

## Original Research Article

# Characterization of the argan tree of southwestern Algeria

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## ABSTRACT

### Keywords

Argania  
area;  
conservation;  
GIS;  
structure;  
Tindouf.

The Argan tree in Algeria is one of the media characteristics whose existence depends heavily on riparian water from wadis and springs. This species plays a very important role in its ecological interest in maintaining ecosystem weakened by desertification, as its economic interest. In therapeutic medicine, its role is not to demonstrate (prevention against cardiovascular disease, prostate cancer, diabetes. Until now, in Algeria, no exact scientific information has been published giving an overview of the Algerian argan (location, size, condition stands). This study is to develop a synthetic cartography of Algerian argan be a tool for decision support operations management space and a framework for action manager. The area mapped using the GIS tool allowed us to locate sites argan and delineate. Based on three zones mapped, a structural study (horizontal and vertical) was made on populations of the argan tree Algerian region of Tindouf. Systematic sampling was adopted where the phytoecological surveys were distributed over the three perimeters Touaref Bou Aam, Merkala and Targant. The parameters studied are: the height, density and surface crown, while making a germination test seeds from three sites in order to assess the production potential of this ecosystem quality seed. The results show that the argan Algeria (Tindouf) occupies an area of 96,940 hectares spread over three main perimeters. The study of horizontal and vertical structures stand argan told us that the area Targant is one that can provide quality seeds, as the elite trees are identified in this area, however, the total area of the argan within this scope can be a strain on the intensive exploitation of this species.

## Introduction

Algeria offers a rich and diverse flora, characterized by a large number of endemic species. This remarkable biodiversity linked to the existence of diverse ecological conditions is well illustrated by the Argan tree which represents the species in Algeria that is a

crossroads of the floras of different origins: Mediterranean and Saharan.

Argan tree or *Argania spinosa* (L). Skeels, is a rustic species, xero-thermophilic, which belongs to the tropical family of Sapotaceae, hence it is the only Northern

representative in the Mediterranean region (Algeria and Morocco) where its endemism is marked at this region. It has great medicinal interest (Adlouni, 2009) and therapeutic (Bennania et al., 2009). This thanks to the oil extracted from its fruits. Furthermore, it is very sought in cosmetics as a skin and hair a revitalizing agent. Stands of this species play important ecological and environmental roles (Bezzala, 2005). Its geographic distribution covers a relatively large area in Algeria, at the northwest of Tindouf, wherein this tree is the second forest species after *Acacia raddiana* (Direction Generale des Forêts "DGF", 2009).

It forms in the territory of the scattered settlements along the banks of wadis where required water compensations are found for its development. The phytosociological study of Algerian Arganerie was founded in 1986 (Baumer et al., 1999)

The current state of the Algerian Argan raises concerns, because in addition to the loss of vigor and its loss of a floristic point of view, the surface regresses (Benabid, 2000), where 2/3 of heritage have disappeared (Brahim, 2007). This degradation appears to be mainly due to anthropogenic factors, overgrazing and cutting fuel wood.

The conservation, evaluation of functional characteristics and enhancement of this particular ecosystem require foremost a delimitation of its distribution which will enable us to distinguish the main argan perimeters then identify some indicators of growth and structure namely: the height, density and surface crown and those in

order to give an assessment of the ability of the ecosystem to provide a potential production of quality seeds which enable the constant regeneration and recovery.

## **Materials and Methods**

The study area is located northwest of the wilaya of Tindouf (south-western Algeria) on an area of 296,000 ha between 8 ° 05'00" W and 8 ° 40'00" W, 28 ° 25 '00" N and 28 ° 45'00" N, bounded on the north by Oued Draa (Moroccan border) and to the east by the wilaya of Bechar, south-east by Adrar and at south by Mauritania, so it is limited to the west by Western Sahara and Morocco. Our study area is characterized by a Saharan climate with cool winters, maritime under the influence of moist winds from the Atlantic Ocean. These climatic conditions give to the area a very rich flora (Chevalier, 1943). We note that almost all of the vegetation in Tindouf region occurs in beds of wadis and depressions because the land at north and west consist of Reg and Hamada.

