Participatory approach for integrated development and management of North African marginal zones: demonstrative plan to fight desertification in Morocco and Tunisia

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Abstract

A demonstrative and participatory development project on desertification mitigation and rural development has been launched in Northern Africa under SMAP Programme (Short and Medium-term priority environmental Action Programme) financed by the European Union. The project, which title is *Demonstration Project on Strategies to Combat Desertification in Arid Lands with Direct Involvement of Local Agro-pastoral Communities in North Africa*, is carried out in sensitive regions of Morocco and Tunisia with the coordination of the *Nucleo Ricerca sulla Desertificazione* (NRD, Desertification Research Center) of the University of Sassari (Italy) and the partnership of Morocco and Tunisia Agriculture Ministries. The areas concerned are located in regions characterised by rural poverty, food dependency and land abandoning where urgent measures are needed to promote optimisation of resource availability and management for a sustainable development. The project involves direct desertification mitigation by vegetation cover restoration, with drought resistant perennial forage species (*Opuntia ficus-indica, Atriplex nummularia* and *Acacia saligna*) in highly degraded rangelands in order to mitigate desertification processes while improving rangelands productivity; and adopts measures for local population technical capacities building through training sessions related to all project activities, and making it a concrete demonstration supported by the direct involvement of local communities. Successful actions already carried out in this field by the participants of the project as well as by other Mediterranean countries, has been taken into account, re-elaborated and exploited, thus promoting south/south co-operation and exchange of knowledge. Participation of all actors and especially of local communities is the key point in all phases of the project and is strengthened by means of dissemination and sensitisation campaigns and by training courses. At the end of the project, all actors own/share all choices made and the technology used participating thus to the intervention sustainability.

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Introduction

The extensive pastoral lands have traditionally played an important role in the evolution of livestock production systems in the Mediterranean areas (Hadjigeorgiou *et al*., 2005), where a wide range of products of quality is still produced (Boyazoglu and Morand-Fehr, 2001; Hadjigeorgiou *et al*., 2002). Moreover, these marginal areas have shaped the local animal species and breeds capable of surviving and utilizing these lands (Bertaglia *et al.*, 2007). Multifunctionality of grazing systems is widely recognized today, where along with production and economic objectives, the cultural, social and environmental dimensions should not be neglected (Steinfeld *et al.*, 2006). If adequately implemented, grazing management can be a suitable tool to upgrade and maintain traditional landscapes and sustain biodiversity (Rook *et al*., 2004).

Arid and semi-arid lands show a fragile natural resource base and offer limited alternatives for sustainable increases in agricultural productivity under purely rainfed conditions (ICARDA, 1995). Agricultural activity in such areas is frequently dominated by range dependent small ruminant production systems (FAO, 1995). However, during the past two or three decades, increases in livestock populations and sedentarization of the population have raised fears of irreversible environmental degradation and increased poverty for the inhabitants of such areas (IFAD, 1996). The ecosystems of arid and semi arid territories are often fragile due to the combination of climatic factors and human activities. Ploughing and indiscriminate removal of the vegetation, added to the rains insufficiency and irregularity is often responsible of land degradation phenomena, destruction on large-scale of the vegetable cover and desertification. The increasing need of forage for animal alimentation, by far higher than the productivity of the rangelands have provoked an increase of the pressure on marginal lands traditionally used exclusively for grazing by their cultivation for cereal production, causing a further acceleration of land degradation of marginal and fragile lands. As a result of political, economic and environmental factors, the dryland

agropastoral systems of the northern Africa have experienced significant changes in the past fifty years. In some cases, a breakdown of traditional system of grazing lands use and control was the effect of the national government attempts to sedentarize nomadic populations. The combination of these factors resulted in a major degradation of rangelands and a higher level of dependency of producers by linkages between these extensive production systems and feed sources, often-unstable, imported or domestic from other higher rainfall or irrigated agricultural areas. Furthermore, the contribution of browse to the livestock diet varies, with the ecosystem nature and strategies for improving shrublands productivity, and use depend on the farming system used. In less favourable environments, where the grazing season is short, the contribution of native fodder shrubs to the animal diet is very high and may exceed 70% (high mountain, steppe and desert ecosystems) and areas containing high numbers of less preferred individuals must be managed to allow establishment and persistence of preferred genotypes. In more favourable areas (semi arid to humid shrublands), shrubs are generally used on a seasonal basis (El Aich, 1987). There is thus a need to keep them and find a way to increase the proportion of high quality preferred food available relative to animal requirements. Grazing pressure is the key factor for shrub management.

