Journal of Research in Ecology

An International Scientific Research Journal

ISSN No: Print: 2319 –1546; Online: 2319– 1554

Original Research

Agricultural dynamics of Saharan oasis and its influence on agro-biodiversity: Case study of palm date farms in Ouargla (Algeria)

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ABSTRACT:

Palm dates farms in Ouargla (Southern Algeria), has experienced a very important agricultural dynamics in space and time. Nowadays, there is an obvious deterioration in plant genetic resources, especially, for indigenous seeds and local dates palm cultivars. Our work is inspired by three farming systems namely the old oasis, its extension and the new land farm developed.

The results of this study showed the predominance of two so-called commercial varieties (Deglet Nour and Ghars). However, the so-called common varieties representing the genetic diversity of date palm present significantly at lower percentages; 11.70 % for old oasis; 7.45 % for extension of old oasis and 3.56 % at the new land developed. For the seeds we have identified, 28 species crossed locally. The new system presented the lowest percentage with only one farmer producer of the seed.

The ancient oasis and its extension concealed until now, an indisputable agro -biodiversity which must be preserved. Unfortunately, there is a low flow of knowledge and phytogenic resource transfer from ancient to new system. The notion of plant genetic erosion is discussed as well as recommendations and perspectives are proposed.

Keywords:

Cultivars, Erosion, Farming systems, Local seeds, Knowledge.

Article Citation:
Belaroussi Med El Hafed Halilat Med El Tahar, Dadamoussa Med L Akhdar, Idder Med Azzedine, Idder-Ighili Hakima, Boualala Med and Boummada Abd-Elbasset
Agricultural dynamics of Saharan oasis and its influence on agro-biodiversity: Case study of palm date farms in Ouargla (Algeria)
Journal of Research in Ecology (2018) 6(1): 1445-1455

Dates:
Received: 28 Jan 2018 **Accepted:** 24 Feb 2018 **Published:** 16 Mar 2018

Web Address:
http://ecologyresearch.info/documents/EC0521.pdf

Journal of Research in Ecology

INTRODUCTION

The oasis agriculture is based on the cultivation of date palm *(Phoenix dactylifera* L.) associated with other cultures *viz*., tree, market gardening, forage, condiments etc., It is also called the oasis ecosystem (Ben Abdallah 1990). Date palm is the backbone of the economy of oases at arid regions, not only to the microclimate it creates to the other shrubs/herbs, but also for products and by products it generates for human, animal feed and various uses necessary to live at oasis (Meradi *et al*., 2016).

The palm is also a different garden estate apart from the architecture standpoint, faunal composition, floristic, age, operation, maintenance, microclimate etc., and form a pretty extensive set that reminds us the appearance of a forest (Idder and Bouammar, 2011). Currently, the development of farming areas and introduction of new farming systems are now becoming a primary objective for rural development at Saharan wilayah (Lakhdar *et al*., 2015).

The inventory work on the varities of date palm at Algeria, were carried out at 70 areas with 14 regions showed that the Algerian palm groves still retain a significant diversity. Indeed, 940 cultivars have been identified in these groves, (Benkhalifa 1996; Hannachi *et al.,* 1998). Several studies have revealed an alarming decline of oasis with regard to the plant genetic resources with a loss to local knowledge. The palm of Ouargla which is a part of the great oases of the Algerian Sahara, has experienced significant deterioration of its heritage phoenicicole (Bouammar, 2010).

The indegenous seeds are essential to the world, they are the source of our food, they are also the guarantors of agricultural biodiversity. The genetic diversity of wild and cultivated plant species are now in decline. FAO estimates that about 75% of the genetic diversity of agricultural crops have been lost since the beginning of the last century. Seeds are at the heart of major issues such as food security, independence of farmers, but also biodiversity.

Many studies of traditional agricultural systems in developing countries have shown that peasant practices on seed management were the key local adaptation for maintaining genetic diversity, through coexistence in the populations of all evolutionary mechanisms such as selection, genetic drift, migration, mutation (Almekinder *et al.,* 2000; Louette *et al.,* 1997; Berthaud *et al*., 2001; Elias *et al*., 2001; Alvarez *et al*., 2005). Usage rights of farmers over their seeds, reproduce, multiply, exchange, sell, threatened by normative frameworks of industrial seeds (catalog, property rights and patent). The traditional farmers' varieties are also distorted by genetically engineered and patented plants (GMOs) (BEDE, 2016).

