

# Evaluation of the Sustainability of Phoenicultural and Market Gardening Production Systems of the Development in the Ouargla Region (Southern Algeria)

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Received : 28/4/2022

Acceptance : 30/5/2022

Available online: 1/6/2022

**Abstract.** The aim of our work is to study the sustainability of seal and market gardening production systems. This study was carried out in two study areas N'goussa and Hassi Ben Abdellah in the region of Ouargla (Algeria), through 75 surveys in different farms where we elaborated a typology of evolution in order to know the determining elements of the trajectories. The Ouargla region's Farm Sustainability Indicator (IDEA) is important. The assessment of agro-ecological, socio-territorial and economic indicators indicates that the agro-ecological indicator is the most represented by (the indicator of fertilizer and agricultural practices) by 46 out of 100. The work was followed by statistical analyses (using Excel stat) to study sustainability constraints. The results show that the polyculture system (date palm, market gardening, etc.) is the most dynamic in terms of cultivation practices. The market gardening production system is economically profitable in the two study areas due to the evolution of market gardening under shelter. The stability of the seal farming system and its uniqueness indicate that it shows the most signs of sustainability.

**Keywords.** Production, System, Development, Sustainability, Saharan region.

## 1. Introduction

The Algerian Sahara, with an area of more than 02 million km<sup>2</sup>, is one of the world's hottest and most arid deserts. In this very dry and evaporating climate, life has traditionally been organized around the cultivation of date palms made possible by the existence of water points and oases [9]. The Saharan regions have experienced significant agricultural dynamics since the second half of the 1980s following the application of the APFA [1,14-15] and even more importantly, since the launching of the PNDA in 2000. [3,4, 5,6]

The usable agricultural area (UAA) represents only 7.6 million hectares, i.e. 3% of the total area. The UAA per inhabitant went from 0.63 hectares in 1967, to 0.36 in 1982, and 0.20 in 2010. [16] The agricultural space in the Algerian Sahara has been experiencing an unusual dynamic for several decades, particularly since the promulgation of Law 83/18 on APFA (Accession to Agricultural Land Ownership). Oases and desert have never ceased to compete for the Saharan space. This dynamic is the result of agricultural policies that are not always coherent [7]. Agricultural development has mainly taken place in the communes of Hassi Ben Abdallah and N'goussa, with 8,815 hectares and 1,237 hectares allocated respectively. [6]

In the Saharan regions, agriculture is characterized by two farming systems:

- The old agricultural system, or agriculture in the old palm groves, which is subject to significant degradation and which involves State intervention through support to farmers for ecological, social, economic and cultural imperatives.
- The new agricultural system or the new palm groves that are being created as part of agricultural land development and the various development programmers. Two types of agriculture can be distinguished in these new areas: the first type through the extension of palm groves which has given rise to "peri-urban" agriculture or small development because it is made up of small and medium farms and the second type which is described as large development through large concession programmers. [6]

The land has often been developed at the gates of old oases, with the farmer combining his old palm grove with a larger, more modern farm [13]. The development resulting from this important evolution is mainly due to farming practices, but the advantages of this development have negative consequences for these lands. Therefore, the sustainability of this Saharan agriculture remains one of the most delicate question marks. The central question lies in determining the factors of sustainability of phoenicultural and market gardening farms?

The objective of our study is to assess the sustainability of phoenicultural and market gardening production systems in two study areas in the Algerian Sahara (Hassi Ben Abdellah and N'goussa in Ouargla).

## 2. Materials and Methods

Our study was based on field surveys in two areas of the Ouargla region. The Working Methodology consists of four steps:

- Collection of information on the study areas.
- Surveys at the level of agricultural structures and perimeters.
- Selection of sampling sites.
- Field surveys (Identification of farms and evaluation of development actions).

### 2.1. Presentation of the Study Zones

Ouargla is bordered to the north-east by the wilaya of El-Oued, to the north-west by the wilaya of Djelfa, to the west by the wilaya of Ghardaïa, to the south-west by the wilaya of Tamanrasset, to the south-east by the wilaya of Illizi and to the east by the Tunisian border and the wilaya of El-Oued. Its geographical coordinates are: 4° 57' 09" East longitude and 31° 47' 59" North latitude. [12]

The commune of Hassi Ben Abdellah is located in the Daïra of Sidi Khouiled. The chief town of the commune is about twenty kilometres away from the city of Ouargla and is located near the intersection of the road linking Ouargla to Touggourt with that linking Ouargla to Hassi Messaoud. [6]

The commune of N'goussa is located in the North-West of the wilaya of Ouargla at a distance of 20 km from the city of Ouargla.