The present contribution is devoted to the presentation of the approach and of the results achieved so far by a SMAP cooperation project coordinated by the NRD of the University of Sassari, with particular reference to the Moroccan component of the project. The target areas identified by the project in Morocco (Marrakech area) and Tunisia (Kasserine area) show some of the main land degradation and desertification issues typical of the Mediterranean areas. They represent significant examples of the dramatic extent of land degradation reached by the Mediterranean rangelands in the last years. Seedling and planting provide an opportunity to spread shrub species that will contribute to stability and diversity as well as to the productivity of the ecosystem. Many shrubs were introduced in the region, such as *Acacia* spp., *Atriplex* spp., *Prosopis* spp. and *Opuntia* spp. (El Aich, 1987). Among these fodder shrubs, *Atriplex* spp. are the most recommended and frequently planted species. The present project mainly made use of *Atriplex nummularia* in Morocco and of a mix of the three mentioned genders in Tunisia, with a traditionally larger use of *Opuntia ficus-indica*.

Project area specificities

In Morocco, the zone of intervention which extends on a surface of 52,400 ha corresponds to the pastoral space of the Ouled Dlim rural district, located in the arid area of Tensift, 30 km North West of Marrakech. Fourty percent of the area is a non-cultivated space, including 28% of rangelands. In Tunisia, the zone of Skhiret, Feriena is located at the South West of Kasserine. The pastoral, little diversified and strongly degraded flora offers annual phytomasse average of 125 UF/ha. The vegetation settlement includes mainly some steppic formations, more or less degraded, basically containing: *Artemisia herba-alba*, *Helianthemum lippii, Stipa tenacissima, Stipa lagascae, etc*. These rangelands are strongly marked by human activities impact. Indeed, their cultivation quickly transformed the landscape and the farming conditions.

In the project areas in both countries, the main economic activity is livestock breeding. The regions are characterised by rural poverty, food dependency and land abandoning, where urgent measures are needed to promote optimisation of resource management in view of a sustainable development. The land can grant only a very irregular forage production; so agricultural activities are often carried out by women because men are frequently obliged to migrate to look for a job in the urban centres. In these contexts, the restoration of vegetation cover with drought resistant perennial forage species (*Atriplex* spp., *Acacia* spp., *Opuntia* spp., *etc*.) has proven to be a very good solution to mitigate desertification processes and to improve rangeland productivity. The present project will mainly make use of *Atriplex nummularia* in Morocco and of a mix of the three mentioned genders in Tunisia.

Materials and methods

This demonstrative initiative has as main objective mitigation of land degradation phenomena and desertification in degraded pastures of Morocco and Tunisia and increment of their productivity. It has been lead through the implementation of a methodology based on two steps:

Direct interventions: evaluation and plantation

Direct plantation in degraded pastures to increase their productivity using perennial fodder shrubs species (*Atriplex nummularia*, *Opuntia ficus-indica* and *Acacia saligna*). In Morocco, 2000 ha of *A. nummularia* totally produced in a local nursery directly managed by beneficiary people and 62 ha of *O. ficus-indica* have been planted, while in Tunisia, 2000 ha of *O. ficus-indica,* 457 ha of *A. saligna* and 44 ha of *A. nummularia* were planted. An inventory of feeding species and production level was carried out through field prospection and rangelands assessment in planted areas, while comparing them with neighbouring non planted sites as control. The choice of methods was made taking in account either the specificities of the study areas and the effectiveness of the observation techniques developed in other similar zones. Phytomass is measured by an effective cut of the vegetation, while distinguishing between several species groups (annual grasses, perennial grasses, annual legumes, perennial legumes, other herbaceous). Only the palatable species are considered in phytomass assessment. For the land covering, two methods were applied: point quadrate method for the herbaceous layer and LIM (Line Intecept Method) for the shrubby layer. Qualitative assessment was approached through two principal parameters: phytomass, floristic and chemical composition. Soil preparation, shrub plantation and irrigation when necessary were assured by local cooperatives.