In addition to genetic erosion observed on the cultivars of date palm, the oases experienced strong genetic erosion following the introduction of new varieties called ‘improved’, particularly for annual species. Some local varieties may disappear completely in a few years if they are not carefully collected and stored (Abdallah, 1990). The major constraints recorded that are partially responsible for the degradation of oases and consequences noted on agro-biodiversity are agronomic. Their genetic erosion, aging of the palm grove, ecological fragility of the environment and silting and socio economic issues including inheritance and rural dispersal are high (Idder and Bouammar, 2011). It is in this context that our study take stock of the situation instead of changing date varieties and farmers' seeds. This study is based on the choice of three representative crop systems of the dynamics of agriculture in time and space at the Ouargla region. This is the old oasis, the extension of the old oasis and new variety development.

MATERIALS AND METHODS

The researcg locality is at the province of Ouargla. It is located at the Southeastern Algerian deep in a small basin Oued valley, about 800 km from Algiers. It

Table 1. Selection farms and agricultural stations

S. No	Culture System	Oasis	Extension of the Oasis	New farm developed	Total
1	Holdings	09	20	31	60
2	Stations	K'sar Chott	Mekhadma, Rouissat, El Bour Haicha, Moussa Aouinat and Bamendil	Hassi Ben Abdallah Kaf El Soltan	08

is at altitude of 164 m, 31° 57' north and 5°19' east, the region and is characterized by intense aridity (Troin *et al*., 2006). It is defined as the result of the combination of low rainfall and of the intensity of the phenomena and evaporation related to the high temperatures (Lacoste, 2003)

For our study, we chose three cropping systems that represent the dynamics of agriculture in time and space at Ouargla (Figure 1).

- The ancient oasis where the palm is subject to significant degradation.
- The extension of the old oasis that gave birth to agriculture "peri" or small setting constituted value of small and medium farms.