### 2.2. Sampling

In our work we chose for sampling two zones in each region and approached 75 investigations to the farmers of these farms in each zone in the study region.

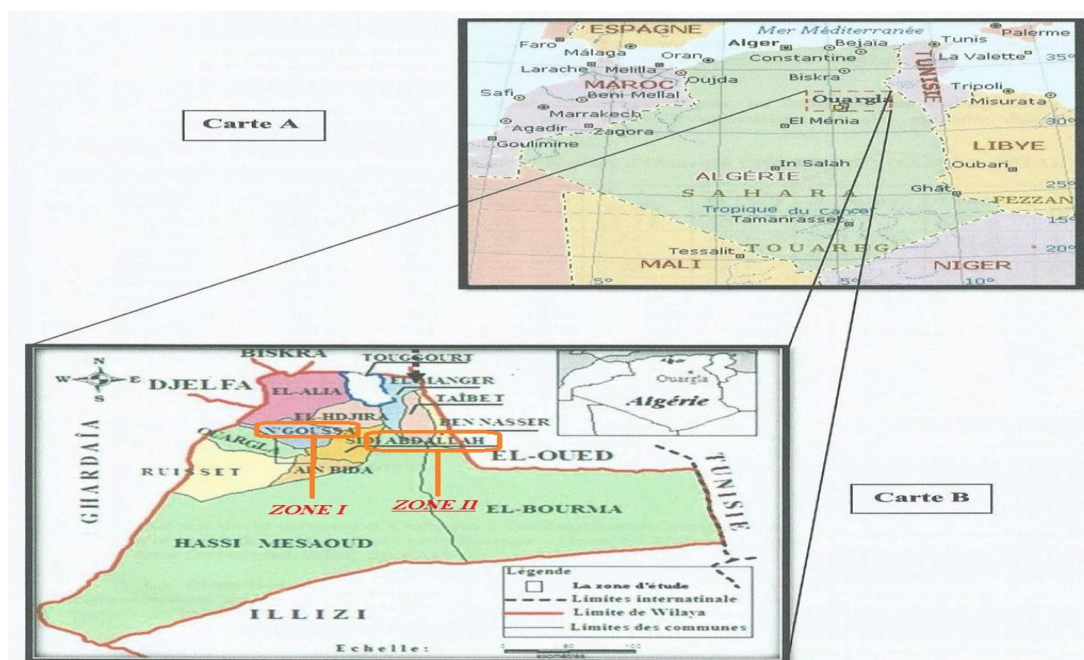
We will therefore constitute a reasoned sampling, which aims to discover the operating diversity of production systems and we will choose production units in each of the previously identified categories and also in relation to the presence of the farmer.

Surveys at the farm level of development: A survey was carried out at the farm level, it enabled us to have essential information on the identification of the activities and the mode of operation of the farm, as well as aspects related to the socioeconomic and environmental environment.

The field diagnosis was based on surveys in two zones of the study region, the approach adopted of which consists in reviewing the main issues and challenges facing collective farms from an agricultural development point of view, and the main factors sustainability.

The number of farms surveyed depends on the presence of the farmer and his agreement to be surveyed. So the main variables studied in our survey for sustainable exploitation in each study area

are: Use of phytosanitary products, type of irrigation system, age of the farmer, use of labor. work... are presented in tables (2,3). These variables are studied by statistical analyzes (Excel Stat)



