases (47,58%), farmers use a combination of constraints which is a barrier to the practice of crop rotation. From a total of 782 farms, 700 of them (89,51%) expressed their willingness and desire to practice rotation, they attribute the reason to the lack of visits of agricultural advisers in 73,15% of cases, but 79,54% of farmers surveyed take the initiative to visit the on-site of the agricultural adviser. According to the survey, the best way to have the necessary information is viewing media, this opinion was found in 72,51% of cases. Direct contact comes in second place with 18,29% of cases.

### 3.2. Cross-analysis of variables grouped

The grouping of variables analyzed in specific groups with common affinities simplifies the mass of data and presents an own typology for each group of farmers as follows:

- Group 1 ( $G_1$ ): set of four variables that shape the profile of the farmer: age, marital status, education level and finally seniority in the profession.
- Group 2 ( $G_2$ ), brings together five variables that reflect the immediate environment of the domain and its place in relation to the operator; the kind of agriculture, the state of the road carrying agricultural production to the market, the distance separating the domain from the nearest market, the status of the farmer and his residence.
- Group 3 ( $G_3$ ) includes also five variables that tell us about the type of operation involved as its useful area, cereal surface, its topography, the nature of its soil and practice of breeding or not.



- Group 4 (G<sub>4</sub>) Composed of eight variables concerning the kinds of information related to crop rotation and practice in cropping systems. The bivariate study conducted allowed to test the statistical relationships between different groups of variables by region as main variable and potential source of variation.

### 3.2.1. Intersection of group 1 (profile of the farmer) by region

The good profile to the target variable (rotation) is represented by a farmer practicing the profession for over 10 years, married, older than 40 years and having an elementary school education or more. We find this analyzed profile by region more frequent in Siliana (50,6%) then in Beja (44,3%) and in Zaghouan (21,9%).

### 3.2.2. Crossover of Group 2 (Farmer's Environment) by region

The environment for the target variable (rotation) is represented by a farmer owning and residing on the premises and whose principal activity is agricultural, located within 10km of a weekly market, and browsing a paved road or semi paved.

### 3.2.3. Intersection of group 3 (Profile of the farm) by region

The model mixed farming to livestock (cattle, sheep or both), with topography sloping or plain with soil type clay or sandy, a floor space of over 10ha represents the beneficial profile to the practice of rotation.

### 3.2.4. Crossing Group 4 (crop rotation and practice in cropping systems) by region

The farmer practicing crop rotation in cropping systems, and whose source of agricultural information is the farm advisor, so the agricultural training and/or the media profile is favorable to the practice of rotation.

## 3.3. Segmentation

The segmentation technique has been used for classification of results. This allows to view the junction of the variables in a hierarchical manner. The unit is configured to tree branches as possible to the parameters included in the model compared to the target variable. Groups of variables were put in hierarchical tree segmentation. Two segmentations were tested: the first with region as a target variable and the

second with knowledge and practice of rotation as the target variable

### 3.3.1. Segmentation according to a simple model

The variation between regions is explained by the profile of the farmer (G1), environmental conditions (G2), the pattern of operations (G3) and the knowledge and practice of rotation (G4). The classification of groups for explanatory variables of regional variation is successively, profile of the operator (G1), environment (G2) rotation (G3) for the three regions.

- First step, all farmers were divided into two classes characterizing the profile of the positive operator ( $\leq$  profile) and unfavorable ( $>$  Profile) to the rotation;
- Second step, the two previous classes bifurcate into four sub-classes. The first two according to the favorable environment of the operation ( $\leq$  about) or not ( $>$  approximately) to the rotation, and the other two sub-classes by knowledge and practice of positive rotation ( $\leq$  know) and unfavorable ( $>$  know) to the rotation.
- Finally, the subclass of operators with a profile and an environment favorable to the rotation is divided into two sub-classes of knowledge and practice of favorable and unfavorable rotation.

This model explains the regional variation to 46.7%.