## **Materials and Methods**

For the delimitation of argan perimeters and characterization of stands, we used the following materials: Topographical map of Tindouf in Algeria-(sheet Merkala 1/200 000); Argan tree distribution map in Algeria published by DGF in June 2009 (Figure. 1); Digital terrain models (DTM) 30 meter of resolution, Google Earth satellite images made a spot image mosaic (2.5 m) and Digital Globe (60 cm); Cross of logger which comprises two rods of equal length are placed perpendicularly to each other;GPS; Germoirs with compost for germination test of argan seeds; Software of statistical processing MINITAB, 2000.

## **Delimitation of argan tree perimeters**

Office work preceded the field trips, where the hydrographic network, the toponymy and boundaries of the Algerian-Moroccan borders were vectorized from the topographic map. The contour, the slope map, map directions and map slopes orography have been generated from the DTM. Vegetation overall was vectorized from Google Earth images.

We divided the study area into geo-mails referred (Tazi et al., 2003) for two kilometers on each side (4 km<sup>2</sup>), (UTM Projection, Datum WGS84, Zone 29 North, Unit meter), then we superimposed this grid of mails on satellite images Google Earth. This superposition has allowed us to obtain support for field prospection.

This method enabled us to divide the Argan distribution area into several distinct habitats, taking into account the physiognomic criterion of stands, the floral procession, the rate of recovery and the type of stations on edaphic and geomorphology Plans. The merger of all these criteria has outlined the main Argan perimeters.

## **Characterization of argan stands**

### **Sampling**

We selected a systematic sampling where phytoecological surveys have been randomly placed one after the other in a systematic network of lines corresponding to the hydrographic network (Long, 1974). During our fieldwork we considered the following criteria: Overall vegetation cover; Density of Argan trees; Appearance of new species of the floral procession; Change in the soil substrate;

Seed samples of argan were collected at random during each survey on different trees.

### **Measurement of trees**

Sampling was carried out for three main argan perimeters, namely Targant, Merkala and Touaref Bou Aam, where the number of reports (geo-referred) differs from one area to another because of the degree of heterogeneity observed during field sampling. The characterization of the Argan stands by fixing the height, the surface crown and density were made as follows:

The measurement of height (expressed in meters) by using the method of cross lumberjack is based on the principle of similar triangles while taking into consideration the position of the tree (Dallmeier, 1992). The user holds this cross at chest height where he is right in front of tree and by moving backwards and must match the first horizontal rod with the base of the tree and the second vertical with the top. The distance separating it from the tree corresponds to its height.

Measuring surface crown (expressed in square meter) was made by the projection of the ends of the crown on the ground by assimilating its form to a geometric shape in order to measure its surface.

Tree density (expressed in number of trees per hectare) was estimated by counting the number of Argan trees per hectare.

To make sense to these findings, we applied analysis and statistical tests by using MINITAB 2000 software, these parameters are: correlation, one-way ANOVA and the NEWMAN and KEULS test for determining homogeneous groups.

### **Germinal test of argan seeds**

During sampling we collected seeds in each argan perimeter. The test is performed at the base with 72 seeds for each area either 216 argan seeds of the entire experimental protocol. After been steeped in warm water for 48 hours (Nouaim, 1994), the seeds are placed in cells containing soil to a depth of 2 cm (Arif, 1994) in a greenhouse where the average temperature during the test varies between 25 and 28 °C (Berka *et al.*, 2001). After 01 months of trial period, the most important factor of germination which has the germinal capacity where germination rate is fixed for each perimeter.

### **Results and Discussion**

Our fieldwork was carried out over a total area of approximately 296,000 hectares, where we were able to delineate the natural area of Argan, whether in the form of stand al or dispersed into individual. The result of the office work associated with the fact on ground are represented as a map as shown in Figure. 2.

