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Review Paper

The argan tree: the exploitation of the genetic potential and adaptation situation in Morocco

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Abstract

The importance of medicinal, food, cosmetic, social and ecological virtues; the Moroccan arganeraie is declared as Biosphere Reserve by UNESCO. To ensure the sustainable development of this arganeraie, a program of domestication and adaptation is under way in Morocco. In order to exploit the results available for this program, we present in this section some synthetic results on the previous studies dealing with the description and organization of the genetic resources of the argan tree in Morocco and the state of these genetic resources economic needs and climate change. We will discuss in this paper the issue of assisted migration of genetic potential to places where future climatic conditions would be more favorable. We propose assisted migration as an innovative tool for advancing conservation program, domestication and improving the genetic potential of the argan tree in Morocco. We interpret this information with a view to adapting argan genotypes to new conditions for growth and mitigation of the effect of climate change on the genetic diversity potential of this species.

Keywords: Argan tree, medicinal plants, genetic diversity and variability, assisted migration, genetic improvement and domestication programs.

Introduction

The argan tree (*Arganiaspinosa* (L.) Skeels) is a species that plays an important ecological and socio-economic role in Morocco[1-4]. On the economic plan; Argan oil is the main product on the national and international market. The spectacular virtues of argan oil are confirmed in traditional medicine[5-7]. However, the distribution air of the argan tree is reduced more and more in the face of several aliases[8,9]; overexploitation of argan trees as firewood or as suspended fodder by herds and extreme aridities that have struck Morocco, soil erosion and the advance of the desert, in addition to climate change and strong demand for the national and international economic market. Due to this, the United Nations Educational, Scientific and Cultural Organization (UNESCO) declared in 1998 the Moroccan argan forest as a Biosphere Reserve[4]. To ensure the products of the national and international economic market, save the ecology of the argan tree, and to ensure a social good to marginalized populations, a program of domestication and adaptation is underway in Morocco[10].

In Morocco, the Sapotaceae family represented by the argan tree occupies characteristic areas with arid and semi-arid climatic stages. Its geographical distribution is widespread in the South-West region, namely the province of Essaouira, Agadir, Chtouka Ait Baha, Tiznit, Taroudante (about 870 000 Ha). It is also found in the central plateau region near Oued Grou (between Tidès and Rommani southeast of Rabat on about 30 ha), northeast of Beni Snassen (between Oujda and Berkane about 200 Ha), and in the southern region at Goulmime or southeast near Oued Noun[11]. All the populations of this species are fragmented and developed on small surface and under different ecological and biogeographic conditions[3,12]. This suggests that this species has a genetic potential that allows it to survive different environmental changes.

Exploiting and managing the potential of genetic diversity to mitigate the impacts of climate change and increase food security in the context of sustainable development is known as assisted genotype migration[1]. To exploit the available results in favor of this concept of assisted migration, we present in this section some synthetic results on previous studies dealing with the description and organization of the genetic resources of the argan tree in Morocco, and the its state in the face of economic needs and climate change. Also in this paper we will discuss the issue of assisted migration of genetic potential to places where future climatic conditions would be more favorable. This work will help decision-makers know how to respond to the needs of the domestication and adaptation program for this species.

Knowledge about the genetic diversity of argan in Morocco

For several years, the genetic resources of the argan has fascinated the Moroccan and foreign researchers who are interested in studies related to its biology, its eco-geographical requirements, its socio-cultural environment and its economic and ecological virtues, valorization of the oil of argan and its

socio-economic impacts and sustainable development. Thus the biological aspects are related to the studies on genetic variability of the argan tree[12-17], evaluation of genetic diversity[18-25], germination[26-28], seedling production[29,30], in-vitro culture and domestication of the argan tree[2,31-33]. Based on different types of markers, a number of different genotype and / or population sampling and over different years and seasons, the studies have confirmed the presence of a diversified genetic potential to conserve and exploit for a breeding program.