### 3.3.2. Segmentation according to a growth model

The rotation (G4) will be determined by the profile of the farmer (G1), environmental conditions (G2), the profile of the operation (G3) and the region. The classification of groups of predictors of rotation (G4) is successively profile operations (G3), the profile of the operator (G1) and the region. Therefore, all operators are ranked:

- First, in two profiles of the favorable operating ( $\leq$  feat) and unfavorable ( $>$  exploit) to the rotation;
- Second, the subclass profile of the operation in favor of the rotation is subdivided into two other classes according to the profile of the positive operator ( $\leq$  profile) and unfavorable ( $>$  Profile) to the rotation.
- Finally, the subclass of operators with a profile of farmer owning exploitation favorable



to rotation is divided into two subclasses according to the region.

This model explains in this case a more interesting variation in the order of 65.3%.

Comparison of two models of segmentation led to opt for the classification of farmers surveyed, according to the target variable which is rotation (G4), within the remainder of this research work.

### 3.4. Multiple correspondence factor analysis (MCFA)

The multiple correspondence analysis requires an organization of the variables in order for a best explain of the target variable which is rotation in the three regions studied.

- The region with three terms, it is denominated V1.
- The profile of the operator or G1 with two terms. This variable is labeled V2.
- The environment or G2 with two terms. This variable is labeled V3.
- The profile of the exploitation or G3 with two terms. This variable is labeled V4.
- Knowledge and practice of rotation (G4) with two modalities. This variable is divided into two parts in the model:

- V5: variable that reports the modal value "p" with a recoding of observed frequencies. Zero values are coded "0", values between 1 and 30 are coded "1", values between 30 and 60 are coded "2" and the values above 60 is coded "3".

- V6: variable that reports the modal value "m" with a recoding of the observed frequencies. Values between 1 and 30 are coded "1", values between 30 and 60 are coded "2" and the values above 60 is coded "3".

The new organization of the four groups of variables G1, G2, G3, and G4 of the survey corresponding to a total of 782 procedures (farmers), allows a typology derived from the multiple correspondence factor analysis (MCFA). These groups of variables are selected because they reflect the aspect of socio-agronomic operating systems studied by several authors as Pelissier (1966); Buldgen et al. (1994); Lericollais (1980); and Diouf (1990). A full contingency table was established by reproducing the results of this organization of data (Table 1).

**Table 1.** Full contingency table of farmers according to the tag groups G1, G2, and G, with G4 as a set of target variables

Region	Prof (G1)	Envir (G2)	Exploi (G3)	Knowledge and practice of rotation (G4)		Total	
				p	m		
Beja	G1 p	G2 p	G3 p	11	13		
			G3 m	4	14	18	
		G2 m	G3 p	4	11	15	
			G3 m	23	43	66	
			G3 p	5	5	10	
	G1	G2 p	G3 m	16	10	26	
			G3 p	5	22	27	
		G2 m	G3 m	27	51	78	
			<b>S/Total</b>		<b>86</b>	<b>167</b>	<b>253</b>
			Siliana	G1 p	G2 p	G3 p	6
G3 m	16	22				38	
G2 m	G3 p	8			4	12	
	G3 m	27			44	71	
	G3 p	4			5	9	
G1	G2 p	G3 m		16	30	46	
		G3 p		1	7	8	
	G2m	G3 p		20	50	70	
		<b>S/Total</b>		<b>98</b>	<b>171</b>	<b>269</b>	
		Zaghou		G1 p	G2 p	G3 p	0
G3 m	0		18			18	
G2 m	G3 p		0		6	6	
	G3 m		0		23	23	
	G3 p		0		14	14	
G1	G2 p		G3 m	2	13	15	
			G3 p	0	10	10	
	G2 m		G3 p	90	74	164	
			<b>S/Total</b>		<b>92</b>	<b>168</b>	<b>260</b>
			<b>Total</b>		<b>276</b>	<b>506</b>	<b>782</b>

