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ICARDA
Science for Better Livelihoods in Dry Areas

Atriplex: A Drought Resistant Forage




Prepared by:

(ARIA) Agricultural Research Institute of Afghanistan and (ICARDA) International Center for Agriculture Research in the Dry Areas

Established in 1977, the International Center for Agriculture Research in the Dry Areas (ICARDA) is one of 15 centers supported by the CGIAR. ICARDA's mission is to contribute to the improvement of livelihoods of the resourc-poor farmers in dry areas by enhancing food security and alleviating poverty through research and partnerships to achieve sustainable increase in agricultural productivity and income, while ensuring the efficient and more equitable use and conservation of natural resources (www.icarda.org).

ICARDA has a global mandate for the improvement of barley, lentil and faba bean, and serves the non-tropical dry areas for the improvement of on-farm water use efficiency, rangeland management and small- ruminant production. In the Central Asia and West Asia and North Africa regions, ICARDA contributes to the improvement of bread and durum wheat, Kabuli Chickpea, Pasture and forage legumes, and associated farming systems. It also works on improved land management, diversification of production systems, and value-added crop and livestock products. Social, economic and policy research is an integral component of ICARDA's research to better target poverty and to enhance the uptake and maximize impact of research outputs.

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The Australian Center for International Agricultural Research (ACIAR) operates as part of the Australian Governments' development cooperation programs. The center encourages Australia's agricultural scientists to use their skills for the benefit of developing countries and Australian's. ACIAR International Agricultural Research funds research projects that are developed within a framework reflecting the priorities of Australia's aid program and national research strengths, together with the agricultural research and development priorities of partner countries. ACIAR was established by the passing of the Australian Center for International Agricultural Research Act (ACIAR Act) in June 1982. The ACIAR Act was described as an act to encourage research for the purpose of identifying, of finding solutions, to, agricultural problems of developing countries (www.aciar.gov.au).

Introduction:

Mr. Mohammad Asif Rahimi, Minister of Agriculture, Irrigation and Livestock, while opening the National Rangeland Development Plan Workshop on April 1, 2011, held in the late Dr. Abdul Wakil Hall, first spoke in detail about the importance of rangelands and their role in protecting the environment. He explained how healthy rangelands help prevent natural disasters, support livestock practices, and improve the livelihoods of local communities and nomads (Kuchis).

He then highlighted the serious issue of rangeland degradation and its negative impacts on water resources and irrigation. These issues have led to lower agricultural production and increased soil erosion. The Minister also pointed out key factors behind rangeland degradation such as overgrazing, unclear user rights, irresponsible expansion of farming into rangeland areas, and other issues that make rangeland protection more difficult. In his opening remarks, the Minister emphasized, "*We cannot allow this vital resource—our rangelands—to disappear. We hope this workshop helps guide the Ministry of Agriculture and its partners toward a clear path to protect and restore Afghanistan's rangelands.*"

He also expressed hope that rangeland protection and restoration efforts would involve everyone, especially local communities, including both villagers and nomads whose livelihoods depend on these lands. The Minister added, "*We believe that the Ministry of Agriculture will manage and secure the future of Afghanistan's rangelands in the most sustainable and fair way. Any challenges that exist can be solved through strong and continued cooperation among all relevant parties. Our rangelands are Afghanistan's green carpet, and we must not allow them to be destroyed.*"

The International Center for Agricultural Research in the Dry Areas (ICARDA), which considers rangeland conservation and promotion a core part of its work, has partnered with the Ministry of Agriculture over the past years. Together, they have carried out joint research on different types of Atriplex plants (a type of salt-tolerant shrub useful for dry rangelands). Out of six types tested in trial nurseries, two were selected and introduced. These selected types of Atriplex were sown with the support and participation of local communities in hilly lands in Baghlan and Balkh provinces. It is hoped that very soon, these areas will become healthy, green grazing lands for livestock and also help prevent further soil degradation in those regions.

Growth Characteristics of Atriplex:

Atriplex belongs to the *Amaranthaceae* family and the Atriplex genus, which includes between 100 to 200 species. Atriplex uses the C4 photosynthesis pathway, which makes it more efficient than C3 plants—producing about 50% more dry matter. Because of this, it plays an important role in efficient water use and conservation.

Atriplex can absorb salts from the soil through its roots and store them in special salt pockets in its leaves. This salt storage ability increases its water absorption capacity. When the leaves fall off or are eaten by animals, the salts are released, and the plant begins absorbing more salt from the soil again—allowing the roots to take in even more water. This is a unique trait not found in most other plants.

Atriplex is a perennial plant (lives for many years) and grows well in dry areas with low rainfall. In salty soils, different types of Atriplex are planted to produce fodder or to prevent soil erosion. This fodder is considered one of the most important types of forage for drylands. It grows well in areas where the minimum annual rainfall is around 4 to 7 inches (100 to 180 mm) and where the climate is hot in summer and cold in winter.