According to the distribution map of the Argan tree, we find that the argan forest covers a total area of 96,940 hectares spread over three main schemes: the first is Touaref Bou Aam which is the largest perimeter, the second is Merkala and the third is Targant. We also note that there is a continuity of the Argan tree between the two perimeters of Merkala and Targant which cover an area of 21,080 hectares and Touaref Bou Aam perimeter spreads over an area of 72,490 hectares. The altitude of the presence of Argan tree varies between 315 and 630 meters.

### **Targant perimeter**

It is located at the western end of the forest house about 45 Km; characterized by rocky and very rugged escarpments where Argan stands dominate upstream of the river. The total area of this species is less important compared to Merkala zone. Argan topics in Targant area have well developed leaves in length with ess thorny with thorny twigs. Many scientific studies are geared towards the in vitro culture (Morsli, 1999) for natural regeneration by seeding of argan stands in Morocco, has not been observed. However, in the Targant area we reported the presence of natural regeneration where we found 07 trees, 30 to 40 centimeters in length. The main species found are: *Phoenix dactylifera*, *Acacia raddiana*, *Balanites aegyptiaca* and *Tamarix* sp.

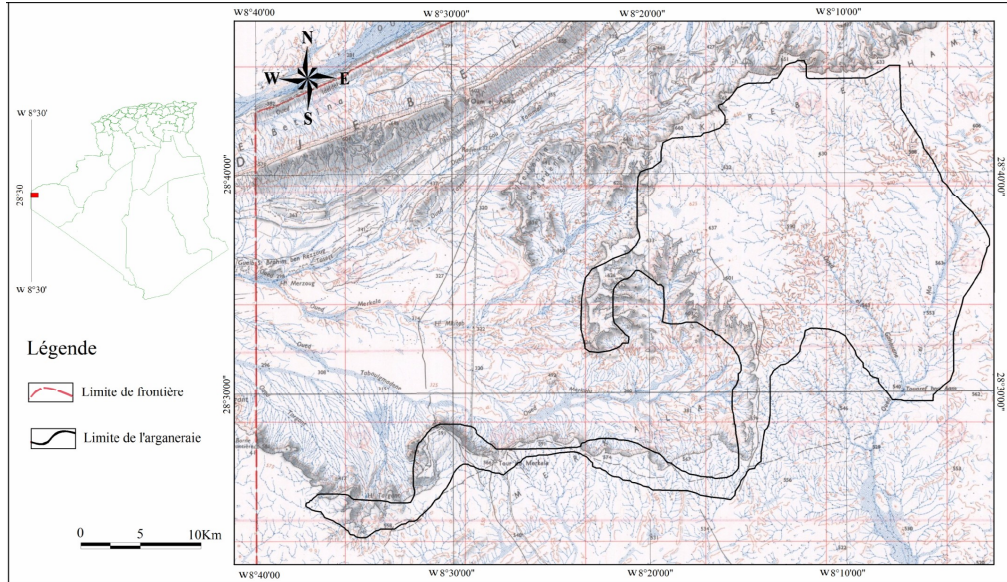
### **Merkala perimeter**

It is situated at the west of the forest house about 32 km; it is characterized by relatively gentle slopes, marked by two main wadis which extend over lengths of 7.3 and 5 km. The main species found in this zone are: *Acacia raddiana*, *Acacia albida*, *Argania spinosa*, *Anvillea radiata* and *Launea Arborescens*. This area is predominantly by *Acacia raddiana*. The appearance of the argan tree is bushy where the heights varied between 01 to 07 meters. Traces of white termites are frequently observed on several Argan trees.

