Lentils in production and food systems in West Asia and Africa

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Abstract: Lentil is a staple food legume that is traditionally grown in West Asia, East and North Africa, the Indian sub-continent and is a primary component of farming systems of those areas. Lentil plays a significant role in human and animal nutrition and in maintenance and improvement of soil health. The International Center for Agricultural Research in the Dry Areas (ICARDA) has a world mandate for lentil improvement and is working with the national programs of the region to enhance production and productivity, increase farmers' income and provide lentil to consumers for food and nutritional security. Average yields of lentil in the region are considered to be relatively low due to cultivation of predominantly local cultivars that have limited yield potential and are vulnerable to a number of stresses. Yield limiting factors include a seemingly lack of response to inputs and apparent susceptibility to various biotic and abiotic stresses. Harvest mechanization is an important research goal in order to reduce production costs. Also, more effective weed management is needed. Lentil will remain as an integral component of farming and food systems in West Asia, and North and East Africa but returns to farmers need to be enhanced.
Key words: crop mechanization, farming systems, international centers, production constraints, weed control

Lentil is a staple food legume crop, traditionally grown in West Asia, East and North Africa, the Indian sub-continent and in the recent past in North America and Oceania. It is an important crop in food, feed and farming systems of West Asia and North and East Africa. Lentil, among other food legumes, plays a significant role in human and animal nutrition and in soil health improvement. Its cultivation enriches soil nutrient status by adding nitrogen, carbon and organic matter which promotes sustainable cereal-based crop production systems in the regions. Lentil is a key food legume crop for intensification of crop production systems in West Asia and North Africa, where lentil is predominantly grown in rotation with barley and wheat. Countries like Turkey, Syria, Iran, Morocco and Ethiopia are the major players in global lentil production. Both red and green lentils are produced in the region with variable proportion. For example, Turkey and Syria grows about 80-85% red lentil and 15-20% green lentil; Iran and Morocco produces about 95% large-seeded green lentil; and Ethiopia is devoted to produce red lentils only. This production preference of red and green lentil by farmers relates to food preparation and consumption habit by the people in those countries. Among them, Turkey, Syria and Ethiopia exports lentil in international markets, but others import lentil to meet their domestic demands.

The International Center for Agricultural Research in the Dry Areas (ICARDA) with its world mandate for lentil improvement is working with the national agricultural research systems of the regions to enhance production and productivity, to increase farmers' income and to provide adequate lentil to consumers for food and nutritional security.

Lentil in food systems in the region

Lentil is used for preparation of various traditional foods in West Asia, North Africa and East Africa since time immemorial. It is the most desired legume because of its high protein (Up to 35.5%) content and fast cooking characteristics. It is used as starter, main dish, side dish or in salads. In West Asia and North Africa, "*Mujaddarah*", made of whole lentil and immature wheat seed, is a popular dish. *Koshary* is a commonly served dish in Egypt, made of mixture of rice and red lentil. In North Africa, lentil is prepared with vegetables and the recipe is known as *lentil Tagine*. Of course, red lentil soup is popular all over the regions, but most particularly in Turkey, Lebanon, Jordan, Palestine and Syria. *Wot* is a traditional dish in Ethiopia. Also, lentil may be deep-fried and eaten as snack, or combined with cereal flour in the preparation of such foods as bread and cake. Large-seeded green lentil is used in salad. Lentil is a key source of protein, especially for the poor, who often cannot afford animal products. Like other food legume crops lentil provides nutritional security to low- income consumers as its seed contains high amounts of digestible protein, macro- and micronutrients (Ca, P, K, Fe, Zn), vitamins (niacin, Vitamin A, Ascorbic Acid, Inositol), fiber and carbohydrates for balanced nutrition. Lentil straw is a valued animal feed throughout West Asia, North and East Africa regions, and sometimes monetary returns to farmers equal that from seed.