Atriplex adapts to soils with varied texture and structure—from clay to sandy soils, and soil depth from 10 cm to 1 meter. However, it performs best in deep soils. It can grow in flat plains, non-arable lands, stony areas, gentle hillsides, and even on sandy dunes formed by wind. Atriplex can grow at elevations between 15 to 2,440 meters above sea level, but it thrives best between 1,370 to 1,830 meters.

This plant is salt-tolerant and grows well in saline areas. It produces many branches, has a light green color, and can reach heights from 1 to 2 meters, sometimes even up to 3 meters. The branches are broad and ash-colored, and the plant does not self-pollinate.

Atriplex is an evergreen and long-living plant—it can live more than 10 years if managed properly in rangelands (depending on the species).

In terms of nutrition, Atriplex contains about 25% protein and 5.3% carbohydrates. Many of its species are even used as food for humans. For example, one annual variety known as "Shurak" is used as a cooked vegetable in Afghanistan

Atriplex Seeds in Afghanistan:

In 2006, six types of Atriplex seeds were received from the ICARDA central office and planted in plastic seed bags for study at the Puz-e-Ishan Research Farm in Baghlan Province. These seed trials are shown in Figure 1, and the names of the varieties are as follows:

1. Lentiformis – Balochistan
2. Lentiformis – USA
3. Nummularia – Australia
4. Halimus – Syria
5. Canescens – Balochistan
6. Holoxylon Aphyllum – Uzbekistan

Out of these, the Lentiformis and Canescens varieties gave the best results and were successfully propagated.

Figure 1: Establishment of Atriplex nursery in Baghlan Province, using plastic seed bags

Figure 2: Establishment of Atriplex nursery in Nangarhar, using plastic seed bags.

In the Badam Bagh Farm, the Atriplex was planted as demonstration plots under rainfed conditions using the Eyebrow system (contour bunds or micro-catchments). Similarly, in Baghlan Province, demonstration plots were established on hillsides and terraces, also using the Eyebrow system. Atriplex was planted both alone and in combination with barley. These are shown in Photos 3, 4, and 5.

Figure 3: Planting Atriplex seedlings in demonstration plots in Baghlan Province.

Figure 4: A demonstration plot of Atriplex forage on a hillside in Baghlan Province.

Figure 5: Mixed planting of Atriplex and barly under rainfed conditions on hillsides in Baghlan Province.

Table 1 : Average yield and income from barley (per hectare)

Estimated Income per Hectare	Average Barley Straw Yield (Kg/ha)	Average Barley Grain Yield (kg/ha)
34,820 AFN = 696 USD	1,500	916

Atriplex can be planted either alone or together with other crops, allowing small livestock to graze on both types of plants. In Figure (5), it is shown intercropped with barley under rainfed conditions in Khalazai village, Pul-e-Khumri district of Baghlan province. During the barley harvest, ten random samples were taken, each from an area of one square meter. The grain and straw weights were measured in kilograms per square meter and then calculated for one hectare, as shown in Table (1).

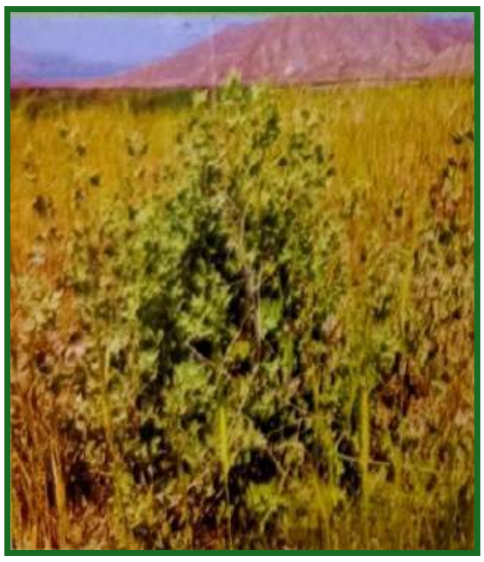
Based on the data in the above table, it can be concluded that in addition to obtaining green forage from Atriplex, barley and wheat can also be planted in autumn between the rows of Atriplex, providing additional fodder for livestock. The data was collected from Khalazai village of Pul-e-Khumri district, where the recorded rainfall from planting to harvest in 2013 was 252 millimeters. The amount of forage produced from barley was 1.5 tons of straw and 916 kilograms of grain per hectare. If the market price per kilogram is estimated at 11 Afghanis for straw and 20 Afghanis for grain, the total income from one hectare reaches 34,820 Afghanis, equivalent to 696 US dollars. The conversion is based on an exchange rate of 50 Afghanis per dollar.

Atriplex Forage Yield:

The two types of Atriplex mentioned earlier were sown in 30 demonstration plots in Baghlan province with the participation of local farmers. An effort was made to estimate both the fresh and dry forage yield and to study the differences in production between the two types.