Thus, agro-morphological markers (Table-1) show a high and significant intra-population variability (among trees) in tree, leaf, fruit, seed, carpel, almond, fruiting branch, flowering, fruit production, and content of the oils. The contribution of intra-population variability is greater than that of inter-population variability, particularly for the morphological characters of fruits, carpels, fruit branches, leaves[12,16,17,34,35]. This small variance between sites or populations in these traits is related to the variance of interaction x years populations or climate x populations, or to environmental factors[16,34-37]. Thus, the populations of argana and Ait Melloul present the great sizes in characters of fruits, carpels and fruiting branches compared to that of Ait Baha. But this latter has the most drought-resistant and productive genotypes in argan oil yield[37]. In terms of yield of argan oils, Taroudante provenances (Aoullouze), Essaouirra (Had Drra), and Tiznit (Lakhsas), are also effective and more adapted to drought conditions, contrary to the origin of Agadir argan oil (Allma)[38]. It should be noted that in terms of adaptive traits in comparative plantations of provenances to study genetic variability and quantitative genetics, studies are limited.

In terms of biochemical and molecular markers, several types of dominant or co-dominant neutral markers have been applied, from the years of 1995 to today, to detect the different levels of polymorphism according to their specificity of the argan tree. The allozymic genetic diversity of the argan tree based on results obtained from 9 isoenzymatic loci extract from 10 populations covering the entire distribution range of the argan tree in Morocco, shows that the species is extremely polymorphous with allelic/ locus richness of 3.6 and genetic diversity (estimated heterozygosity) near 0.24, and has high population genetic differentiation (Gst); let Gst = 0.25[18].

Table-1: General review of previous research based on agro-morphological markers for the description of the potential of the genetic variability of the argan tree.

Ref.	Regions (Populations)	Sample size	Agro-morphological traits
14	Souss Plain (AitMelloul), Atlantic Ocean (Arganaand Ait Baha)	-	Branch, flowering
15	Souss Plain (Ait Melloul), Atlantic Ocean (Argana and Ait Baha)	-	Seeds (dormancy)
16	Souss Plain (Ait Melloul), Atlantic Ocean (Argana and Ait Baha)	30 fruits x 30 trees x 3 natural populations	Fruits and carpels
12	Hahaand Ida OuTanane, Souss plain, Central and Western High Atlas, Anti-Atlas, Central Plateau. 26 populations are collected from all these regions.	-	Fruits and carpels, Branch, flowering
17	Beni Snassen (Douar Chwihiya), North West (Tassademt, Admine, Houbara Sanctuary).	20 tress*x*4 populations	Tree, Fruits, Seeds, Fruits Productivity
38	Taroudante (Aoullouze), Essaouirra (Had Drra), Agadir (Allma), Chttouka Aitt Baha (Biougrra), Tiznit (Lakhsas).	90 fruits *x* 15 trees*x* 5 natural populations	Trees, leaves, fruits, seeds, carpels, almonds and oil yield
34	Souss Plain (Ait Melloul), Atlantic Ocean (Argana and Ait Baha)	33 trees/ Population	Fruiting branches
35	Souss Plain (Ait Melloul), Atlantic Ocean (Argana and Ait Baha)	33 trees/ Population	leaves
24	Souss Plain (Ait Melloul), Atlantic Ocean (Argana and Ait Baha)	All fallen fruits (Argana and Aitbaha), - 9 trees selected for Ait Melloul.	Fruit productivity and oil yield
36	Souss Plain (Ait Melloul), Atlantic Ocean (Argana and Ait Baha)	In situ	Flowering