p: strong, m: lower



## 4. Discussions

### 4.1. Descriptive study and crossing of variables

The survey crop rotation specific to mountain areas of Tunisia received a total of 782 farms distributed almost equally between the three northern governorates in the Tunisian dorsal Beja, Siliana and Zaghuan. A Beja, 4 delegations from a total of 9 were affected by the investigation. The number of respondents was higher at the Delegation of El Bab Medjez (104), followed by Testour (65), then Goubelatt (55) and finally Teboursouk (29). In Siliana, 8 delegations were surveyed on the 11 that make up the governorate. The Delegation of Siliana has absorbed a total of 58 investigations, then Bou Arada and Kesra (45 each), and finally others (15-30). Regarding the governorate of Zaghuan, 4 delegations were the subject of several investigations among 6. The number of respondents was higher in El Fahs (117), followed by Bir M'chergua (99), Zaghuan (29) and finally Zriba (15).

The gender distribution of respondents shows that the sex ratio is in favor of males (0,97). The predominance of the male often appears as head of agricultural exploitation where he is primarily chief in 91% of cases (Mbetid-Bessane et al. 2002), while the role of the female is to help. In these farm threesomes, she plays a major role in meeting the food and money, freeing income for non-farm activities. However, the lure of easy money tends to raise a lot of men tempted to move away from farming to other industrial activities especially around major cities. As a result, the work of the operating farm are assigned to women (Anonymous 2002). So the low rate of women producers conceals a high rate of female participation in agricultural work.

The legacy of farming from father to son as quoted by Morou and Rippstein (2004) explains this distribution by age group. The chi-square test of Pearson for the variable age is significant ( $51.764^a$ ), at 5%, there farmers over 40 years are (88,8%) in Siliana, (75,1%) in Beja and (61,9%) in Zaghuan.

The crossing of the variable marital status by region showed that the test of Pearson Chi-square is significant at 5% ( $35.691^a$ ). The rate of married farmers vary respectively 95,9% in Siliana, 94,1% in Beja and 81,9% finally in Zaghuan.

The difference between the levels of education is statistically significant ( $p < 1\%$ ). The cumulative rates of farms managers according to their educational level shows 74% of cases had taken up a primary school and whose average age is between 40 over 60 years. The situation analysis by level of education of farmers reveals that the governorate Zaghuan absorbs the highest rate of farmers less educated (53,1%) followed by Siliana (36,8%) and Beja (24,1%).

Farming is an activity often inherited from father to son (Morou and Rippstein 2004). Otherwise, their action appears following the cessation of activity of retired parents for advanced age reason (Gibon 1998). Young graduates operators are beginning to discover agriculture after training without subsequent experience in the sector. Farmers practicing since 10 years and more are more likely in Siliana (93,7%), then Zaghuan (91,2%) and in Beja (82,2%).

In a similar Algerian bioclimatic regions, Benniou and Brenis (2006) have shown that, the rate of tenants is 46%. However, Morou and Rippstein (2004) explain the leasing of land by the phenomenon of competition to "new lands" so the most fertile. The chi-square test of Pearson ( $51.331^a$ ) is significant at 5%, and shows that farmers tend to own their exploitation much more Siliana (88,5%), then Zaghuan (73,1%) and finally in Beja (61,3%). This ranking can be attributed to the difference of soil fertility in these areas, which encourages farmers to land tenants.

The crossing of the variable place of residence of the farmer by region showed that the test is significant at 5%. Thus, the residence in situ on the farm is represented in Siliana followed by Beja and finally Zaghuan. In 84,5% of cases, the nearest market is less than 10km. The analysis of the distance between the farms to closes markets shows that the markets are closer to the farms (less than 10km distance) to Zaghuan (98,1%) and in Beja (82,6%) and in Siliana (73,2%). The crossing of the variable transportation to move product by region showed that the Pearson test ( $33.471^a$ ) is significant at 5%. Under these conditions, the asphalted road or mixed represents 86,2% in Beja, 81% in Siliana and 65,8% finally in Zaghuan. Generally the condition of the track leading to the market from the field operations is mostly a paved road (43,86%) or mixed (33,76%). Marketing of production to an urban