**Figure 1.** Geographic location of the study areas. Source D.P.A.T. of Ouargla [11].

Example of the investigation



<p><b>Investigation sheet</b></p> <p>1. Identification of the operator and his family:</p> <p>1. Name and first name of the beneficiary: .....</p> <p>2. Name and first name of the operator: .....</p> <p>3. Age : ... Gender: female <input type="checkbox"/> male <input type="checkbox"/></p> <p>4. Place of residence:</p> <p>Exploitation <input type="checkbox"/> the village <input type="checkbox"/> the municipality the wilaya <input type="checkbox"/>          other wilaya <input type="checkbox"/></p> <p>5. Distance housing and farm: : .....</p> <p>6. Family situation          Single <input type="checkbox"/> Married <input type="checkbox"/> nombre of children : <input type="checkbox"/></p>	<p>10. what culture do you practice          _____          _____</p> <p>11. types of plowing: mechanical <input type="checkbox"/> manual <input type="checkbox"/></p> <p>12. what is the time spent working/ month?          _____</p> <p>13. the preferred crop management: Modern <input type="checkbox"/> traditional <input type="checkbox"/></p> <p>14. the type of fertilization used: : mineral <input type="checkbox"/> traditional (farmyard manure mixed) <input type="checkbox"/></p> <p>15. do you respect the doses of fertilization ?          . Yes, as required <input type="checkbox"/> .No, but depending on availability <input type="checkbox"/></p>	<p><b>OPEN QUESTIONS</b></p> <p>1. What culture are you most interested in and for what?</p> <p>2. What are the problems encountered in your palm grove?</p> <p>3. If so, what are the real threats that you could give us?</p> <p>4. What would you suggest to ensure rational management of phoenicultural?</p> <p>5. What do you think about agricultural extension in your region?</p>
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So we set up a reasoned sampling, which aims at discovering the diversity of functioning of the production systems according to two criteria studied farm size (small farms 16 farms surveyed, and large farms 24 total of 40 farms). And according to cropping system: phoenicultural farms (06 farms), phoenicultural farms with market garden crops under shelter (25 farms) and phoenicultural farms with underlying crops (excluding palms), market garden crops (under shelter) and fruit trees (04 farms), which represents the following table:

**Table 1.** Sample distribution by cropping systems and farm size in the two Study Areas.

Criteria	total samples	Percentage (%)
Small-scale operation $\leq$ 2ha	16	21
Large-scale operations $>$ 2ha	24	32
Seal farms with sheltered market garden crops	25	34
Seal farm (date palm)	6	8
Seal farming with underlying crops (excluding palm trees), vegetable crops (under cover) and fruit trees.	4	5
Total operations	75	100

Surveys will therefore be carried out on the various new (development) farms by integrating the Hassi Ben Abdellah zone and the N'goussa zone into the phoenicultural production and market gardening systems

### 3. Results and Discussions

#### 3.1. Typology of Farms

This typology consists in characterizing the types of farms identified and highlighting their assets and constraints and identifying their evolution. To this end, we identified four types of farms in the two study areas based on farm size and cropping systems. The typology highlights the following systems:

- In relation to the cultivation system:
  - Model A: phoenicultural system (date palm);
  - Model B: phoenicultural system and vegetable crops;
  - Model C: phoenicultural system + market garden crops under shelter and underlying crops (excluding palm) and fruit trees.
  - Abandoned model
- In relation to the size of the farm:
  - Large-scale operations  $>$  2ha;
  - Small-scale operation  $\leq$  2ha.
  - Typology of farms in the area of Hassi ben Abdellah.

**Table 2.** Typology of farms in the area of Hassi ben Abdellah.

	Date Palm	Palm + market gardening	Palm + market gardening (under shelter +undercover crops (excluding palm trees) +fruit trees)	Abandoned Operations	
Studied parameters	Use of plant protection products	Low usage	Uses 86% crop treatments	Uses 86% crop treatments	Absence of crop treatments (there are spontaneous plants)
	Irrigation	Saguiats irrigation system (insufficient irrigation)	Drip irrigation system (sufficient irrigation More than 70%)	Drip irrigation system (sufficient irrigation More than 70%)	No irrigation system
	Breeding	Goat breeding	Goat breeding and Ovine	breeding Ovine	No breeding
	Use of labor	Family labor force	Family labor force by 69%	Seasonal family labor force 73%	Inexistent
	Farmer 's age	very old farmer	farmer under 50 years old	farmer under 50 years old	very old farmer
	Type of fertilizers	Do not use fertilizer for palm	67% organic	67% organic	Do not use fertilizer
	Status of the operation	Poorly maintained operations	Well-maintained operation	Well-maintained operation	Very poorly maintained operation
	Constraints and problems	Weeds 80%	Weeds Insects	Weeds Insects temperature wind	Weeds (camels course)

The typology we have developed shows that the polyculture production system (date palm, market gardening and fruit trees ....) is a system diversified by the different cultivation practices and remains open to new cultivation practices and techniques. This has been confirmed by Bouammar [6] WHO states that "The stability of the phoenicultural production system and the extension of phoenicultural areas on cereal farms, combined with a decrease in cereal areas, all indicate that the phoenicultural production system is more profitable and more sustainable".