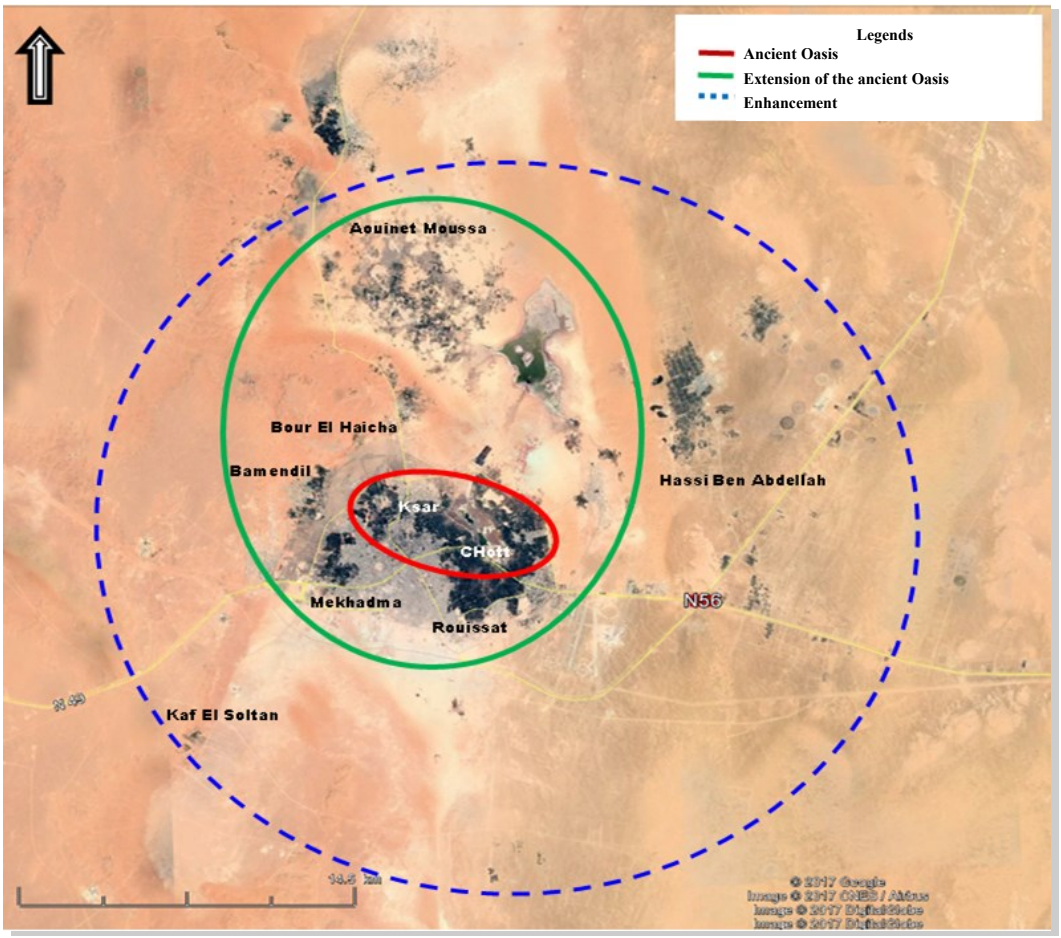

Figure 1. Sampling areas in the study area

Table 2. Analysis of the variance of the number of cultivars by culture system

S. No.	Source	DDL	Sum of Squares	Mean square	F	Pr > F
1	Model	2	58.758	29.379	5.206	0.008
2	Error	57	321.642	5.643	-	-
3	Total	59	380.400	-	-	-

Table 3. Fisher's Test (LSD), analysis of the differences between the terms with a confidence interval of 95%

S. No	Modality	Estimated average	Groups	
1	Ancient oasis	7.56	AT	-
2	Extension	6.00	AT	B
3	Enhancement	4.47	-	B

- The great new farm development through extensive programs, Investments in agricultural areas supported by the public power.

The criteria for selection of farms that we have selected are:

- Administrative data and literature available.
- The accessibility for exploitation.
- The presence of an agricultural activity.
- Direct contact with the operator.

Through surveys conducted at farms and investigations at the local market supported by interviews with some farmers 'seed collection enthusiasts, we tried to identify different cultivars of date palm trees and farmers' seeds in the three cropping systems. The number of farms and stations culture system are presented in Table 1. The survey was conducted over an eight-month period from September 2015 to April 2016 and investigations were carried out at three levels, which are closely related to the operation, the local market and seed collectors.

At the farm level

The characteristics of the operations, including the varieties of date palm, seed collection and description of the multiplication mode and destination of the production thereof.

At the local market

The identification of farmers' seeds and notification of their origin. Many visits were performed to harvest several samples of the above said local seeds.

At collectors

Many contacts with seed collectors were established in order to have as much information on seeds namely:

- The origin and seed multiplication mode
- The preservation of rare seeds.

Statistical analysis

An analysis of variance (one-way ANOVA) was performed on the number of varieties for cultivation system. A Factorial Correspondence (AFC) analysis is performed on the specific composition of seeds of the