The populations that contribute in large part to this genetic differentiation between argan populations in Morocco is Beni-Snessen (north-east of Oujda) which is extremely remote from other populations (genetic distance = 0.31), that of Goulimine (north of the Sahara) which is also much differentiated (genetic distance = 18), and that of Oued Groud (south-east of Rabat). The general review of the results of El Mousafik and Petit[18] shows that the populations of argana, Ait Baha and Admine (close to Ait Melloul) are very polymorphic (intra-population variation) which confirms the results based on the characters agro-morphological[12,16,34,35,39] and morpho-molecular[20]. The genetic difference (Gst = 0.6) between the populations, forming two lineages, of the north-west compared to those of south-east of Morocco is well confirmed with the molecular marker of chloroplast DNA[19,22]. However, the results of the ISS-marker (Inter-Simple Sequence Repeats), applied to a set of populations well distributed over the geographical area of the species, reveal a genetic diversity (H) and a genetic differentiation, respectively ranging from H = 0.15 to 0.32, and Gst = 0.22 to 0.4[23-25]. For all these studies on the ISSR, no correlation between genetic distance and geographic distance is noted. This indicates that remoteness and geographical isolation are not the main factors in explaining the genetic structure of the argan tree in Morocco.

What contribution of genetic diversity of the argan tree to the conservation of ecosystems

Genetic diversity vs the arganeraie ecosystem: Like all the natural ecosystems of Morocco, the arganeraie, contains diversified genetic resources. It constitutes a reserve of plant genetic diversity for several kinds of cultivated species and wild species, which are also of aromatic and medicinal plants[1,3,12]. The arganeraie ecosystem represents not only a considerable floristic but also faunistic reservoir and has a key function in soil and freshwater conservation. As for arganier, in addition to its ecological importance, it plays a considerable role for the economy thanks to the relatively diversified number of its food, cosmetic and pharmaceutical use.

The argan tree as a genetic resource has long been subject to over-exploitation, causing an imbalance between the supply of the ecosystem and the demand for the development of various economic products at the local, national or international level. For example, 100 kg of ripe fruit gives only 1.1 liters of argan vegetable oil versus an estimated annual production of 32,000 tons / year[11,30]. A regression of 27.5% of argan distribution air area in Morocco is recorded during the period 1800 to 2004; an estimated decline of 600 ha / year[11]. This growing demand for products of this species weakens the genetic potential through the creation of genetic erosion and consequently the disruption of the argan tree ecosystem (a depopulation of forests resulting in a density ≤ 100 trees / ha). These consequences are particularly harmful in the presence of predicted climatic contrasts and whose soils are slowly reconstituted[1]. The preservation and the future development of the argan tree ecosystems require the conservation of their genetic diversity in a framework of sustainable and integrated management of forests.

The conservation of the genetic diversity potential of the argan tree can be done "in situ" in the environment in which it evolves naturally or "ex situ" outside this same natural environment. The guidelines of these "in situ" and "ex situ" conservation programs are based on the results of scientific research on the genetic diversity and the process of demographic evolution of natural populations. In the case of in situ conservation, a good practice guide for collecting the fruits of the species and a delineation of seed areas will be needed for the value of the genetic potential. "Ex situ" conservation strategies are highly desirable in order to avoid the threats recognized in endangered populations, to minimize the risk associated with the creation of artificial populations / varieties, and to ensure a sustainable plant life effective argan tree for genetic improvement actions. Thus, several general concepts for the conservation of forest resources, combining "in situ" and "ex situ" measures or "cryopreservation" measures, have been published[40-42]. However, the conservation of the genetic diversity of this species is necessary to meet the food needs of the future and also to safeguard the rich agricultural heritage of the various regions of the world.

Genetic diversity vs vulnerable ecosystems: The concept of biodiversity is today at the heart of concerns that are expressed in all countries of the world. Among the levels of biodiversity, there are ecosystems that play a very important economic and ecological role. In Morocco, the regression of forest ecosystems is alarming compared to the rest of the Mediterranean basin. Some areas are very strongly affected; as an example, the areas of Cedar and Cypress forests at the top and middle Atlas. Under the effect of climate change, these ecosystems in regression are under pressure from migration of species to climates that are adapted to them. For example, palaeoclimatic and paleobotanical data show that a dynamic of large-scale species changes is underway over evolutionarily, ecologically and even historically short times: natural systems are very mobile and this has direct consequences not only on the species present locally within the communities, but also on the evolution of their biology[43].