**Table 3.** Typology of farms in the area of N'goussa..

	<b>Date Palm</b>	<b>Palm + market gardening</b>	<b>Palm + market gardening ( under shelter +undercover crops (excluding palm trees) +fruit trees</b>	<b>Abandoned Operations</b>	
Studied parameters	Use of plant protection products	Low usage	Uses 80% crop treatments	Uses 80% crop treatments	Absence of crop treatments (there are spontaneous plants)
	Irrigation	Drain irrigation system (insufficient irrigation) Collective drilling	Insufficient flood irrigation system)	Drip irrigation system sufficient irrigation more than 90%	No irrigation system
	Breeding	No breeding system	Goat breeding	Breeding Sheep and camel	No breeding
	Use of labor	Family labor force	Family labor force by 67%	Family and foreign Labor force by 33%	Inexistent
	Farmer 's age	very old farmer	old farmer	farmer under 50 years old	very old farmer
	Type of fertilizers	Do not use fertilizer for palm	100% Organic	100% Organic	Do not use fertilizer
	Status of the	Poorly	Poorly	Well-maintained	Very poorly

operation	maintained	maintained	operations	maintained
	operations	operations		operation
Constraints and problems	Weeds	73% Weeds	Weeds aquifer rise + lack of water	Bad Weeds (camels course)

### 3.2. Type of Manure

The manure used in the Hassi ben Abdellah and N'goussa area is shown in the following table:

**Table 4.** Types of manure in Hassi Ben Abdellah and N'goussa. Source: based on survey with manure seller.

Type of manure	Weight	Price
Sheep	30-35 Qt	250000-350000
Red poultry	30-35 Qt	40000-50000
white poultry	30-35 Qt	250000-350000
Cattle	30-35 Qt	250000-350000

Type of manure	Weight	Price
Red poultry	2t	120000-150000 millions
White poultry	2t	12-9 millions
Sheep	2t	6-9 millions

The types of manure most used in agriculture in the Ouargla region are white poultry and red poultry.



**Figure 2.** White poultry [10].



**Figure 3.** Red poultry [10].

### 3.3. Use of Phytosanitary Products

According to our surveys in the farms in the area the majority of farmers use phytosanitary products (such as pesticides and herbicides) against the diseases that affect your crop. But the majority of farmers do not recognize the risks of irrational use of these products.



Figure 4. Phytosanitary products.

### 3.4. Evolution of The Seal Production System

The number of farms growing only date palms (generally Deglet Nour and Ghars) in the two study zones. Underlying crops and a few fruit trees, as a second stratum, for self-consumption are found. This system is generally characterized by small areas, with production oriented towards a large proportion for self-consumption. In addition, the phoenicultural production system is weakly integrated upstream to the input market (requires few inputs) and above all more labour-intensive. This singularity makes it more suitable in terms of sustainability and much more likely to diversify economically.