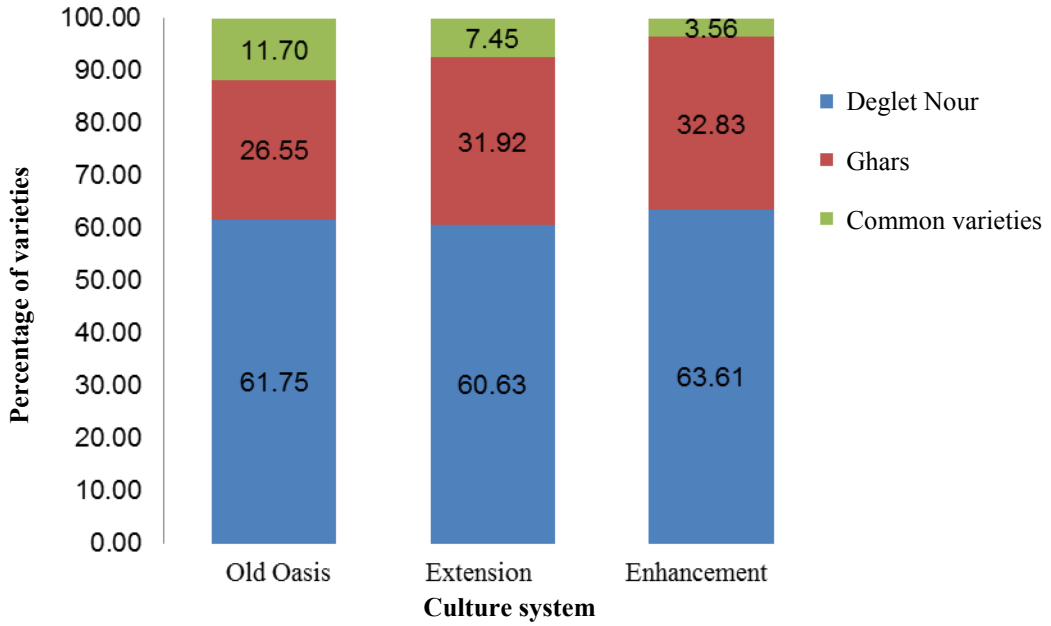

Figure 2. Percentage of varieties of date palms by culture system

culture system by XLSTAT software 2009 (version 1. 02).

RESULTS

Varietal quantitative inventory of date palm

Figure 2 shows two predominant varieties Deglet Nour and Ghars in the three cropping systems, 88% to the ancient oasis, 93% for the extension of the old oasis and 96% in terms of new farm development. Many lesser-known varieties are common but their presence is at much smaller percentages. The analysis of variance (Table 2) made on the number of varieties of palm (sixty samples) showed a very highly significant difference between the three systems (p = 0.008). According to the Fisher's LSD test (differences between the terms analysis with a 95% confidence interval) we note the existence of three groups, namely a group (a) an average of eight cultivars, an intermediate group (ab) six cultivars and a third group (b) five cultivars (Figure 3, Table 3).

Varietal composition of date palm in the three cropping systems

According to Figure 4 and from the results obtained through the inventory of varieties of date palm in the three cropping systems, it appeared that:

- These varieties are observed in the three cropping systems and are frequent. These are: Deglet Nour

Table 4. Determination and classification of peasant seeds

S. No	Seed	Scientific name	Family	Percentage
1	Melon	*Cucumis melo* L.	Cucurbitaceae	14%
2	Pumpkin	*Cucurbita maxima* L.	Cucurbitaceae	14%
3	Squash waxy	*Benincasa hispida*	Cucurbitaceae	14%
4	Watermelon	*Citrullus lanatus*	Cucurbitaceae	14%
5	Alfalfa	*Medicago sativa* L.	Fabaceae	14%
6	Peas	*Pisum sativum*	Fabaceae	14%
7	Green bean	*Phaseolus vulgaris*	Fabaceae	14%
8	Fenugreek	*Trigonella foenum graecum* L.	Fabaceae	14%
9	Tomato	*Lycopersicum esculentum*	Solanaceae	11%
10	Chilli pepper	*Capsicun annuum* L.	Solanaceae	11%
11	Eggplant	*Solanum melongena* L.	Solanaceae	11%
12	Carrot	*Daucus carota* L.	Apiaceae	11%
13	Celery	*Apium graveolens*	Apiaceae	11%
14	Coriander	*Coriandrum sativum* L.	Apiaceae	11%
15	Kale	*Brassica oleracea acephala.*	Brassicaceae	11%
16	Turnip	*Brassica rapa*	Brassicaceae	11%
17	Rocket	*Eruca sativa*	Brassicaceae	11%
18	Safflower	*Carthamus tinctorius*	Compositaceae	7%
19	Lettuce	*Lactuca sativa* L.	Compositaceae	7%
20	Oat	*Avena sativa* L.	Poaceae	7%
21	Sorghum	*Sorghum vulgare* L.	Poaceae	7%
22	Okra	*Hibiscus esculentus* L.	Malvaceae	7%
23	Cotton	*Gossypium* L.	Malvaceae	7%
24	Chard or bette	*Beta vulgaris* var. *cicla* L.	Amaranthaceae	4%
25	Basil	*Ocimum basilicum*	Lamiaceae	4%
26	Onion	*Allium cepa* L.	Liliaceae	4%
27	Henna	*Lawsonia inermis*	Lythraceae	4%
28	Purslane	*Partulaca oleracea* L.	Portulacaceae	4%