The indicators of climate change reveal: - an increase in the earth's surface temperature of 0.8 ± 0.2°C since 1870, - an increase in the temperature of the oceans since 1980, - almost generalized retreat of continental glaciers since 3 at 4 decades, with a marked increase in the last 20 years[1]. In addition, future IPCC simulation models predict an overall increase in temperature and a decrease in precipitation[44]. This climate change is accompanied by that of geographical distribution of species. Thus, depending on dispersal patterns, species lifespan and reproductive frequencies, plant populations may move 300 km north over the next 50 years[45]. In Morocco's regions, future projections of climate change, according to the A2 scenarios, result in an increase in average temperatures, a decrease in

average precipitation, a significant increase in summer heat waves and in intra-annual period's drought, and a reduction in the area of major wetlands; for example, 25% between 1978 and 1999[1,46]. The authors M'Hirit and Et-Tobi[1] noted that at the level of the Atlas and Anti-Atlas, a temperature increase of 2°C would lead to a northward migration of plant communities of 200 km in latitude. However, tree populations would have difficulty migrating, coupled with the difficulty of colonizing so quickly new environments and adapting to new competitions. Note that animal species are also affected by this phenomenon of migration, because different species of the same ecosystem do not have the same ability to move and adapt to a new environment. The food webs will be strongly disturbed, which threatens in the long term the sustainability of the ecosystem and the species that compose it.

The need for assisted migration of the argan tree: Assisted migration by exploiting the genetic diversity of the species for the improvement and production of genetically superior seeds is an innovative tool for adapting species to the new ecological niche and mitigating climate change. Reforestation of ecosystems by new species of near climax is an ecological adaptation. For example, the degraded thuya ecosystem (Precipitation ~ 350 to 620mm, Temperature ~ - 2.7 to 45°[1]), can be rehabilitate with the argan tree (Precipitation ~ 212 to 350mm; Temperature ~ - 0,9 to 45.6°C [1]). The assisted migration of seeds from the argan tree to other environments will not only contribute to the sustainability of the disturbed ecosystems but it is also an issue for the "ex situ" genetic diversity conservation. This is especially true since the populations of the argan tree are already threatened by the disappearance of their habitats and the degradation of their environment, accentuated by the climatic change which could make their habitats unsuitable for their survival. In these cases, the collection and conservation of threatened genetic diversity will be crucial. And the introduction of more suitable argan tree crop varieties with a higher quality gene pool to areas where future climatic conditions would be more favorable is needed. This involves the establishment of a breeding program that would answer questions such as the ability of the species to adapt to competition with new species and colonize new climatic niches, and plasticity of the genetic variability of the species, etc. Initiating the argan Genetic Improvement Program by establishing provenance tests will help to better understand the potential response of provenances and offspring to changing growing conditions, measuring their plasticity to adapt, evaluating interactions between genotypes and the environment, etc.

Conclusion

In conclusion, an in-depth knowledge of the impact of assisted argan migration is essential for informed decision-making on the use of this strategy and its application in Morocco in order to limit the degradation of the genetic diversity potential of the argan tree. This species will be improved and domesticate to improve it to meet the needs of the national and international market. Knowing that the argan tree is successfully introduced in Israel but also in other countries including Australia, Tunisia and Spain which is starting to take an increasing interest in the sensitive climate change in Spain[17,47].

References

1. M'HiritOmar and Et-Tobi Mohammed (2010). Les écosystèmes forestiers face au changement climatique : Situation et perspectives d'adaptation au Maroc. Institut Royal des Etudes Stratégiques E-Publication, Maroc, 1-260.