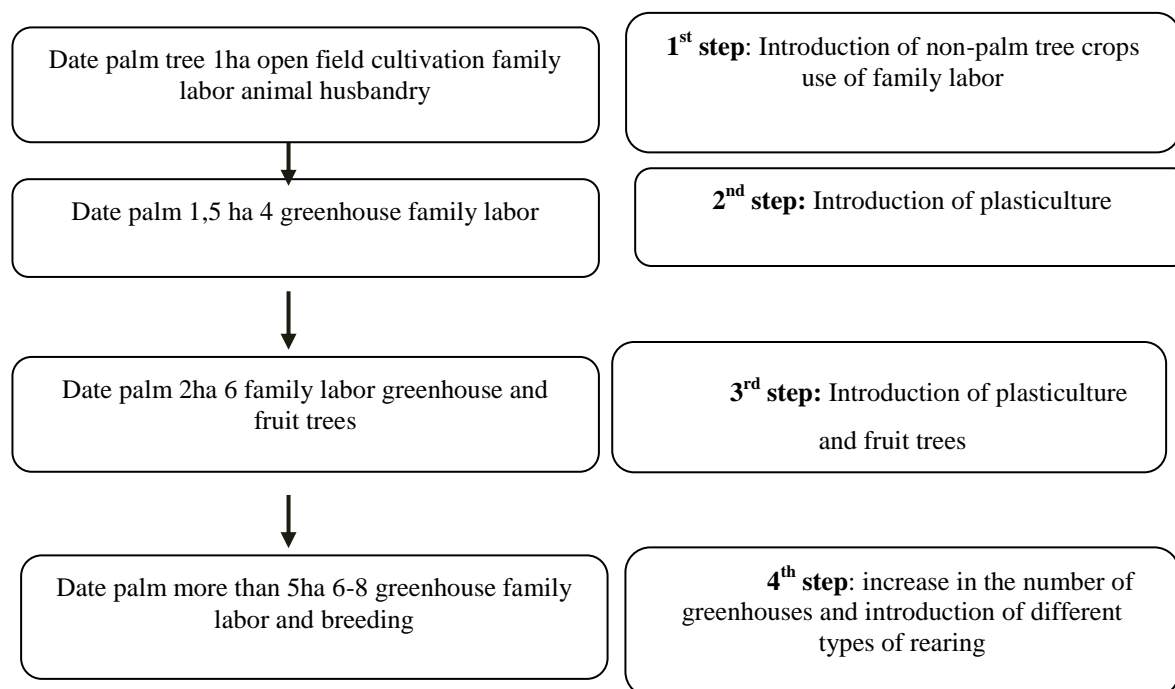


Figure 5. Evolutionary trajectory of a Phoenicultural and market gardens farm at Hassi Ben Abdellah.



#### 4. Discussions

There are several indicators to assess the sustainability of farms in the Ouargla area among them:

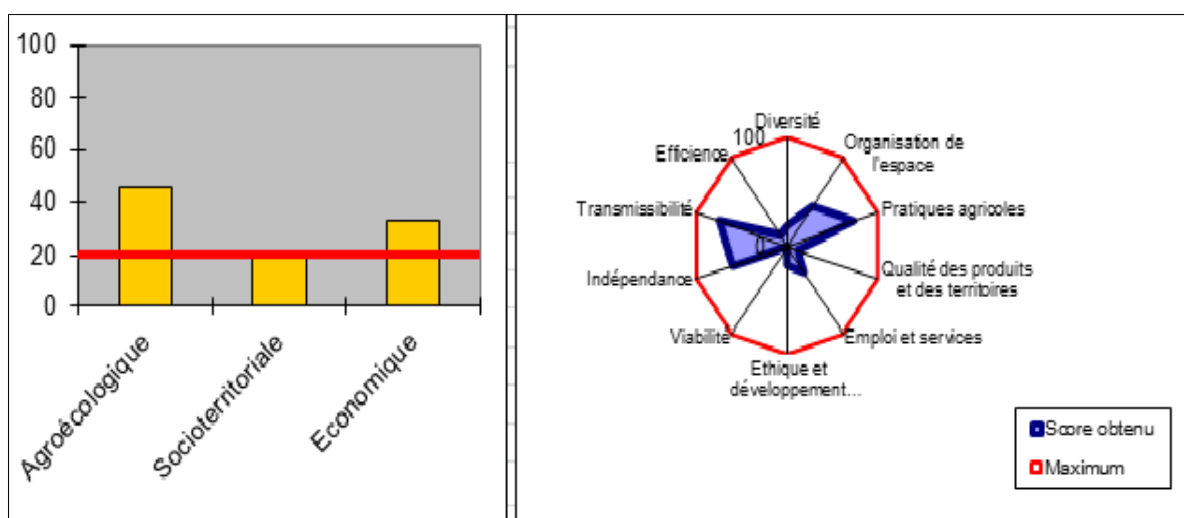
##### 4.1. Indicators of Farm Sustainability

As IDEA is an ecosystem and quantitative approach method that was developed in a multidisciplinary working group. This grid makes it possible to quantitatively evaluate, for a plot or a vegetable farm, practices likely to go in the direction of sustainable development. [2].