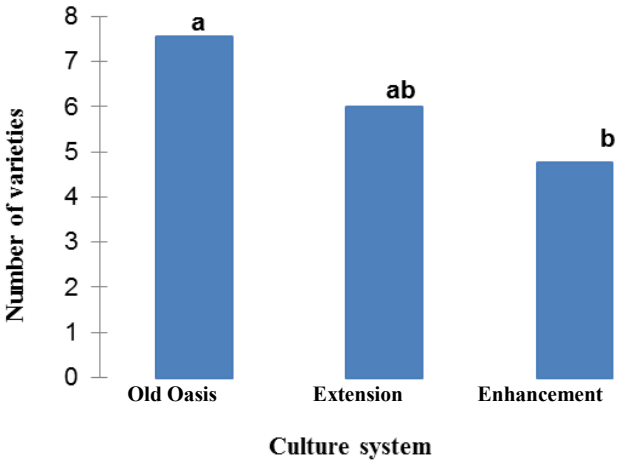

Figure 3. Chart of the average number of cultivars by culture system

Ghars Litim, Bentkhbala, Tafezwin, Tamesrit, Mizit Ali wrached and Degla Beida.

- Other varieties are common to two cropping systems, the ancient oasis and extension. They are described as moderately frequent. These varieties are Takarmust Timjuhart, Taddela and Tazerzayt.
- These are some varieties belonging to the ancient oasis which are rare to be considered. These are Bayd Hmam Al Khabia, Hamraya Tati watnuh, Ticherwit, Abde the azzez, Azerza, Bajmil, Degla safra, Tawdant and Degla Lhamra

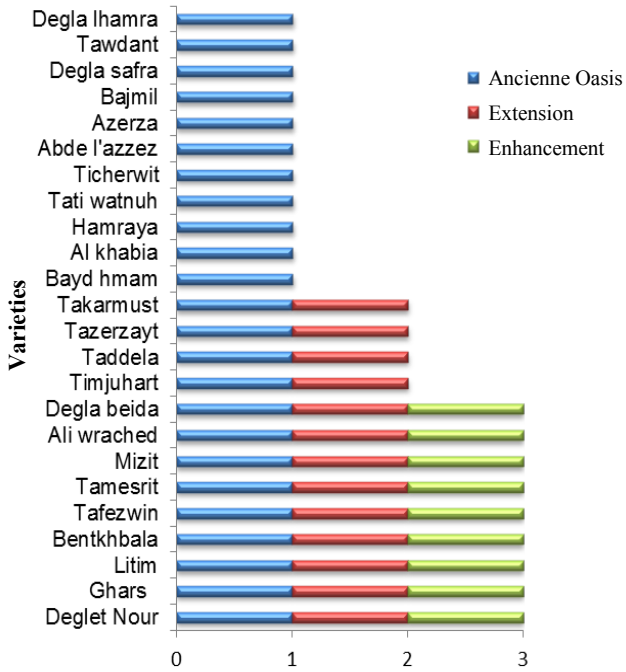

Figure 4. Composition of date palm varieties in three cropping systems

From Figure 5, the results of investigations in Ouargla region at all the three culture systems have demonstrated the distribution of the 61 samples identified at all the three culture systems. The local market has 41% of identified seeds, extension of the old oasis 39%, the ancient oasis 10%, the local market 7% and 3% from the collectors.

Inventory and classification of peasant seeds

From Table 4, there are 28 seed species in the three systems of locally produced crops, seeds are spread in 13 families.

Distribution of farmers' seeds in the study area

According to Figure 6, the ancient oasis and its extension have more percentage production of farmers' seeds and are important locally. The new farm development has shown only little seed production.