2. Travis J., Lybbert J. and Aboudrare A. (2011). Gagnant - Perdant : La valorisation des produits d'argan semble être bénéfique pour les ménages ruraux, mais menaçante pour la forêt endémique d'arganier. Actes du Premier Congrès International de l'Arganier.Agadir, Maroc, 281- 288.

3. HCEFLCD (2012). Update of the National Program against Desertification (PAD-LCD): Adaptation to Areas Specificity,High Commision for Water, Forests and Desertification Control E-Publication. Morocco. (In French).

4. El Mounfalouti H. (2013). Contribution à la détermination des propriétés photo protectrices et anti-oxydantes des dérives de l'arganier : Etudes chimiques et physiologiques (Unpublished doctoral dissertation). Thèse de Doctorat, Faculté des Sciences Rabat, Maroc.

5. Charrouf Z. and Guillaume D. (2010). Should the Amazigh Diet (Regular and Moderate Argan-Oil Consumption) Have a Beneficial Impact on Human Health?. *Crit. Rev. Food Sci*., 50(5), 473-477.

6. Monfalouti H.E., Guillaume D., Denhez C. and Charrouf Z. (2010). Therapeutic potential of argan oil: a review. *Journal of Pharmacy and Pharmacology*, 62(12), 1669-1675.

7. Guillaume D. and Charrouf Z. (2011). Argan oil and other argan products; use in dermocosmetology. *Eur. J. Lipid. Sci. Technol*., 113(4), 403-408.

8. Mellado M. (1989). S.O.S. Souss: argan forest destruction in Morocco. *Oryx.,* 23(2), 87-93.

9. Yousfi E.l.M. and Benchekroun F. (1992). La dégradation forestière dans le sud marocain, exemple de l'arganeraie d'Admine (Souss) entre 1969 et 1986. *Ann. Rech.Forest.Maroc*, 26, 43-49.

10. Naima A.I.T., Msanda F. and El Mousadik A. (2012). Univariate and multivariate analysis of agronomical traits of preselected argan trees. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, 40(2), 308-316.

11. HCEFLCD (2011). La gestion durable de l'arganeraie : Enjeux et perspectives. Séminaire du Haut-Commissariat des Eaux et Forêts et de lutte contre la désertification. Marrakech, Maroc 1er Juin.

12. Bani-Aameur F. (2004). Morphological diversity of Argan (*Arganiaspinosa* L. Skeels) populations in Morocco. *For.Genet.,* 11(3-4), 311-316.

13. Ferradous A. (1995). Genetic diversity of some morphological characters of the fruit and seed of Argan tree (*Arganiaspinosa*. (L.) Skeels) (Unpublished doctoral dissertation). Thesis presented for graduation graduate of 3rd cycle. IbnouZohr University, Faculty of Sciences Agadir, Morocco.

14. Zahidi A. (1997). Phénologie, typologie et variabilité: génétique de la ramification et de la foliation de 1'Arganier *(Arganiaspinosa*(L.) Skeels) (Unpublished doctoral dissertation). Thèse de Diplôme des Etudes Supérieures de 3ème cycle (DES), Faculté des Sciences, Université Ibn Zohr. Agadir, Morocco.

15. Bani-Aameur F., Ferradous A. and Dupuis P. (1999). Typology of fruits and stones of Argania spinosa (Sapotaceae). *Forest Genetics*, 6(4), 213-219.

16. Bani-Aameur F. and Ferradous A. (2001). Fruit and stone variability in three argan (*Argania spinose* L. Skeels) populations. *For.Genet.*, 8(1), 39-45.

17. Zunzunegui M., Ain-Lhout F., Jáuregui J., Barradas M.D., Boutaleb S., Álvarez-Cansino L. and Esquivias M.P. (2010). Fruit production under different environmental and management conditions of argan, Argania spinosa (L.). *Journal of arid environments*, 74(10), 1138-1145.