Method for Estimating Fresh and Dry Weight of Atriplex:

The method used to estimate Atriplex forage was developed in 1979 by Andrew and colleagues in Australia and was applied in this study. A typical plant, representing the area of the demonstration plots, was selected. A healthy green branch from the selected plant was cut, and its fresh weight was recorded. The same branch was then placed in sunlight for three days to dry, after which its dry weight was measured. The number of similar branches on each plant was counted and recorded. By using the fresh and dry weights of the sample branch and multiplying it by the total number of branches on each plant, the forage yield per plant was estimated and then converted to kilograms per hectare. In total, 30 plants of each Atriplex variety were used for estimating the yield.



Andrew, M.H, I.R. Noble and R.T.Large.1979.A non-destructive method for collecting the weight of forage on shrubs. Aus. Range L.J. (3): 225-310.

And also in Syria, as shown in Figure (6), Atriplex has been planted in furrows between rows of barley on rainfed flat lands using the intercropping method. This technique produces a large amount of forage for livestock.

Figure 6: Atriplex planted on flat land between barley rows in Syria

Uses of the Atriplex Plant

1. **Livestock Feeding:**

Atriplex is an excellent feed for goats and sheep, a good feed for cattle, and a fairly good option for horses. Its taste is salty, which helps increase the animals' appetite. However, if animals graze on Atriplex continuously without any rest period, it can lead to the destruction of the plant. Therefore, grazing should be done alternately, allowing Atriplex bushes to recover. It is best to use it as a part of a mixed pasture system, where it grows alongside other plants.

2. **Soil Erosion Control:**

Atriplex is a long-living perennial plant, with a lifespan of 10 to 12 years. In areas where no other native plants can grow, Atriplex sends its roots 2 to 6 meters deep into the soil, helping to prevent soil erosion.

3. **Wildlife Support:**

In addition to goats and sheep, deer are particularly fond of Atriplex, especially in winter. Various birds, especially partridges, use the plant for shelter and food. Other animals such as gerbils, weasels, and foxes also feed on Atriplex and benefit from its presence in the ecosystem.

Landscaping and Environmental Protection:

Atriplex has the potential to grow in areas with relatively low rainfall and helps to clean and protect the environment from pollution. In general, it is drought-tolerant and needs only about 150 mm of water throughout the growing season. By covering the ground and providing shade, it also creates favorable conditions for the growth and restoration of other plant species and fodder varieties.

Atriplex seedlings can be produced throughout the year, although spring gives the best results. For planting, about 2 to 2.5 kilograms of seed per hectare is sufficient. The seeds must be separated from their husks to ensure proper germination. Atriplex seeds mature three to four months after flowering, which usually occurs around August and September. The seeds should be collected between September and December.

Table 2: show the quantities of seeds collected from four different types of Atriplex in Baghlan Province in the year 2013.

No	Type of Atriplex	Seed Quantity Avialable (kg)
1	Lentiformis – American	11
2	Lentiformis – Balochistan	5.5
3	Halimus – Syria	0.5
4	Pali-Corpa – USA	5.0
Total		**5.17**

Figure (7): Weighing the collected Atriplex seeds and placing them into storage bags.

Currently, under joint programs between the Ministry of Agriculture, Irrigation and Livestock and ICARDA, approximately 5 jeribs of rainfed land have been used for Atriplex demonstration plots in Khalazai village, Pul-e-Khumri district, in collaboration with contracted local farmers. The roles and responsibilities of each party have been clearly outlined in the agreement.

This approach enables farmers to produce seeds in the future, thereby putting into practice one of the Ministry's key goals: involving local communities in the restoration and rehabilitation of rangelands.

Methods of Planting, Propagation, and Care of Atriplex:

The best method for planting and propagating Atriplex is by sowing the seeds in plastic seed bags, although row seeding by broadcasting is also practiced. In either case, the seeds must be clean and healthy, and planted at a depth of less than one inch in the soil or plastic bags. As shown in Figures 1 and 2, once the Atriplex seedlings grow, they are removed from the bags and transplanted into the field, as seen in Figure 3.

Before transplanting, the land should be cleared of weeds, and the seedlings should be planted at the recommended spacing. The suitable distance between two plants is 1.8 to 2.4 meters, and

between two rows is 2.4 to 3 meters. In the first year, Atriplex requires irrigation to grow well. It also needs care during the winter season, as its branches are delicate and can be easily damaged during early growth.

Grazing should be done in alternating cycles so that the plant can grow properly and produce enough forage for livestock. If no other feed is provided to the animals, Atriplex will be heavily grazed. Since the plant is very delicate at the early stages of growth, it should not be planted near roads or areas with frequent movement of vehicles and animals.

Pests and Diseases:

Atriplex does not suffer from major insect problems, but rabbits and mice may damage young seedlings.

Note:

NGOs, local residents, or individuals interested in obtaining Atriplex seeds can contact the following persons:

1. Haji Abdul Razzaq – Forest Manager, Directorate of Agriculture, Irrigation and Livestock, Baghlan Province –
2. Engineer Wazir Gul Rasuli – ICARDA Office, Baghlan –

Atriplex in the flowering stage

Demonstration plot on marginal lands in Baghland Province.

Intercropping of Atriplex with rainfed barley used as forage

Atriplex in the growth stage

Intercropping of Atriplex with barley in Baghlan