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in

Acar Z. (ed.), López-Francos A. (ed.), Porqueddu C. (ed.).  
New approaches for grassland research in a context of climate and socio-economic changes

Zaragoza : CIHEAM

Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 102

2012

pages 449-452

Article available on line / Article disponible en ligne à l'adresse :

<http://om.ciheam.org/article.php?IDPDF=6994>

To cite this article / Pour citer cet article

Chebli Y., Mrabet R., Chentouf M. **Alley cropping as a durable alternative for pasture land development in the drought prone region of Eastern Morocco.** In : Acar Z. (ed.), López-Francos A. (ed.), Porqueddu C. (ed.). *New approaches for grassland research in a context of climate and socio-economic changes*. Zaragoza : CIHEAM, 2012. p. 449-452 (Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 102)



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# Alley cropping as a durable alternative for pasture land development in the drought prone region of Eastern Morocco

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**Abstract.** Eastern region of Morocco, which is under permanent water shortage and recurrent drought, is facing problems of pastoral land degradation that threaten economic livelihoods of resource-poor farmers. In order to diversify the productivity and meet livestock nutritional requirements during feed gap periods, saltbush (*Atriplex nummularia*) was planted in association with barley (alley cropping). This study was conducted in Tancherfi area in order to assess the socio-economic impact of changes in farming systems using alley cropping. The vegetation parameters (shrub biomass and canopy cover) were measured during three periods. The results showed that biomass and canopy cover of *Atriplex nummularia* increased by 15% and 10% respectively due to the inclusion of barley. This association had positive effects on soil properties, which improved soil water status. Farmers expressed their satisfaction with this technique that allowed a 38.9% increase in barley grain yield. This result could be explained by the microclimate created by fodder shrubs that benefited barley growth and development. As a conclusion, with active involvement of community alley cropping should be introduced in any policy related to development of pasture lands in eastern region of Morocco.

**Keywords.** Mediterranean region – Pasture – Alley cropping – *Atriplex nummularia* – Barley.

## **L'alley cropping : Alternative durable pour le développement des pâturages dans les régions sèches de l'Orientale du Maroc**

**Résumé.** L'Orientale du Maroc, qui est sous la pénurie d'eau et une sécheresse permanente, est confronté à des problèmes de dégradation des terres pastorales qui menacent les moyens de subsistance économiques des agriculteurs à faibles ressources. Afin de diversifier la productivité et répondre aux exigences alimentaires du bétail pendant les périodes de disette, l'*Atriplex nummularia* a été planté en association avec l'orge. Cette étude a été menée dans la région de Tancherfi afin d'évaluer l'impact socio-économique des changements dans les systèmes agricoles utilisant l'alley cropping. Les paramètres de la végétation (biomasse arbustive et recouvrement) ont été mesurés pendant trois périodes. Les résultats ont montré que la biomasse et le recouvrement végétal d'*Atriplex nummularia* a augmenté de 15% et 10% respectivement en raison de l'introduction de l'orge. Cette association a eu des effets positifs sur les propriétés du sol ce qui a permis d'améliorer son état hydrique. Les agriculteurs ont exprimé leur satisfaction pour cette technique qui a permis une augmentation de 38.9% du rendement en grain d'orge. Ce résultat pourrait s'expliquer par le microclimat créé par les arbustes fourragers qui a fait bénéficier la croissance et le développement de l'orge. En conclusion, la participation active de la population par l'introduction de la culture intercalaire devrait être envisagée dans toutes les politiques de développement des terres de pâturage dans l'orientale du Maroc.

**Mots-clés.** Région méditerranéenne – Pâturage – Culture intercalaire – *Atriplex nummularia* – Orge.

## **I – Introduction**

Pastoral lands in Eastern Morocco are facing a myriad of problems (i.e. water shortage, recurrent drought and desertification). In order to restore these lands, alley cropping was proposed as an alternative technology for rebuilding soil fertility and enhancing crop and forage production (Kang *et al.*, 1985; Lal, 1989; Kang and Ghuman, 1991).

Alley cropping is an agroforestry practice where trees or shrubs are grown on single or multiple rows simultaneously with a crop between the rows. This technique can benefit from the use of agricultural by-products and dispose of green fodder during the feed gap seasons (USDA, 1999).

This technique is rather advised in areas where the complementarity between animal and plant production is strong, and who present poor soils in terms of quality and structure.

In Eastern Morocco, *Atriplex nummularia* is used in alley cropping. It can play an important role as animal feed; the *Atriplex* have high content of crude protein and mineral contents throughout the year (Franclet and Le Houérou, 1971; Otsyina *et al.*, 1982).

This paper attempts to assess the impact of using alley cropping as an agroforestry practice on productivity of fodder shrubs and barley crop.

## II – Materials and methods

The study was carried out in the east of Morocco (Tancherfi site). It is located at 34°21' N 2°37' W and 980 meters above sea level. The lands are mainly cropped for cereals; although originally they were pastoral areas dominated by esparto grass (*Stipa tenacissima*). The climate of the area corresponds to a semi-arid Mediterranean type with mean minimum and maximum temperatures of 1.5°C and 44°C respectively. Total annual precipitation is 200 mm.

In order to diversify feed resources and meet livestock nutritional requirements during feed gap periods, *Atriplex* was planted in association with barley in dry areas (alley cropping). This plantation was performed on an area of 30 ha. In order to harvest most rainfall and runoff for shrub and barley growth, contour planting was practiced. The space between the shrubs with the same line is 1.5 m and 5 m between rows, therefore planting density is 1333 plants per hectare. For the control plot (without alley cropping) *Atriplex* and barley were planted in separate plots.