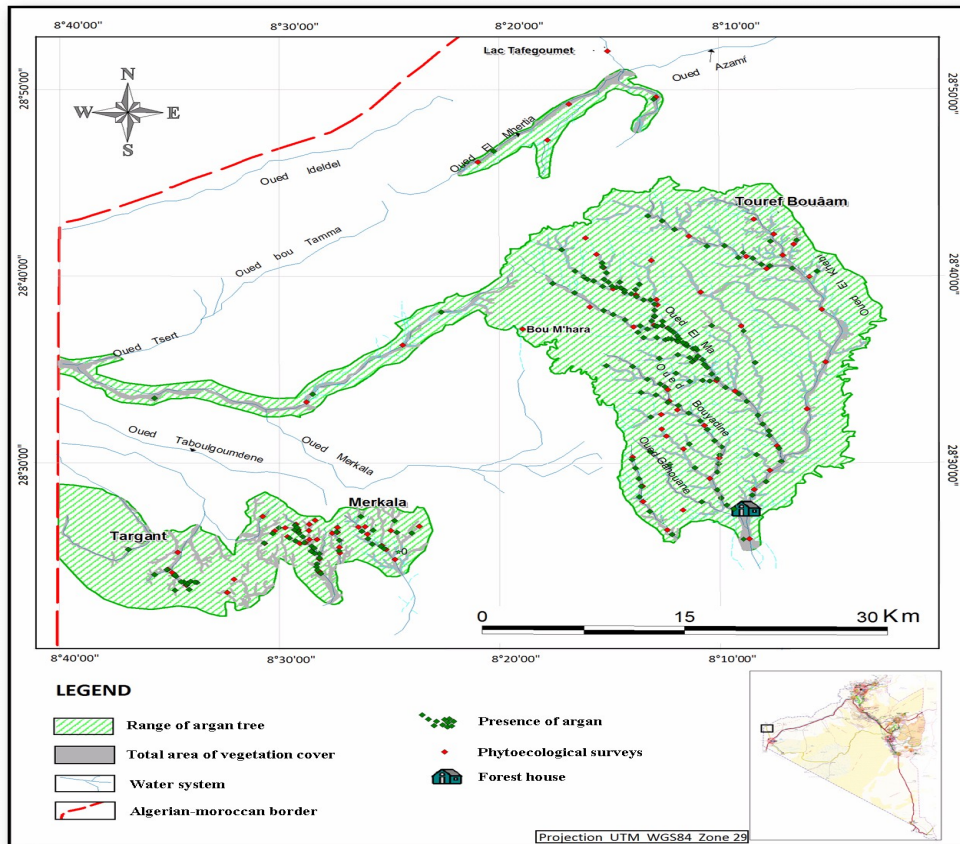
### **Touaref Bou Aam perimeter**

This scope perimeter corresponds to the natural reserve of the Argan trees, which contains the largest number of this tree

**Figure.1** Argan tree boundary of Tindouf (Source: DGF, 2009)



**Figure.2** Argan distribution area map in Algeria



with a large area estimated at 72,490 hectares. Within this scope we noted that the Argan tree is located mainly in four wadis :

**Oued El Ma**

This is the river that includes the largest density of Argan trees where there is an almost pure stand with the presence of: *Anvillea radiata*, *Retama retam* and *Rhus tripartitus*. Density starts to increase gradually from the fifth Km at north of the house. This density peaked between the 15th and 20th km, then decreases beyond it.

**Oued El Khebi**

Is located at the north-east of the forest house about 6 km, it is spread over a length of 40 Km within the nature reserve. The Argan tree is absent on the southern part of the Oued and begins to be identified under dispersed form from 25th Km at the north of the forest house. The main species found are: *Acacia raddiana*, *Argania spinosa*, *Retama retam* and *Anvillea radiata*. At this level it is *Acacia raddiana* dominates the Argan trees.