18. El Mousadik A. and Petit R.J. (1996). High level of genetic differentiation for allelic richness among population of argan tree (*Argania spinosa* (L.) Skeels) endemic to Morocco. *TheorAppl Genet,* 92(7), 832-839.

19. El Mousadik A. and Petit J.R. (1996). Chloroplast DNA phylogeography of the argan tree of Morocco. *Mol. Ecol.,* 5(4), 547-555.

20. Majourhat K., Jabbar Y., Hafidi A. and Martínez-Gómez P. (2008). Molecular characterization and genetic relationships among most common identified morphotypes of critically endangered rare Moroccan species *Arganiaspinosa* (Sapotaceae) using RAPD and SSR markers. *Ann. For.Sci.,* 65, 805, 1-6.

21. Bahloul E., Dauchot N., Machtoun I., Bouzoubaa Z., Saidi N. and Gaboun F. (2011). Analyse de la diversité génétique de l'arganeraie marocaine : collecte, caractérisation et analyse de la structuration des populations. Actes du Premier Congrès International de l'Arganier, Agadir, Maroc, 15ème– 17ème Déc.

22. El Bahloul Y., Dauchot N., Machtoun I., Gaboun F. and Van Cutsem P. (2014). Developpment and Characterization of microsatellite loci for the Moroccan endemic endangered species *Arganiaspinosa* (Sapotaceae). *Appl. Plant. Sci.,* 4, 1-4.

23. AitAabd N., Msanda F. and El Mousadik A. (2015). Genetic diversity of the endangered argan tree (*Arganiaspinosa* L.) (sapotaceae) revealed by ISSR analysis. *J.Agr.Sci*., 4(46), 176-186.

24. Mouhaddab J., Naima A.I.T., Achtak H., Msanda F., Zahidi A., Filali-Maltouf A. and El Mousadik A. (2015). Patterns of Genetic Diversity and Structure at Fine Scale of an Endangered Moroccan Endemic Tree (*Arganiaspinosa* L. Skeels) Based on ISSR Polymorphism. *Not. Bot.Horti.Agrobo*., 43(2), 528-535.

25. Yatrib C., Belkadi B., Pakhrou O., Alami M., Medraoui L., El A. and Filali-Maltouf A. (2015). Assessment of Genetic Diversity of *Arganiaspinosa* L. growing in Arid and Semi-arid Areas of Morocco as Revealed by Inter-Simple Sequence Repeats. *J.Agr.Sci.Technol.*, 5, 336-346. doi: 10.17265/2161-6264/2015.05.005

26. El Mazzoudi H. and Ehrana M. (1977). Contribution e l'étude ce la germination des noix d'argan (Argania spinosa L.) per ces pretreitemente chemiques. *Ann. d'Eaux et Forêts au Maroc*, 17, 61-66.

27. Bani-Aameur F., Louali L. and Dupuis P. (1998). Maturation et chute des fruits de l'arganier. *Actes J. Agr. Veto*., 18(3), 151-158.

28. Bouzoubaa Z. and El Mousadik A. (2003). Effet de la température, du déficit hydrique et de la salinité sur la germination de l'arganier - *Arganiaspinosa* (L.) Skeels. *Acta Bot.Gallica,* 150(3), 321-330.

29. Ferradous A., Bani-Aameur F. and Dupuis P. (1996). Climat stationnel, phénologie et fructification de l'arganier (Argania spinosa L. Skeels). *Revue Marocaine des Sciences Agronomiques et Vétérinaires*, 17(1), 51-60.

30. Bouzoubaa Z., Mimouni A. and Wifaya A. (2009). L'arganier entre mondialisation et changements climatiques. *Agriculture du Maghre,* 35, 49-51.