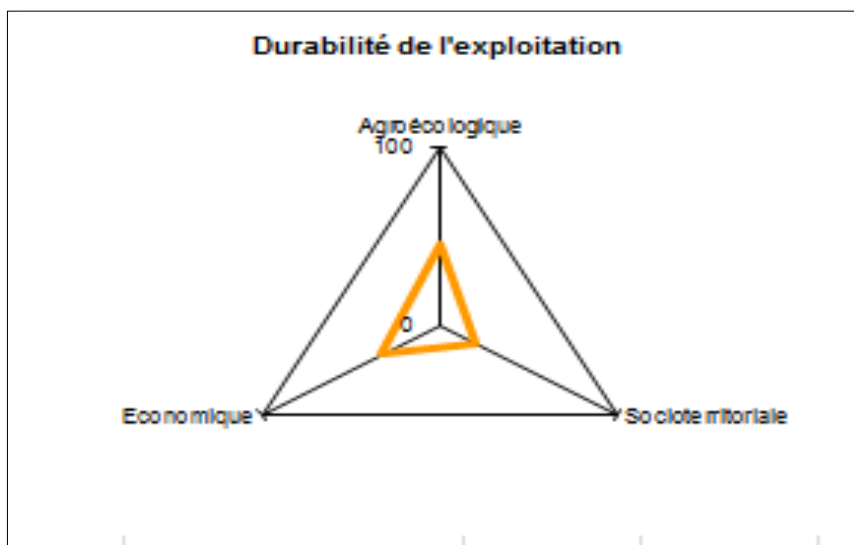
**Table 4.** Distribution of agro-ecological, socio-territorial and economic sustainability.

**Rule of 3 to reduce all max to 100**

	obtained Score	Maximum	obtained Score	Maximum
Diversity	6	33	18	100
Organisation of the space	15	33	45	100
Agricultural practices	25	34	74	100
Quality of products and territories	4	33	12	100
Employment and Services	10	33	30	100
Ethics and human development	6	34	18	100
Viability	0	30	0	100
Independence	15	25	60	100
Transmissibility	15	20	75	100
Efficiency	3	25	12	100



**Figure 6.** Theoretical averages and maxima of sustainability component scores. Source: Enquêtes-2017-2018.



**Figure 7.** Sustainability of operations.

#### 4.2. Agro-Ecological Sustainability

The average for agro-ecological sustainability was 46 points out of 100. This pillar of sustainability brings together ecological diversity, spatial organization and agricultural practices. Figure 5 shows the large difference between the average of this component and its theoretical maximum. The farms are less diversified in terms of production and the activity as carried out does not promote the maintenance of specific soil diversity. Among the indicators of this component, only that of "Valorization and conservation of the genetic heritage".

#### 4.3. Socio-Territorial Durability

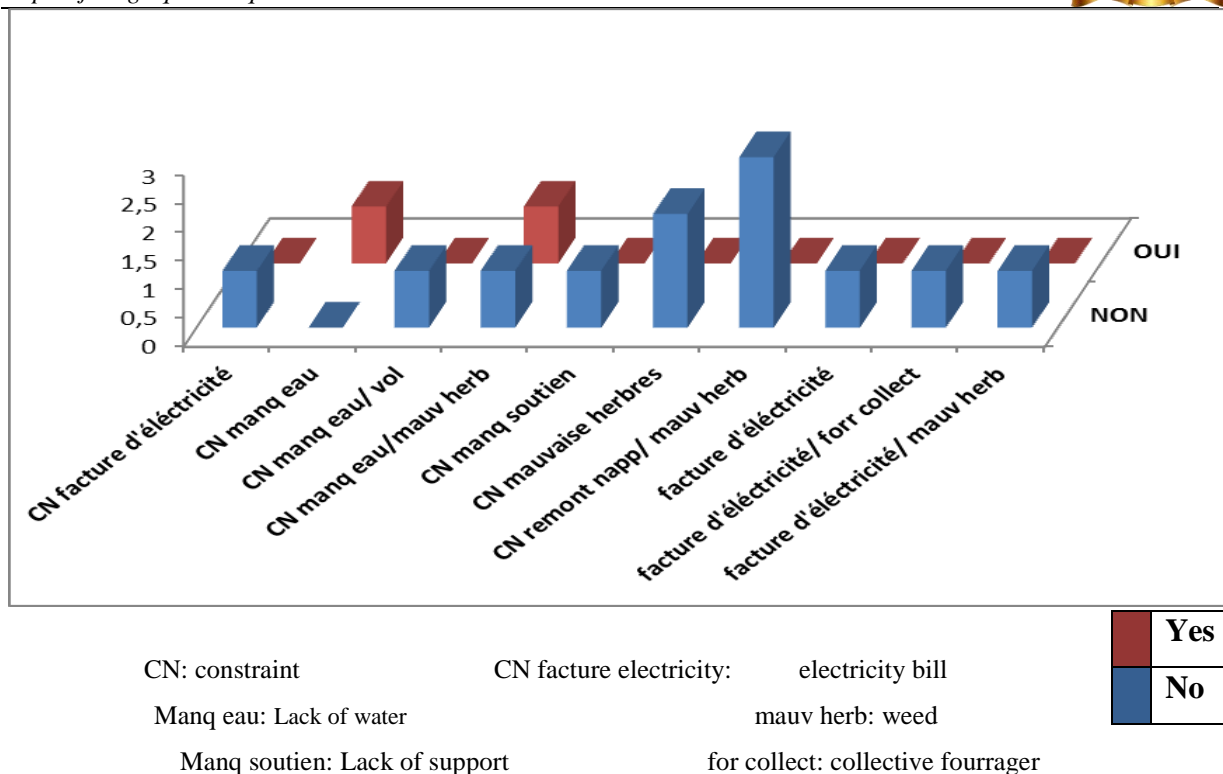
The average of this dimension of sustainability was 20 points out of 100. The average for this dimension of durability was 20 out of 100 points. This pillar of sustainability has three components: human development, management and quality of production and employment and local development. The "human development" component had an average of 18 points with a maximum of 33 points. This indicator is less represented on farms in this region