clientele has advantages as for example the selling price of products becomes more interesting compared to rural areas. Indeed, the distance, and also road conditions in winter are strong constraints on the daily sales by farmers away from the city (Hostiou 2003). The negociation of agricultural products being the final link production is highly dependent on the proximity of the market and roads leading to. The practice of multiplicity (7,93%) is mainly related to work outside the farm. This strategy combines farming with other sources of income. According Gibon (1998), youth under 35 years, pluriactivity is non-existent among single, becomes systematic when they get married, adding that the contribution of their children leaving the farm, and exerting other professions to provide additional income to the family. Agriculture is the main activity of owners in Zaghouan (96,9%), in Beja (92,1%) and in Siliana (87,4%). Surveyed farms are small (64,34%) to moderate (35,66%), respectively, with an UAA less than 15ha and from 15 to 30ha (Gibon 1998).

The imbalance between the various speculations is mainly due to fixed-income insured by the sale of cereals each year. According Mignolet (2008), the surface of wheat in France increased to 50% in thirty years, whereas permanent grassland had decreased considerably (-25%). In southern Senegalese groundnut basin, mechanized farming has led to the expansion of cultivated areas resulting in the exploitation of marginal lands. Thus, with the saturation of space, the earth becomes a limiting factor, it is transmitted from father to son. This reflects the unequal distribution of land between the farms (Morou and Rippstein 2004). The crossing of the variable region by UAA showed that the chi-square test of Pearson (58.269<sup>a</sup>) is significant at 5%, and we found that the UAA exceeds 10 hectares (on average) much more in Beja (91,7%), then Zaghouan (76,5%) and in Siliana (63,6%). The average area reserved for cereals, over 10hectares more located in Beja (88,1%), then Siliana (77,0%) and finally in Zaghouan (38,5%). The farms with rugged land is much more Zaghouan (87,7%), then Siliana (65,1%) and in Beja (60,5%). Topological and topographical characteristics of the plots of the operation, as the distance, direction or slope (Andrieu et al. 2004) and vegetation types that determine the use value (Cruz et al. 2002) of crops, are fundamental

components determining the allocation of plots. Distinguishing cases where the same plot is affected or not to multiple uses (Coleno and Duru 2005). The analysis of farmers reports on the soil exploited by region showed that the chi-square test of Pearson (60,252<sup>a</sup>) is significant at 5%, and there is much soil type limestone in Siliana (37,9%) then in Beja (32,4%) and finally Zaghouan (9,6%).

The large representation of farming is explained by the specific bioclimatic and edaphic regions surveyed long been known by their adaptation to this speculation in agriculture. Farmers add to agriculture, animal husbandry, in 82,3%, 79,2% and 65,6% of cases, respectively in Zaghouan, then Siliana and finally Beja. The analysis of long-standing knowledge of the rotation shows a lot more farmers recently informed Zaghouan (55,4%), then Siliana (39,0%) and in Beja (36,8%). The media is often the main source of information (over 54% of cases) on the practice of crop rotation, the rest is shared between investigation and recycling (20%), family (1%), neighbors (0,4%) and agricultural adviser or professional agronomist (23%). The analysis of variable source of information on the rotation by the agricultural adviser has shown that the chi-square test of Pearson (64.944<sup>a</sup>) is significant at 5%, and there are farmers informed by counselors in 95,0%, 92,9% and 73,6% respectively in Zaghouan, Beja and Siliana.

#### 4.2. Cross-analysis of variables grouped

If we calculate the coverage rate (Morou and Rippstein 2004) represented by the ratio of the number of favorable profile available to the practice of rotation relative to the needs of the region. This rate is equal to 79,43%, 102,25% and 28,07% respectively for the regions of Beja, Siliana and Zaghouan. However this rate is about 63.94% for the three regions. Analysis of these rates shows that there is a strong inter-regional imbalance, the region of Zaghouan seems to be the region most affected by the development needs for improving the profile of the farmer practicing rotation. But the region of Siliana presents a balance between what is available and the need.