**Oued Gahouane**

Located at north-west of the forest house about 6.5 km, it extends over a length of 10 Km. The main species found are: *Acacia raddiana* (dominant species), *Argania spinosa*, *Lycium intricatum* and *Rhus tripartitus*. Traces of coal and illegal logging on several trees are observed at this wadi. In arid and semi-arid regions of North Africa, overgrazing is generally considered as a major cause of degradation of natural ecosystems (Le Houerou, 1968). Illegal grazing in this region is the more threatening constraint for the development of this species

**Oued Bouyadine**

it is located at north-west of the forest house and it crosses at the south. The biggest Argan tree is identified at this wadi (over 12 meters). The main species are noted: *Argania spinosa*, *Acacia raddiana*, *Anvillea radiata* and *Rhus tripartitus*. The rapid spread of the mealybug in the aerial part of the Argan tree (leaves, fruits and twigs) can cause harm damages in the absence of treatment.

The comparaison between each parameter averages (height, surface crown and density) for the three sections, was made using the MINITAB 2000 software by applying the FISHER test and to highlight homogeneous groups we used the NEWMAN and KEULS test with the same software. The results are listed in Table.1.

**Table.1** Distribution’s mean of height (meter), surface crown (square meter) and density (tree/hectare) of argan tree in the three perimeters.

Perimeter	Height	Surface crown	Density
Targant	6.8a	68.3a	13a
Merkala	3.4b	18.5b	08a
Touaref Bou Aam	4.6c	24.8c	11a

According to the outcomes, we observed highly significant differences between the three zones for height and surface crown (Table.1) where the largest averages of height and surface crown are identified at the Targant perimeter.

NEWMAN and KEULS Test revealed the presence of three groups of height (Table.

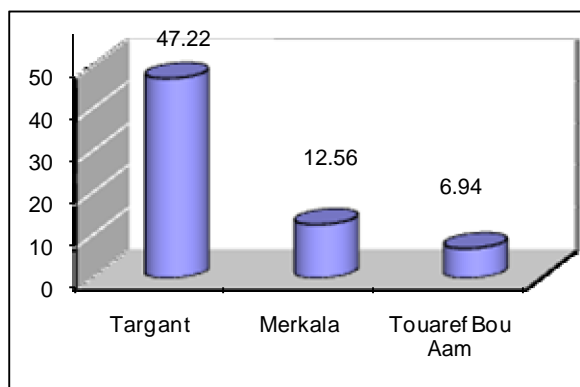
1), the first consists of Targant perimeter and the second is Merkala very close to the Touaref Bou Aam perimeter which forms the third group.

In terms of surface crown, the test outlined two homogeneous groups (Table. 1) where the Targant perimeter is individualized with a group and the two other perimeters form the second group, thus we deduce that the Targant perimeter is structured differently compared to the two perimeters of Merkala and Touaref Bou Aam.

These findings confirm our observations made on the field, and showed that the Targant perimeter is considered unique, hence we noted the presence of natural regeneration, a mono-specific stands and seeds with much higher calibre than the two other perimeters.

In order to confirm the results, a seed germination test was done and we fixed the germination rate for each area. The outcomes are shown in Figure.3. From the histogram indicated in Figure.3, we see that the highest germination rate is at the Targant perimeter with 47.22%, followed by Merkala with 12.56%, while the lowest rate was identified at Touaref Bou Aam perimeter.

**Figure.3** Seed germination rates of Argan trees from the three perimeters.



These findings enabled us to improve more the perimeter which includes the elite trees and their quality seeds with better germination. Hence, we can say that the characterization of stands and the germination test lead us to confirm that Targant area involves the good seed trees.

It is clear from all of this analysis that the whole population of the argan region of Tindouf follows a certain regressive dynamic, since the dynamics of a plant population is mainly based on natural regeneration. Our results show a total absence of natural regeneration in both perimeters of Merkala and Touaref Bou Aam, however, the presence of natural regeneration at the perimeter of Targant may be related to two main causes: the first related to the exclosure and second to scarification.