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Agro-ecology and production environments

The national and international efforts for the last three decades identified the factors of lentil adaptation based on morphological characters, temperature and photoperiod, distribution and amount of rainfall, prevailing abiotic stresses, etc. Understanding of genotype and environment interaction, the local constraints to production and consumer requirements for seed as food and straw as feed, has been a guide to the national and international breeding programs to develop new genetic materials for West Asia, North and East Africa region. The major target agro-ecological regions of production of lentil are:

East Africa - Ethiopia, Sudan, Eritrea, where seed yield, early maturity, resistance root diseases and rust are important;

Mediterranean low to medium elevation <850 asl) - Morocco, Tunisia, Algeria, Jordan, Syria, Turkey, Iran, Lebanon, Iraq, where biomass (seed + straw), drought and heat tolerance, combined resistance to wilt and root rots, rust and ascochyta blight diseases, weed control attributes are key to lentil production;

Highlands (>850 asl) - Anatolian highland of Turkey, Atlas Mountain regions of Morocco and Algeria, where winter-hardiness, biomass, and resistance to ascochyta blight are the major focus.

The lentil breeding programs generally uses parents of diverse origin with known traits with the aim to combine gene(s) that contribute to yield and resistance to major biotic and abiotic stresses, and other morphological traits. Wide crosses among cultigens and with wilds are also done at ICARDA by manipulating planting dates and providing 18 hours extended light period to the parents to attain synchrony in flowering. More than 250 crosses are commissioned at ICARDA every year and the products in the form of yield trials, stress nurseries, segregating populations are distributed to national programs to select promising genotypes for varietal releases. Elite genetic stocks are also conserved in national gene banks for future use.

Major constraints to production

Average lentil yields in West Asia, North and East Africa except Turkey are still low because of cultivation of predominantly local cultivars which have the limited yield potential and are also vulnerable to an array of stresses. The yield limiting factors are lack of seedling vigour, slow leaf area development, high rate of flower drop, low pod setting, poor dry matter, low harvest index, lack of lodging resistance, low or no response to inputs, and subject to various biotic and abiotic stresses. The major abiotic limiting factors to lentil production in these regions are intermittent and terminal drought, high temperatures during pod filling stage, and, at high elevations, cold temperatures in winter, besides mineral imbalances like boron, iron, salinity and sodicity. Among biotic stresses, rust, vascular wilt and ascochyta blight diseases, sitona weevil, broomrape are the major agents for yield loss. Additional constraints to production include agronomic problems of pod dehiscence and lodging, and inadequate crop management, particularly weed management practices by growers. Adequate variability for many of the important traits exists within the crop gene pool allowing manipulation through plant breeding. However, several other important traits, such as biomass yield, pod shedding, nitrogen fixation, aphids and Sitona weevil and the parasitic broomrape (*Orobanche* sp.) are not currently addressable by breeding because of insufficient genetic variation, where appropriate management strategies are applied.

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Research products and delivery

ICARDA and its partners in the regions searched for desirable genetic variability among >11,000 genetic resources conversed at ICARDA gene bank. Sources of resistance to the above stresses, parents with desirable morphological agronomic traits have been identified and used in breeding programs This has resulted in improved varieties with multiple desirable traits. Simultaneously, appropriate matching production technologies have been developed and transferred to farmers to achieve actual potential yields. Through joint research, a total of 59 lentil varieties have been released by national programs of West Asia, North and East Africa with yield advantages ranging from 12-98%, and many are in pipeline. Some of these varieties have combined resistance to multiple stresses, higher yield potential, high iron and zinc contents, lodging resistance, etc. For example, the red variety 'Alemaya' is popular in Ethiopia (Fig. 1), has high level of resistance to rust and root diseases, excellent phenological adaptation in new cropping niches, attractive seed traits, high iron and zinc. 'Bakria', an early maturing green lentil with resistance to rust have been adopted by farmers in low-rainfall areas of Morocco. 'Idlib-2' (Fig. 2) and 'Idlib-3' (Fig. 3) with higher yield, wilt resistance and erect growth habit are spreading rapidly among farmers in Syria. Of them, Idlib-3 is suitable to low rainfall areas (<280 mm). They also have high Fe and Zinc contents. Likewise 'Firat-87', locally known as 'Commando' and Syran-96 are popular in South-East Anatolia in Turkey, a major hub of red lentil in the region. The winter-hardy variety 'Kafkas' is spreading among farmers in Central Anatolia. Appropriate production packages with seeding time, seed rate, weed management, and other intercultural operations have been disseminated to farmers. Farmers have been trained in improved production technologies and the merits of new varieties.