The analysis by region showed that the more common environment is in Siliana (40,1%) then in Beja (26,5%) and finally in Zaghouan (21,9%). The overall coverage rate for the three regions is about 42,18%. The comparison



of regional rates from the rate of the three regions showed a very important need for the region of Zaghouan (28,07%), followed by Beja (36,02%), however in Siliana the situation is better with a coverage rate of 67,08%. This analysis shows the need to strengthen development projects on the environment of the farmer by more targeting the areas of Zaghouan and Beja.

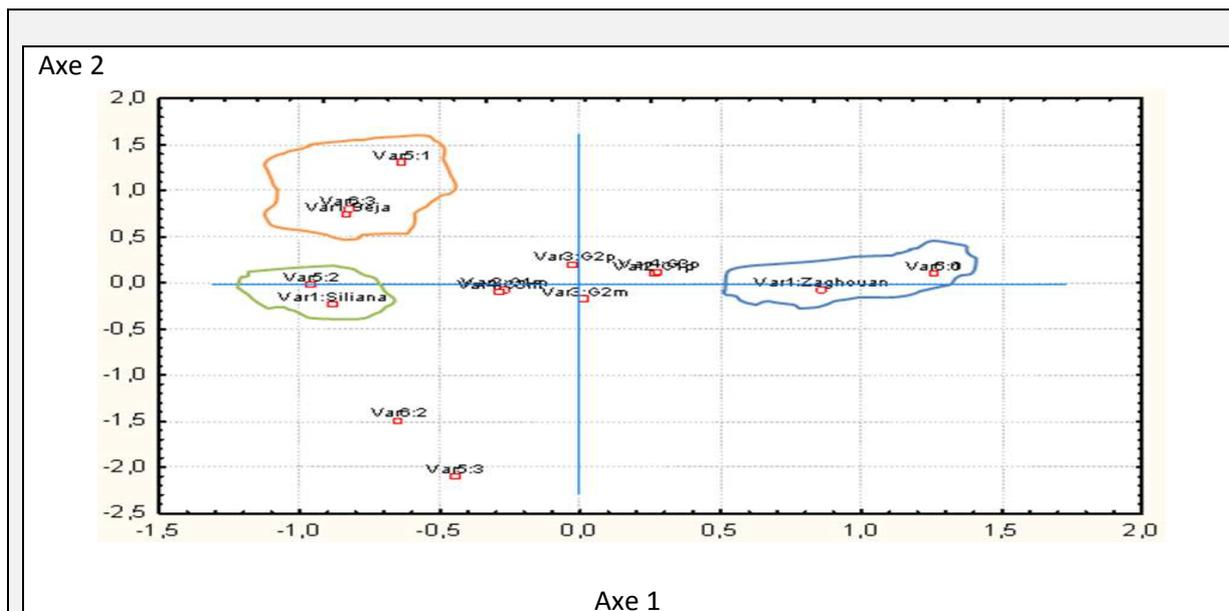
The beneficial profile to the practice of rotation analysis by region is more common in Beja (25,7%), then Siliana (16,4%) and finally Zaghouan (15,4%). The coverage rate of the three regions is very low and equal to 23.53%. Distributed as follows in Beja 34,57%, then in Siliana 17,25% and 18,18% in Zaghouan. These low rates shows that the model of the farming must be supported in any study of regional development especially in areas Siliana and Zaghouan.

The representation of operators with the favorable characteristics of practice and knowledge of the rotation are similar in the three regions with rates ranging from 34 to 36,4% for Beja and Siliana. Similarly, the coverage rate is about 51,49%, 57,3% and 54,76% respectively in Beja, Siliana and Zaghouan.