Targant area is a border with Morocco, having said that access for livestock or farmers is prohibited, why grazing of seedlings is absent. This observation was mentioned by Anthelme and Michalet (2009) on the problem of regeneration of acacias in the desert of Niger.

The second cause that is scarification, improves germination of seeds and to the permeability of water and oxygen to the seed coat (Halevy, 1974).

Regeneration of the Algerian Argan remains alarming, because soil and climatic conditions unfavorable, especially in the area of Tindouf, where the water content of the soil determines the vegetation dynamics and influencing the structure of the population, and therefore seedlings will be unable to withstand the stresses (Noumi et al., 2010). Other authors (Larwanou & Saadou, 2004) show that natural regeneration of trees is

determined by the water content of the soil, this parameter is considered as a key factor for the growth of trees, floristic composition and therefore the functioning of ecosystems. In against part, inhibition of seed integument is an adaptive factor important for the survival of the species, since it allows the maintenance of a stock of viable seeds in the soil (Coe and Coe, 1987 ; Tybirk, 1991). These seeds can survive so many years pass without damage periods unfavorable for germination and survival of seedlings and germinate when environmental conditions become favorable (Tybirk, 1991).

The Argan tree is noteworthy species, given its importance on ecologically and economically scales. We have noticed on the ground that this tree form small stands scattered more or less like any Saharan trees because they need more living space for the development of roots and withstand drought conditions of these environments.

Mapping indicates that plant formations *Argania spinosa* are distributed along the wadis beds ensuring fertility and restoration of soil inputs, and thanks to its herbaceous stratum, it helps to stabilize stream in the borders of wadis and provide a habitat for wildlife.

The distribution area of the Argan tree is located mainly on three zones, the most important is Touaref Bou Aam, the second Merkala and the third and Targant, covering a total area estimated at 96,940 hectares where the Argan tree is identified on altitudes ranging from 315 to 630 meters. Argan stands are founded on different substrates namely: Sandy, stony and rocky. Similarly, it is present on steep slopes at Targant, average slopes at ravines level which feed Oued El Ma Oued El Oued and Khebi Bouyadine and

on gentle slopes at Merkala and the southern and south-eastern Touaref Bou Aam perimeter.

We recognize that the Argan stands of Tindouf experienced illegal felling interventions, overgrazing and coal for decades. The presence of biological pests such as termites and cochineals, observed frequently within Merkala and Touaref Bou Aam perimeters, can be considered as a serious threat due to their rapid spread.

On the basis of this study, we were able to delineate the main Argan sites in Algeria and mapping its natural range. Comparison of growth factors and spatial distribution for the three zones allowed us to draw the following conclusions:

Targant perimeter is more homogeneous than the other two (Merkala and Touaref Bou Aam) providing the heterogeneity of horizontally and vertically structure;

The Targant perimeter can provide quality seeds in terms of germination capacity, as the elite trees are marked at this perimeter, however, the total area of the Argan tree, which is less important, may be a constraint for the intensive use of this species.

This work, which is a first for the Algerian Argan tree, will be a significant starting point for any scientific basis of any scientific study in order to develop a decision-support tool (Joliveau, 1995) with a view to preserve, develop and promote this exceptionally natural heritage ; the argan tree.