Harvest mechanization… …A key issue

Lentil cultivation in West Asia and North Africa has been threatened by rising costs of agricultural labour with hand harvesting accounting for approximately 47% of the total cost of production. Therefore to reduce costs, it is essential that lentil harvest be mechanized. To address this constraint, ICARDA has developed economic machine harvest systems for lentil cultivation involving cultivars with improved standing ability, a flattened seedbed and the use of cutter bars/combine (Fig. 4). The Center has developed and promoted a lentil production package that includes mechanization and the use of improved cultivars with good standing ability. Such cultivars include, Idlib-2, Idlib-3 and 'Idlib-4' in Syria, 'Hala' and 'Rachayya' in Lebanon, 'IPA-98' in Iraq, 'Saliana' and 'Kef' in Tunisia, and 'Firat-87' and 'Sayran-96' in Turkey. On average, mechanical harvesting combined with improved varieties having good standing ability reduces harvest costs by 17-20%.

Effective weed management… to ensure a better yield

Lentil is poor competitor with weeds and this is attributed to short plant stature and slow early growth. Yield reductions due to weed infestations of up to 84% have been recorded in West Asia. Generally, weeds emerge before or at the time of crop emergence. Among five weed control techniques (preventive, cultural, mechanical, chemical and biological), the farmers in West Asia and North Africa are mostly using preventive, cultural and chemical controls. Farmers use lentil seed free of weed seed, they destroy weeds before flowering and they use clean field equipment to prevent or reduce weed infestations. Farmers also use delay planting until after the first rain to allow weeds to germinate and removed by cultivation, crop rotation, seeding depth and higher seeding rates to reduce effects of weed infestations. Mechanical weed control is rare at farmers' level. In Turkey, both pre-emergence and post-emergence herbicide use is gaining popularity. In general, most farmers still use hand weeding, which increases cost of production. Broomrape is a major menace of lentil production in West Asia and North Africa. To control broomrape, two post emergence application of Imazapic (3 g a.i./ha) is being effectively used by farmers in Syria and Turkey. The first application when lentil seedling is at 5-7 eafed stage followed by second application 2-3 weeks later. Effective weed management is necessary for good lentil crops.

Conclusion

West Asia, North and East Africa are potential regions for lentil cultivation and the crop has a unique place in food and feed systems. Although good progress has been made to develop new cultivars and improved production technologies, its true reflection has not been observed to a desirable level in farmers' fields. Among many varieties available with national programs only a few have been picked up by end users. There is an urgent need to disseminate the improved technologies at hand to farmers through strong extension systems. Farmers also need to be educated through effective training. More research emphasis is needed for drought and heat tolerance in the context of climate change, changing consumers' demands, application of new science, value addition components. **Lentil was..is..and will remain** an integral component of farming and food systems in West Asia, and North and East Africa, but it must be made remunerative to farmers. ■

Figure 1. Alemaya-revolutionized lentil cultivation in Ethiopia: A popular variety

Figure 3. Idlib-3 is erect and suitable to machine harvest

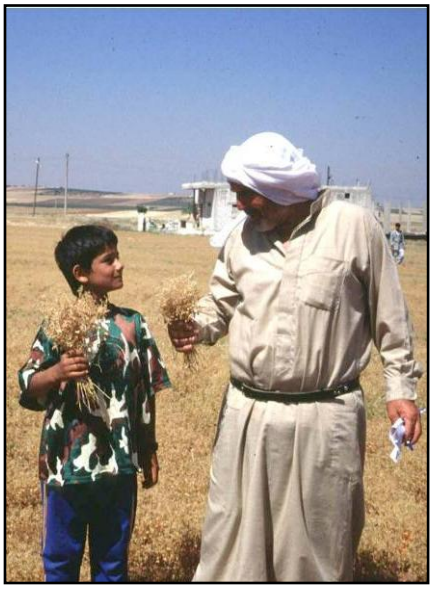

Figure 2. Transfer of production knowledge from a grandfather: Idlib-2 a popular variety in Syria

Figure 4. Local-lodging type; Traditional harvest; Harvest mechanization is important to keep the crop in cropping systems; Idlib-2 is suitable for harvest by double-knife cutter bar