- The old oasis is characterized by the production of nine seeds. We can mention the green beans locally called Tadelakhat, the arugula called Djardjir, the carrots, the celery, the savoy cabbage, the basil, the henna, the chard and lettuce.
- In the extension of the ancient oasis nineteen peasant seeds including carrot, coriander, safflower, kale, chard, the melon, Wax gourd, alfalfa, peas, sorghum, basil, onion, okra, cotton, purslane, tomato, pepper, eggplant and pumpkin were mainly occured.
- New farm development is characterized only by the production of four seeds namely carrot, chili, alfalfa and melons.

Farmers' seed production mode

The supply of seed farming in the study area is from three sources: his own farm if seeds are produced locally, neighboring farms and palm groves, i.e. seed exchange between farmers and the local market. Farmers adopt any one of the following methods for the production of seeds:

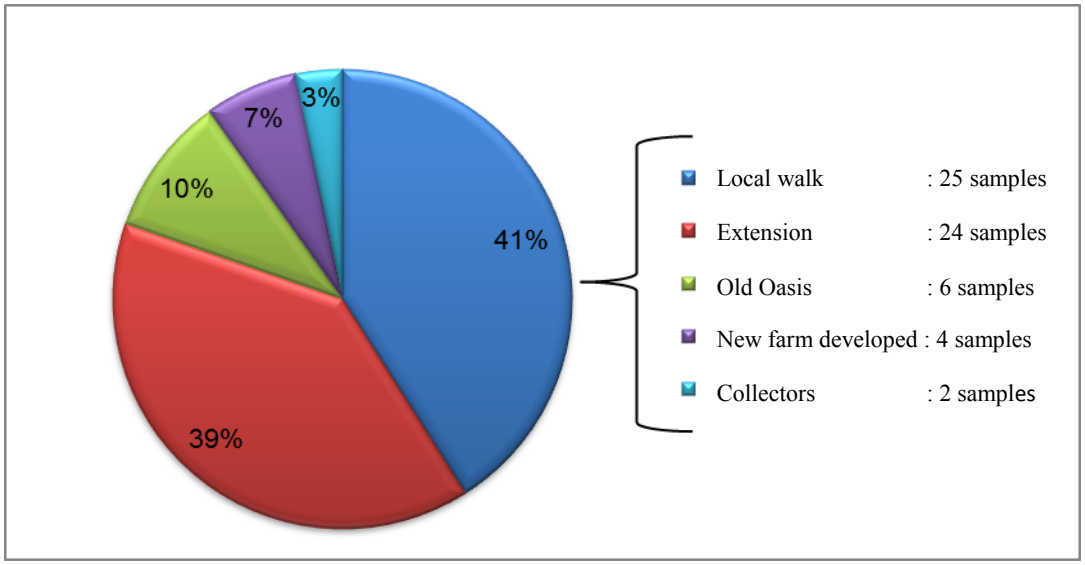

Figure 5. Distribution of farmers' seeds by origin from

- Seed producted was initiated by the allocation of a complete surface or plate for culture (Figure 7). The board worked well and irrigated more than other amenities of the exploitation. The farmer's took great importance to the seed used (size, phytosanitary state) to ensure good production. For this method, the plants were left to maturity and waited until total dryness. The farmer's selected and harvested the best plants, which are stored in a dry and ventilated room. The seeds are