#### 4.3. Multiple correspondence factor analysis (MCFA)

Table 1 shows eight groups identified by governorate as variables ranging powerful at lower. To better characterize the defined groups, a classification of persons was performed according to their proximity to the center of mass of the different aggregates. The characteristics of persons within the same group are those encompassed by the aggregate of the plan which brought together most informations. From the contingency table, three frequency tables have been developed: the total frequency, line frequency and frequency columns. The values of the frequency table rows correspond to the conditional probability having the knowledge and practice of rotation. For example, the probability that an operator respond very positively to the knowledge and practice of the rotation is as follows: 2,8% in Beja, 5,6% in Siliana and 8,3% in Zaghouan. There is a perfect independence between the variables if all the line profiles are identical (it is same for the profiles column). The hypothesis void is that all rows in the table of frequencies are

equal. Thus, the probability of knowing and practicing the rotation is the same for all regions. The inertia of the point cloud thus formed is equal to  $\chi^2/n$  or  $\chi^2$ , where  $n$  is equal to the statistics of chi2 test of independence. The first two axes absorbs 46.3% of the total inertia, therefore the two axes 1 and 2 may reflect on their own, the type sought (Figure 3).



**Figure 3.** Planar groups of variables studied by the method the multiple correspondence factor analysis (MCFA). Three subsets were identified reprasantant each Beja, Siliana and Zaghuan.

The proximity of two points shown on the flat projection means that the corresponding terms have a similar profiles or that the centroids of

selected individuals with these conditions are similar (Table 2).

**Table 2.** Proximity of points on the projection

Terms with high contribution on axis 1with a negative coordinate	Terms with high contribution on axis1 with a positive coordinate
<p>V1: This variable region has two modes Beja and Siliana that the overall percentage is around 15%.</p> <p>V5 is the knowledge and practice of rotation (positive responses) with three terms (1, 2 and 3) that the overall percentage is around 23.8%.</p>	<p>V1: the variable region with a modality Zaghuan that the overall percentage is around 5%.</p> <p>V6: Knowledge and practice the variable rotation (negative responses) with a term (3) that the overall percentage is around 6.3%.</p>

Three subsets were identified:

- **Subset 1:** represents the Beja region characterized by a knowledge of the rotation of level 1 (low) and paradoxically a misunderstanding of the rotation of level 3 (high enough). This group is located axially one side axis1 (negative) and side axis 2 (positively) and spatially far enough away from the center.
- **Subset 2:** Specific to the region of Zaghuan with knowledge of the rotation of level 0 (absent) and a misunderstanding of the rotation of level 1 (low). This group is located axially side axis 1 (positive) and side axis 2 (negative) and spatially far enough away from the center.
- **Subset 3:** Regarding the region of Siliana with knowledge of the rotation level 2 (medium). This group is located axially one

side axis1 (negative) and side axis 2 (negative) and spatially far enough away from the center. The variable region is dependent on the variable knowledge and practice of rotation. This dependence is generally negative. This result is seemingly paradoxical relative to the responses of the operators surveyed on issues concerning rotation. But the multivariate analysis provided a better understanding of the nature of this connection.

### 5. Conclusion

The survey on the practical of crop rotation in the mountainous areas of Tunisia and typology of the farms showed that the profiles of the favorable operators to the practice of rotation is among farmers parcticing this profession since more than 10 years, married, over 40 years and with elementary education or more. This analyzed profile is more frequent in



Siliana (50,6%) then in Beja (44,3%) and finally in Zaghouan (21,9%).

However, the enabling environment for rotation is represented by a farmer owner and residing on the premises and whose principal activity is agricultural, located within 10km of the weekly market, and browsing an asphalt paved road or semi pave dis in the range of 40,1% in Siliana, 26,5% in Beja and 21,9% in Zaghouan. The model mixed farming to livestock (cattle, sheep or both), with topography sloping plain or with soil type clay or sandy, a surface area of over 10ha is the favorable profile to the practice of rotation, represent 25,7, 16,4 and 15,4% respectively in Beja, Siliana and Zaghouan.

The multivariate analysis provided a better understanding of the nature of links between the different production parameters of a given region, to show that the region depends on the variable knowledge and practice of rotation. This dependence is generally negative. This result is seemingly paradoxical, having regard to the responses of the operators surveyed on issues related to the rotation. Where there are, that Beja region is characterized by a knowledge of the rotation-type small, the region of Zaghouan is characterized by a lack of knowledge of the rotation and in the region of Siliana with an average knowledge of the rotation.

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