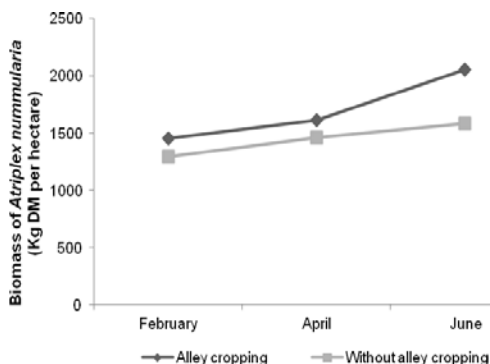
The vegetation parameters of *Atriplex* (shrub biomass and canopy cover) were measured during three periods (February, April and June), while the interviews with breeders were conducted during June. The barley yield was recorded at the end of the cropping season.

To measure biomass of *Atriplex* "Reference Module Method" was used. Andrew and Lange (1979) suggest that the preferred size of the reference module be 10-20% of the foliage weight. Fifteen branches (modules) were selected randomly, these modules were defoliated and weighted (leaves and wood) to determine the average weight by module. After, we counted the number of modules on the basis of 50 shrubs (5 shrubs per line transect selected randomly). Thus, the mean individual shrub biomass is obtained by multiplying average number of modules per shrub by the average weight of module. Plant material is oven dried (68°C for 48 h) to obtain Dry Matter (DM). The canopy cover was determined by measuring the surface area of each clump of shrubs within quadrats 20m x 20m. Data presented as percentages underwent angular transformation prior to statistical analysis.

## III – Results and discussion

### 1. Seasonal variation of consumable biomass

Biomass of *Atriplex* gradually changed with the advancement of the season, from 1.453 kg DM per hectare in February, 1.613 kg DM per hectare in April to 2.053 kg DM per hectare in June, which gives an average of 1.706 kg DM per hectare. This latter exceeds *Atriplex* production without alley cropping (1.450 kg DM per hectare) (Fig. 1).



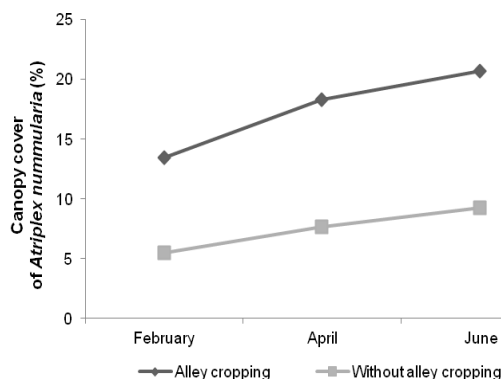
**Fig. 1. Seasonal variation of consumable biomass of *Atriplex nummularia*.**

Alley cropping has permitted better productivity due to possible soil restoration within rows by barley cultivation. It is also important to consider that alley cropping was applied for 3 to 4 years. Mulch from barley and *Atriplex* occurs naturally; it's a nutrient rich, moisture absorbent bed of decaying leaves, twigs and branches, teeming with fungal, microbial and insect life. Natural mulch serves as a nutrient element. Mulching improves nutrient and water retention in the soil, encourages favorable soil microbial activity and worms, and suppresses weed growth. In addition to the other benefits of alley cropping, planting the furrows along the contour helped to maintain moisture.

In fact, contour planting has allowed to increase rainfall capture and improving soil moisture condition which benefited *Atriplex* and barley.

## 2. Seasonal variation of canopy cover

The canopy cover of *Atriplex nummularia* increased from 13.5% in February, 18.3% in April to 20.7% in June. In areas without alley cropping, the average canopy cover of *Atriplex* doesn't exceed 7.5% (Fig. 2). This trend results from the development of the aerial part of *Atriplex* favored by microenvironment within the canopy, rainfall and temperature. To limit risk of tree competition with barley for light, farmers prune the *Atriplex* to increase solar penetration and rainfall reception to the alley.



**Fig. 2. Seasonal variation of canopy cover of *Atriplex nummularia*.**

### 3. Socio-economic impacts

#### A. Feed cost

In area of study, farmers have noticed that before alley cropping was applied, the cost of feeding was approximate 250 Dh/year/head. After alley cropping adoption, farmers have noticed a reduction in annual expenses by 50%. In the same areas, the feeding costs were reduced by 30% for those with small flocks, and by 70% for those with large flocks (ICARDA, 2005). With alley cropping; farmers can also benefit from barley grain and straw and green fodder from of *Atriplex*.

#### B. Barley grain yield

With alley cropping we noticed an increase in barley grain yields, which reached 15 quintals per hectare against a production of 10.8 quintals per hectare in a control plot without *Atriplex*. This high production of barley would be linked to the positive effect of furrows that helped to retain water runoff and improve soil water status, in addition to effect of *Atriplex* shading that could limit evaporation from the soil and creates a microclimate favorable to the development of barley.

#### C. Fuel wood production

In Tancherfi, *Atriplex* has allowed producing 3.200 kg / ha of wood, which allowed to reduce costs of firewood used mainly for cooking and heating in cold season.

### IV – Conclusion

Alley cropping has positive impact on farming system. This study showed that biomass and canopy cover of *Atriplex nummularia* increased by 15% and 10% respectively as compared to monoculture of *Atriplex*. Farmers expressed their satisfaction with the alley cropping system mainly due to 38.9% increase in barley grain yield, a significant reduction in feed cost and an important production of fodder and fuel wood.

It is recommended that rangeland strategic policy for Eastern Morocco includes large diffusion of alley cropping.

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