DEVELOPMENT

Iron and Zinc Lentils

Ashutosh Sarker (ICARDA)

Target Micronutrient		Iron; secondary: zinc	
Target Countries		Bangladesh, Nepal, India	
Baseline (parts per million, ppm)		40 ppm	
Target Increment		30 ppm	
Target Level in Crop		70 ppm	
Nutrition Factors		**Original Assumption**	**Measured/Revised**
Lentil Consumption, grams/day (dry weight)	Women	50 g/d	40 g/d
	Children	25 g/d	20 g/d
Iron Retention (%)		85%	90%
Iron Absorption (%)		Not known	Not known
Absorbed Iron as % of EAR		Not known	Not known
Releases			
India		L4704	125 ppm Fe, 74 ppm Zn
Nepal		ILL 7723	83 ppm Fe, 61.5 ppm Zn
Bangladesh		Barimasur-7	81 ppm Fe

Breeding to Date: The International Center for Agricultural Research in the Dry Areas (ICARDA) leads research to biofortify lentils with higher levels of iron (Fe) and zinc (Zn). A large number of breeding lines (>1,600), landraces, and released varieties have been analyzed for iron and zinc content. Iron content ranged from 42–132 ppm and zinc content ranged from 23–78 ppm. Iron and zinc were analyzed at Waite Institute, Australia; University of Saskatchewan, Canada; Indian Agricultural Research Institute, India; and North Dakota State University, USA.

Several released varieties that possess high iron and zinc levels and have good agronomic performance have been identified; these varieties are in fast-tracking and include:

- Bangladesh: Barimasur-4 (86.2 ppm Fe), Barimasur-5 (86 ppm Fe, 59 ppm Zn), Barimasur-6 (86 ppm Fe, 63 ppm Zn), and Barimasur-7 (81 ppm Fe);
- Nepal: Sisir (98 ppm Fe, 64 ppm Zn), Khajurah-2 (100.7 ppm Fe, 59 ppm Zn), Khajurah-1 (58 ppm Zn), Sital (59 ppm Zn), Shekhar (83.4 ppm Fe), and Simal (81.6 ppm Fe);
- India: Pusa Vaibhav (102 ppm Fe);
- Syria/Lebanon: Idlib-2 (73 ppm Fe) and Idlib-3 (72 ppm Fe); and
- Ethiopia: Alemaya (82 ppm Fe, 66 ppm Zn)

Since 2009, seed multiplication, large-scale demonstrations, and seed dissemination have been prioritized. Farmers, including women farmers, have participated in capacity development and awareness programs.

In parallel to the identification of fast-track varieties, parents with high iron and zinc were identified and have been used in cross-breeding programs at ICARDA, Bangladesh Agricultural Research Institute (BARI), Nepal Agricultural Research Council (NARC), and Indian Agricultural Research Institute (IARI). Final, intermediate, and primary products have been developed and are under evaluation for yield traits and micronutrient levels. Identification of genetically fixed lines and germplasm with high levels of iron and zinc at ICARDA helped to develop new international nurseries for red lentils and green lentils (Lentil International Elite Nursery-Micronutrient). These nurseries (LIEN-MN-R and LIEN-MN-Y) have been shared with 14 national programs. Additionally, recombinant inbred lines with a sufficient number of progenies are in F7/F6 stages for genetic studies.

Multi-location testing is strong, and varieties/advanced lines have been tested in Bangladesh, Ethiopia, India, Nepal, and Syria. Significant genotype-by-environment (GxE) interaction was observed in many cases; iron content is more sensitive to environmental fluctuations compared to seed zinc content. A few genotypes were identified with stable high-iron and zinc contents (IPL 320, L4704).

In India, one high-iron and zinc line, L4704 (125 ppm Fe and 74 ppm Zn) has been registered by the National Bureau of Plant Genetic Resources. In Bangladesh, Barimasur-7 was released for high iron (81 ppm).

Future Releases: In Nepal, ILL 7723 has been recommended by the National Variety Release Committee and is expected to be released in 2014. Additionally, a proposal for RL-12 is under preparation and will be submitted by mid-2014.

Regional Testing: High-iron and zinc content lines with excellent agronomic performance are selected from the ICARDA international nursery and national breeding programs of Bangladesh, India, and Nepal and are subject to regional testing.

Highlights:

- Screening of a large number of germplasm, breeding lines, and varieties led to the identification of several released varieties high in iron and zinc; these are in fast-tracking.
- Farmers and consumers are increasingly aware of the value of daily diets rich in iron and zinc and the health benefits of lentils. Enthusiasm for growing high-iron and zinc varieties and consuming them is increasing.
- Identification of high-iron and zinc genotypes has encouraged breeders to use these in hybridization programs.
- High-iron and zinc lentils are available to consumers in Bangladesh, Nepal, India, and Syria/Lebanon.

Challenges:

- The production of sufficient quantity of quality seed of high-iron and zinc varieties.
- The development of high-yielding and high-micronutrient varieties with stable performance across environments.
- The understanding of correlation of iron and zinc levels with other macro- and micronutrients in lentil seeds.