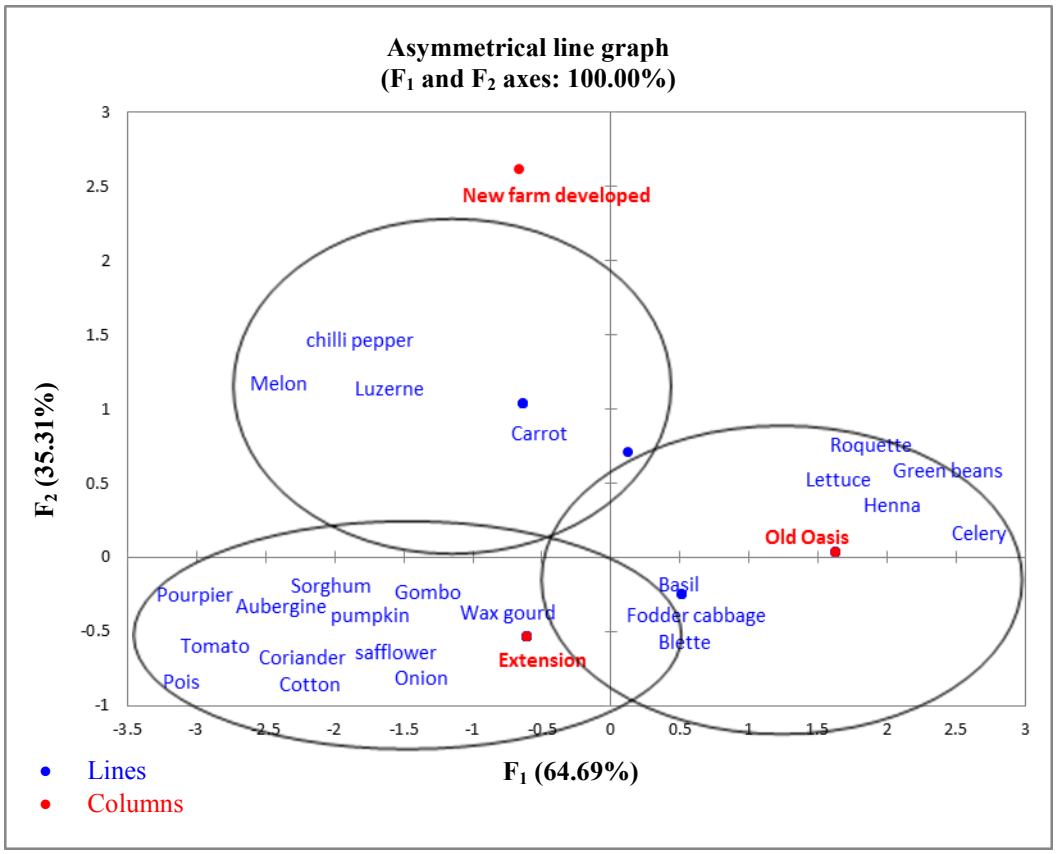

Figure 6. Factorial correspondence analysis of seed produced in the three cropping systems

Figure 7. Culture in the local chili field for seed production in scope of development

collected and packed in boxes or cloth bags. Most seed is intended for the market.

- The farmer's cultivated several agricultural species on the same plot in an associative system (such as basil, egg plant and oats). Culture is intended for family consumption leaving. One or more plants for seed production. Sometimes it's not the whole plant which is selected but just the first fruit that appears on the plant (the ripen fruit is harvested and kept separately). The fruit is allowed to dry in a ventilated place without moisture and the beans are sorted and stored in boxes or canvas bags.

DISCUSSION

According to our investigations, the varietal phenotypic research in the study area showed a predominance of commercial varieties namely Deglet Nur and Ghars (Figure 2). As against the common varieties the so-called "Aoula" also intended mostly for home consumption, they have significantly lower percentages. The percentage of common varieties is 11.70% to the ancient oasis, 7.45% for the extension of the old oasis and 3.56% for the new farm development (Figure 2). These figures reflect a low representation of the varieties compared with two dominant cultivars namely Deglet Nour and Ghars. According to Idder-Ighili (2016) and Bousdira (2007), varieties such as Dgoul, Aoula are devalued and often improperly called communes that have some nutritional value despite their low market values.

The number of varieties in cultivation system is a discriminating factor because it brings up three distinct groups: the ancient oasis with eight cultivars, extention of the ancient oasis with six cultivars and the developed new farm with five cultivars (Figure 3). The ancient oasis, is a special and diverse agro-ecosystem of agro-ecological. Figure 4 clearly shows a wide range of cultivars (24). At the extension of the old oasis existence there are 13 varieties. By enhancing the number of cultivars it is reduced to nine. Therefore, there is a selective orientation of a number of cultivars. Hannachi and Khitri (1991) highlighted sixty varieties; Buelguedj (2007) reported 59 varieties in Ouargla region and Idder-Ighili (2016) reported the existence of 55 cultivars. Our work investigated and revealed a total of 24 cultivars. Faced with this situation we are witnessing a regression of cultivars in time, and therefore we could evoke the notion of genetic erosion.