Collateral activities

Activity of formation and implementation of specific studies on the project areas, actions to strengthen the abilities to all the stakeholders involved in the project activities. Travels of exchange between the two Countries, demonstrative activities, of sensitisation and dissemination of project results to local, national and international level, through the involvement of institutions as the Union Arabic Maghreb (UMA) and the Observatory of the Sahara and Sahel (OSS), to promote and to strengthen know-how and competences exchange on the thematic faced by the action at South/South and North/South level as well.

Results and discussion

In Morocco, the first pastoral production level assessment was conducted at the first year of plantation, where the plantations were in establishment phase (Table 1). The production level of *A. nummularia* was thus very low, but the biomass of spontaneous annuals and perennials was very high due to the grazing exclusion, and relatively high level of precipitations (213.2 mm). The second evaluation was done during a very dry year (80.5 mm of rainfall) and the production level of *A. nummularia* was almost 3 times the first one, for the plantations conducted with the agroforestry system, while the spontaneous biomass was very low (Table 1). This demonstrates that also in critical climatic conditions and

overgrazing, where *A. nummularia* was the only forage resource available during drought, this species not only remains alive, but can also product biomass especially when is planted with alley cropping technique. Table 1 also shows that if the rangelands are not managed, the production levels already low decrease drastically during drought periods. A third assessment was conducted three years after the end of the project when the plantations were five years old and were browsed for three months a year to verify the project sustainability also under regulated grazing. A mean production of 791 UF was registered (*data not shown*). In Tunisia, one evaluation was carried on during April 2006 for plantations realised during 2003, 2004 and 2005 and thus being 3, 2 and one year old respectively. For *A. nummularia*, only plantations of 3 years old were assessed. Table. 2 shows the mean values of 22 sites for production increase of *O. ficus-indica*, widely used in Tunisia and also the high level of *A. nummularia* production. Le Houérou (1989) suggested that *Atriplex* plantations can be produced at a moderate cost as soon as yields are over 1000 UF /ha. In our case, and in some sites, a mean production of 1102 UF was registered in zones with a deep soil in Morocco (*data not shown*) and 719 UF in Tunisia (Table 2). These levels are very acceptable if compared with previous experiences in Morocco, where Acherkouk *et al.* (2002) reports a production of 875 UF/ha in a plantation density of 1000 plants/ha while Kebdani, 1993 reported a production of only 110

Table 1. Evaluation of *Atriplex nummularia* production under two agro-practices in Morocco.

***A. nummularia* plantation + intercropping (wheat or lentils)**	***Mean production (UF/ha)**	
Species / species groups	1-year-old plantation	2-year-old plantation
Atriplex nummularia	54.1	164.7
Annual grasses	8.7	6.6
Legumes	52.8	7.0
Centaurea alba	144.7	8.3
Hirchfeldia incana	100.4	10.9
Mesembryanthemum crystallinum	120.8	0.0
Asphodelus sp	4.3	0.0
Other herbaceous	232.2	18.8
Total	718.1	216.3
***A. nummularia* plantation**		
Species / species groups		
Atriplex nummularia	16.4	8.5
Legumes	22.0	15.4
Other herbaceous	54.0	18.3
Sinapis alba	45.3	6.65
Total	137.6	48.9
Control (not grazed and not planted)		
Species / species groups		
Reseda phyteuma	122.4	12.2
Sinapis arvensis	143.1	10.8
Legumes	6.0	9.0
Other herbaceous	113.4	5.6
Total	384.9	37.7

*The results reported are the mean value of 15 sites distributed in the area of intervention.

Table 2. Evaluation of fodder shrubs plantations production in Tunisia and their effects on the rangelands. Values are means of 22 sites representing 20% of planted areas (118 ha).