#### 4.4. Durability Economic

This sustainability scale has four components: sustainability, transferability, independence and efficiency. Had a dimension of 33 out of 100 points. Vegetable farms are. These observations are linked to the small cultivated areas which do not allow producers to reap high profits.

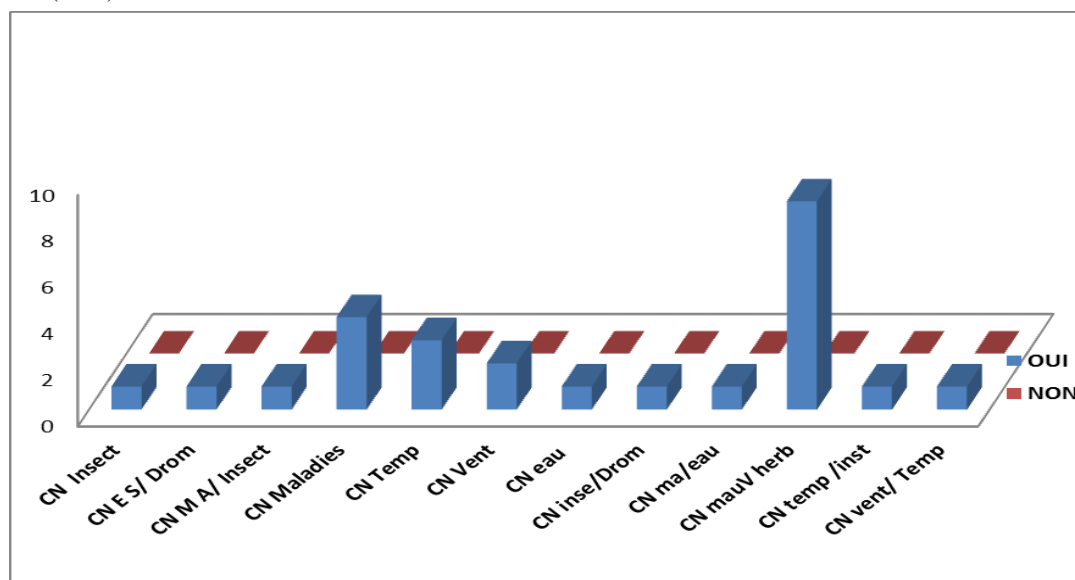
#### 4.5. Socio-Economic and Environmental Constraints

Compared to the investigation used we have highlighted the differences constraints by the statistical analysis (Excel stat (table of constraint)