The inventory of farmers' seeds in the study area in the three system of cultures namely the ancient oasis, the extension of the old oasis and the new farm development as well as the local market and interviews with collectors of seeds produced locally showed a specific variability notably. Altogether the presence of 28 vegetable species, forage, cereal and condiments notably (Table 4). The species of seeds locally produced and researched are divided into 13 families, mostly the cucurbitacées (14%), the pea crop (14%) Solanaceae (11%) and Apiaceae (11%). These families are represented essentially and successively by seed pumpkin, wax gourd, alfalfa, carrot, celery, coriander, tomato and aubergine chilli. According to our investigations, these seeds are well adapted to the soil and climatic conditions of the study area namely soil salinity and high temperatures.

The local market with 41% of samples of peasant seeds (Figure 5) were represented by two traders who like main activity of the sale of medicinal

plants, traditional seeds and condiment products. Sometimes you can meet farmers who are both of sellers of their own seeds to the local market. Some seeds may come in therapeutic preparations as medical remedies or also used as a condiment. The transaction and purchase of seed producers in the region is primarily based on a perfect relationship of trust between seller and buyer. According to the factorial correspondence analysis of seed produced in the three cropping systems (Figure 6), the ancient oasis produces eight peasant seeds, extension of the old oasis with 19 and new farm development with four. Collectors have provided us two peasant seeds, the local market has 23 species. From this observation we could argue that the extension of the old oasis constitute the main source of supply of the local market peasant seeds.

In terms of development, we met one farmer producing four peasant seeds. The value setters generally are young with lack of knowledge and information on the practices of farmers' seeds produced locally. At this system the operator makes use of conventional import of seeds. Furthermore, monoculture is virtually present. According to Abdelguerfi (1988) and Rahal Bouziane (2006), formerly cultivated varieties or populations have been neglected. They have been replaced by the foreign material with high genetic potential, but very demanding and often inappropriate. These new varieties have replaced traditional varieties, a source of genetic diversity - "the new chased the old" (Fraleigh, 1989).

The transfer of the flow of knowledge from the ancient oasis and its extension to the new farm developed is very low. The industry requires standardized seeds instead of traditional seeds. It promises a better return from the first harvest but fails in the health as they are importing chemical fertilizers. The same plants are placed everywhere which poses a threat of new out break of novel diseases. Also, you have to pay for this efficiency of hybrid seeds everytime; this will escalate and force the farmers to buy them in the next year (BEDE, 2014). The oases are a special and unique ecosystem of its kind in the world. Genetic diversity of date palm has emerged from a long process of natural evolution and the patient work of the farmers. (Ben Salah, 2013). Today, oases suffer from the consequences of a profound deterioration largely due to socio-economic mutations among which we mention the stress of inheritance, hand-aging work and the loss of local expertise.

CONCLUSION

Our study raises the existence of genetic erosion at two levels:

- Decline of phenotypic heritage
- Significant reduction of farmers' seeds

Our investigations have shown that the ancient oasis remains the main reservoir of agro-biodiversity. Many observations have shown that local seed grown ecologically can produce superior or equivalent yields than conventional farming.

The results of this study brought very significantly low transfers of plant genetic resources from the ancient oasis towards development. To save this agricultural biodiversity and to ensure its sustainability, a number of guidelines is to be considered:

- For older cultivars or endangered, consider an *in vitro* culture program of their propagation.
- The creation of farmers' associations may be involved in research projects and in making political decisions.
- The popularization of agro-ecological activities for the contribution to the conservation of plant genetic heritage through schools, print and broadcast media

Seed companies are the guarantors of agro biodiversity and are good indicators for the conservation of peasant seeds. In this sense we recommend the strengthening and preservation of biodiversity to improve food production, harmonization between environ-

ment and production systems to ensure the health of man and farmland and to maintain a level of food self-sufficiency. Further investigations are required to undertake for identifing other peasant seeds or cultivars of still unknown date palms.

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