	1-year-old plantation	2-year-old plantation	3-year-old plantation
Opuntia ficus-indica			
O. ficus-indica production (UF/ha)	177.0	784.2	1566.5
Total covering (%)	47.2	44.2	36.6
Annual covering (%)	23.8	20.2	20.3
Perennial covering (%)	23.4	24.0	16.3
Production (kg/ha)	1340	907.5	1141.3
Acacia saligna			
A. saligna production (UF/ha)	-	558.6	399.2
Total covering (%)	45	61	20
Annual covering (%)	12.6	31	18
Perennial covering (%)	32.3	30	2
Production (kg DM/ha)	657	750	75
Atriplex nummularia			
A. nummularia production (UF/ha)			719.2
A. saligna production (UF/ha)			259.5
Total covering (%)			9.5
Annual covering (%)			3
Perennial covering (%)			6.5

UF/ha for a three years old plantation under 174 mm annual precipitations. Perennial cover is very important in Tunisia and it indicates a low degradation level, while in Morocco the vegetation cover is mainly made by annual species, thus indicating a more marked desertification process. El Aich (1987) found that 40% and 15% of the animal needs were provided by *Stipa tenacissima* and *Artemisia herba-alba*, two perennial menaced species in normal and dry years, respectively. *Artemisia herba-alba* communities are used as spring pastures by sheep producers. A study conducted on the oriental steppe of Morocco indicates that sheep ingest a large proportion of *Artemisia herba-alba* and the other shrubs, especially during periods of drought (El Aich, 1992). Besides the rangelands quality and quantity production increase, other benefit effects of the plantations can be summarised as:

- improvement of soil state and the quantity and quality of spontaneous herbaceous species: increase organic carbon in the soil from 0.45% to 0.70%, decrease of electrical conductivity, increment of the nitrogen amount and the pH under canopy, consequent reduction of erosion phenomena due to the windbreak action of the species planted;
- increase of the fodder production by *A. nummularia* (from 54.1 to 164.7 UF/ha in Morocco) (Table 2);
- production of prickly pear fruits for the direct consumption and/or commercialisation.

Collateral activities that accompanied the direct interventions led to the improvement of local technicians, breeders and women professionality, through the organization of 120 formation sessions during the 5 years of project which involved a total of 992 breeders in the two countries, of which 400 women and allowed the formation of 6 feminine cooperatives in order to eliminate illiteracy and involve rural women in activities as source of income. These training activities helped people to fully benefit of new income sources and to rationally exploit the resources in a sustainable way reducing grazing pressure to preserve the fodder shrubs plantations. Local cooperatives have been able to manage the nursery and 4 years after the end of the project, the nursery not only still produce plants for other plantation project but has diversified plant production to other local species.

Other benefits are previewed in the mean and long term: the improvement of animal production, further improvement of soil fertility, the involvement of a wider number of breeders to increase the planted superficies. Dissemination took effect through the organization of workshops which have given a great visibility to the participation. The demonstrative action has thus become a model of development already adopted from the Moroccan and Tunisian governments.

Conclusions

Direct interventions in the field through the fodder shrubs plantation have given a response to the breeder preoccupations, standing green fodder reserve for the dry season and as interannual buffer feed reserve of fodder for severe and prolonged droughts besides the real environmental protection against frequent sandy winds.

It is worth reminding that the fully involvement of local communities in planning and scheduling and the flexibility of participatory approach adopted by the project allowing people to propose also their changing needs and expectations has contributed significantly to the correct implementation of the action. Early participatory evaluations allow some changes to better meet the population needs. When the project proposal was discussed with local community's representatives, it was warmly welcomed. People agreed on the objectives of the proposal that, by introducing perennial species, intends to create the conditions for breaking food dependence in the long term. In Morocco the project was implemented through an established group of farmers by signing a preliminary agreement and taking over the responsibilities for plantation management also after the end of the project. In a similar way in Tunisia the project was implemented through the constitution of an association by the farmers that spontaneously adhered to the project. People place their land at disposal and contribute to cover plantation and management costs. The action was a concrete demonstration to the neighbourhood. The continuous confrontation with the stakeholders has allowed to modulate the actions of technical formation that have represented a point of force for post project follow-up, which allowed to fully valorise the not negligible equipment of structures and means supplied by the project. The relational capital associated to the organizational models in the two countries, promoted through the actions of project, has allowed to give to the new organizations a role of representatives of the local communities and interlocutors with the local governments, in the perspective of regulating the use of the rangelands and the sustainable management of the realized plant.

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