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## References

- Adlouni A., 2009. Place de la nutrition à l'huile d'argan dans la prévention des maladies cardiovasculaires et des cancers au Maroc. *Revue. Francop.des Laborat.* 416 : 34.
- Anthelme, F., and Michalet, R. 2009. Grass-to-tree facilitation in an arid grazed environment (AïrMountains, Sahara). *Basic.Appl. Ecol.* 10: 437–446.
- Arif, A., 1994. Effect of seedling depth on emergence of *Argania spinosa* (L.). *Al Awamia.* 87: 149-153.
- Baumer, M., and Zeraia L. 1999. Most continental stations argan North Africa. *Revue forestière française.* 5 (3): 446-452.
- Benabid, A., 2000. Flora of Morocco and Ecosystem. Ed. Ibis Press, Paris. 335.
- Bennania, H., J. Fiet and Adlouni, A. 2009. Impact of argan oil on prostate cancer: a study of the antiproliferative effect of polyphenols. *Revue. Francop.des Laborat.* 416: 23.
- Berka, S., and Harfouche, A. 2001. Effect of some physico-chemical and temperature on the germination of seeds of argan. *Biology and ecology.* *Rev. For. Fr.* LIII : 2.
- Bezzala, A., 2005. Introductory essay of the argan tree (*Argania spinosa* L. Skeels) in the area M'Doukel and evolution of some parameters of drought resistance. Thèse de magistère en sciences agronomique. Université de Batna. Algeria. pp.142.
- Brahim, H., 2007. Socio-economic dynamics in the Argan Biosphere Reserve (RBA). IAV Hassan II, Agadir Complex Horticultural Association Agro-technologies Souss-Massa-Draa. In : colloque international. 27-28 Avril 2007. Synthèse des communications. Rabat. 68.
- Chevalier A. 1943. Argan, the marmulanos and walnut tree future in North Africa, in Morocco and in the semi-arid regions of the world if we improve. *Rev. Bot. Appl. Agric. Trop.* 165-168 and 363- 364.
- Coe, M., and Coe, C. 1987. Large herbivores, acacias trees and bruchid beetles. *South African.J. Sci.* 83: 624-635.
- Dallmeier, F., 1992. Long-term Monitoring of biological Diversity in Tropical forest Areas: methods for Establishment and Inventory of permanent plots. M.A.B. Digest 11. United Nations Educational, Scie. and Cultural Organization (UNESCO). Paris. France.pp. 72.
- DGF., 2009. The Algerian argan tree. Special Issue publication of the project ALG/G35. 15.
- Halevy, G., 1974. Effets of gazelles and seed beetles (*Bruchidae*) on germination and establishment of *Acacia* species. *Israel. J. Bot.* 23: 120-126.
- Joliveau, T., 1995. Environmental management and information on the natural environment in the French regional parks. In : Rencontre internationale sur la cartographie pour la gestion des espaces naturels, 13-17 novembre 1995. Saint- Etienne (France). 41-49.
- Larwanou, M., and Saadou, M. 2004. Biodiversity of ligneous species in semi-arid to arid zones of southwestern Niger according to anthropogenic and natural factors. *Agricult., Ecosyst. Environ.* 105: 267-271.

- Long, G., 1974. Phytoecological diagnosis and management of land. In : centre nationale de la recherche scientifique. Ed. MASSON & CLE. Paris. pp.237.
- Le Houerou, H.N., 1968. Desertification in the northern Sahara and the steppes.
- Morsli, A., 1999. Test vitro propagation of the argan *Argania spinosa* L. Skeels from vitro seedlings. In : Thèse de magistère protection de la nature. INA. Algérie. pp. 89.
- Nouaim, R., 1994. Microbial ecology of soils arganeraies (SW Morocco): Activities and microbiological soil endomycorrhizal role in the growth and nutrition of Argan. in : Thèse de doctorat Es sciences, Fac. Sci. Agadir. Maroc. pp.193.
- Noumi, Z., S. Ouled Dhaou, F. Abdallah, B. Touzard and Chaieb, M 2010. *Acacia tortilis* subsp. raddiana in the North african arid zone: the obstacles to natural regeneration. *Acta. Bot. Gallica*. 157 (2): 231-240.
- Tazi, M.R., A. Berrichi and HalouI, B. 2003. Sketch map of the area of the argan tree *Argania spinosa* (L.) Skeels in north-eastern Morocco. In : Bulletin de l'Institut scientifique n°25. Rabat, section Sciences de la vie. 53-55.
- Tybirk, K., 1991. Regeneration of woody legumes in Sahel, AAU Report vol.27, Aarhus Univ. Press, Aarhus, Denmark.pp. 1-81.