**Figure 8.** The constraints of agriculture in N'goussa.

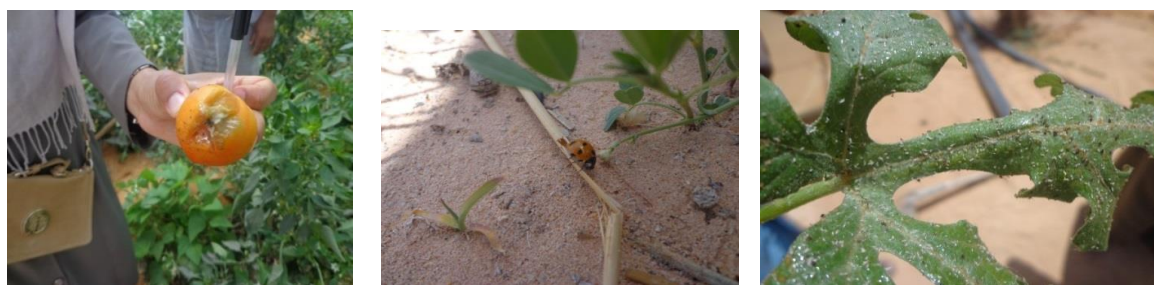
The main problems of the developed agricultural system (phoenicultural and market gardening) in the farms of N'goussa can be summed up in the problem of weeds present in 50% of the farms, the problem of the rising water table (27%) and the lack of water.



CN: Constraint, ES: Salt Water/Drom: Dromedary, Inse: Insect, Temp: High temperature, Ma/water: Lack of water  
 Ma: Diseases

**Figure 9.** The constraints of agriculture in Hassi Ben Abdellah.

Compared to the zone of Hassi Ben Abdellah, the constraints reported in the farms: insects by 27% and diseases by 23% affecting market gardening and the high temperature of irrigation water is a problem reported by 23%, followed by the weed problem by 80%.



**Figure 10.** The various diseases of greenhouse crops in Hassi Ben Abdellah.

#### 4.6. Socio-Economic Constraints

The constraints related to socio-economic problems in our study are mainly: the cost of electricity, lack of manpower and the problem of theft, the increase in the price of fertilizer and seed. This implies that the economic environment has a strong influence on the functioning of these farms.

#### 4.7. Environmental Constraints

Among the environmental problems from which the farms suffer we mention the diseases that affect market gardening crops especially, silting (problem of wind and the absence of wind breezes) and the great problem of weeds especially (Guesab: *Phragmites communis*) problem of drainage functioning that occurs mainly in the area of N'goussa (old palm grove).

The natural conditions in the Ouargla region require a rigorous management of these conditions in order to achieve acceptable agricultural production.

Analysis of the results (1st Figure) indicates that the most dominant natural constraint in the region raised by the farmers is climatic: frequent and violent sand winds cause damage to young plantations. Silting of the development perimeters may occur in the medium term. To cope with this phenomenon, the need to invest in the establishment of adequate wind breakers becomes an absolute necessity for the protection of these recent farms following the problems affecting crops, especially market gardens (diseases).

The water stress in these desert environments is forcefully raised by farmers despite a very large underground water reserve in the region.

The study by DADAMOUSA et al [8] also indicates the constraints on the environmental level: soil pollution by salinisation and the waste of non-renewable fossil water.

### Conclusion

Our study showed that the monoculture system (date palm) in the N'goussa area is slowly evolving and remains more stable and sustainable. On the other hand, in Hassi Ben Abdellah, the Phoeniculture farms have been extended by the introduction of market gardening. The polyculture system (Phoeniculture and market gardening system) in the two study areas is evolving through farming practices and techniques (mechanical ploughing 50%, use of organic manure more than 90%, crop treatment more than 80%). For the "abandonment" system, most of the farms are transformed into "fallow" land. The areas of Hassi Ben Abdellah and N'goussa have experienced a remarkable dynamic in the development of market gardening in greenhouses. This situation is the result of an evolution of the production system which was mainly phoenicultural and underwent profound changes to give birth to a market gardening production system and a mixed production system (market gardening - phoenicultural). The Ouargla region's Farm Sustainability Indicator (IDEA) is important. The assessment of agro-ecological, socio-territorial and economic indicators indicates that the agro-ecological indicator is the most represented by (the indicator of fertilizer and agricultural practices) by 46 out of 100. The management of development perimeters or operations is complex for the management and development actors and for the operators.

Several natural and socio-economic constraints exist and they constitute an impediment to agricultural development in the Ouargla region. Indeed, the scarcity of irrigation water, desertification, diseases of

certain crops, the fragmentation and narrowness of farms and weeds are natural and socio-economic constraints that limit agricultural development in this region.

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