31. Echairi A., Nouaim R. and Chaussod R. (2008). Intérêt de la mycorhization contrôlée pour la production de plants d'arganier (Argania spinosa) en conditions de pépinière. *Science et changements planétaires/Sécheresse*, 19(4), 277-281. doi : 10.1684/sec.2008.0147.

32. Bellefontaine R. (2010). De la domestication à l'amélioration variétale de l'arganier (Argania spinosa L. Skeels)?. *Science et changements planétaires/Sécheresse*, 21(1), 42-53. doi : 10.1684/sec.2010.0226.

33. Bellefontaine R., Ferradous A., Alifriqui M. and Monteuuis O. (2010). Multiplication végétative de l'arganier (Argania spinosa) au Maroc: le projet John Goelet. *Bois et forêts des tropiques*, 304(2), 47-59.

34. Zahidi A., Bani-Aameur F. and Mousadik E. (2013). Morphological variability of the fruiting branches in Argania spinosa: Effects of seasonal variations, locality and

genotype. *Journal of Horticulture and Forestry*, 5(10), 168-182.

35. Zahidi A., Bani-Aameur F. and EL Mousadik A. (2013). Growth variability in *Argania spinosa* seedlings subjected to different levels of drought stress. *J.Horti.For.*, 5(11), 204-217.

36. Benlahbil S., Zahidi A., Bani-Aameur F. and El Mousadik A. (2015). Duration of blossoming, longevity of argan flower and assessment of pollen fertility by staining. *Int. J.Agri.For.,* 5(6), 291-304.

37. Metougui M.L., Mokhtari M., Maughan P.J., Jellen E.N. and Benlhabib O. (2017). Morphological Variability, Heritability and Correlation Studies within an Argan Tree Population (Argania spinosa (L.) Skeels) Preserved in situ. *International Journal of Agriculture and Forestry*, 7(2), 42-51.

38. Aabd N.A., El Ayadi F. and Ms F. (2011). Evaluation of agromorphological variability of argan tree under different environmental conditions in Morocco: implication for selection. *International Journal of Biodiversity and Conservation*, 3(3), 73-82.

39. Abdelaziz Z. and Fouzia B.A. (2014). Morphological Variability in Argan Seedlings (Argania Spinosa (L.) Skeels) and Its Implications for Selecting Superior Planting Material in Arid Environments. *International Journal of Agriculture and Forestry*, 4(6), 419-434.

40. Riggs L.A. (1990). Conserving genetic ressources on site in forest ecosystems. *For.Ecol.Manag*., 35(1), 45- 68.

41. Kremer A. (1994). Diversité génétique et variabilité des caractères phénologiques. *Gent. Sel.Evol*., 26, 105- 123.

42. Lefèvre F. (2000). Conservation « in situ » des ressources génétiques forestières. Réseaux de conservation et espaces protégés. *Cah.Agric.,* 9(3), 211-222.

43. Léotard G., Duputié A., Kjellberg F., Douzery E.J., Debain C., De Granville J.J. and McKey D. (2009). Phylogeography and the origin of cassava: new insights from the Northern rim of the Amazonian basin. *Mol.Phylogenet.Evol.,* 53, 329-334.

44. Solomon S., Qin D., Manning M., Marquis M., Averyt K., Tignor M. and Chen Z. (2007). Climate change 2007: The physical science basis.

45. Pedlar J.H., McKenney D.W. and Aubin I. (2012). Comment la migration assisté pourrait-elle faciliter l'adaptation des forêts aux changements climatiques?. Nouvelles Express 63, Canada. ISSN 1496-7847.

46. Driouech F., Déqué M. and Mokssit A. (2009). Numerical simulation of the probability distribution function of precipitation over Morocco. *Clim.Dyn.,* 32, 1055-1063.

47. Yaghmur A., Aserin A., Mizrahi Y., Nerd A. and Garti N. (2001). Evaluation of argan oil for deep-fat frying. *LWT-Food Science and Technology*, 34(3), 124-130.