Importance, Challenges and Potential of Neglected and Underutilized Crops

FAO Regional Initiative on Zero Hunger

Regional Consultation on Scoping and Mapping of Neglected and Underutilized Crop Species in Asia

FAO, Bangkok, Thailand, 3 – 5 December, 2016

Mahmoud El Solh

Outline

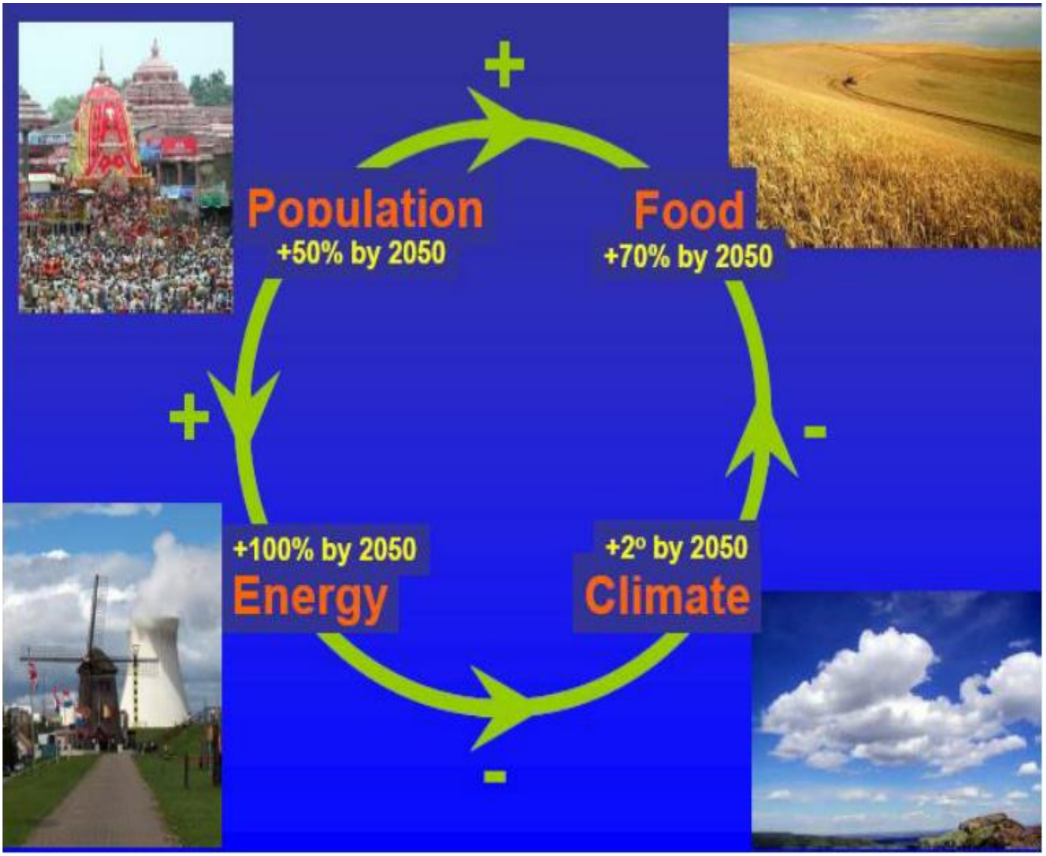
- **Neglected & underutilized crops (NUS): importance, challenges and potential.**
- **Examples on developments of NUS:**
  - **Quinoa**
  - **Lentils**
  - **Grass pea**
- **Conclusion.**

Bixa orallana **Fruit Opened**

By Leonardo Ré-Jorge - Own work, GFDL,

Neglected & underutilized crops (NUS): importance, challenges and potential.

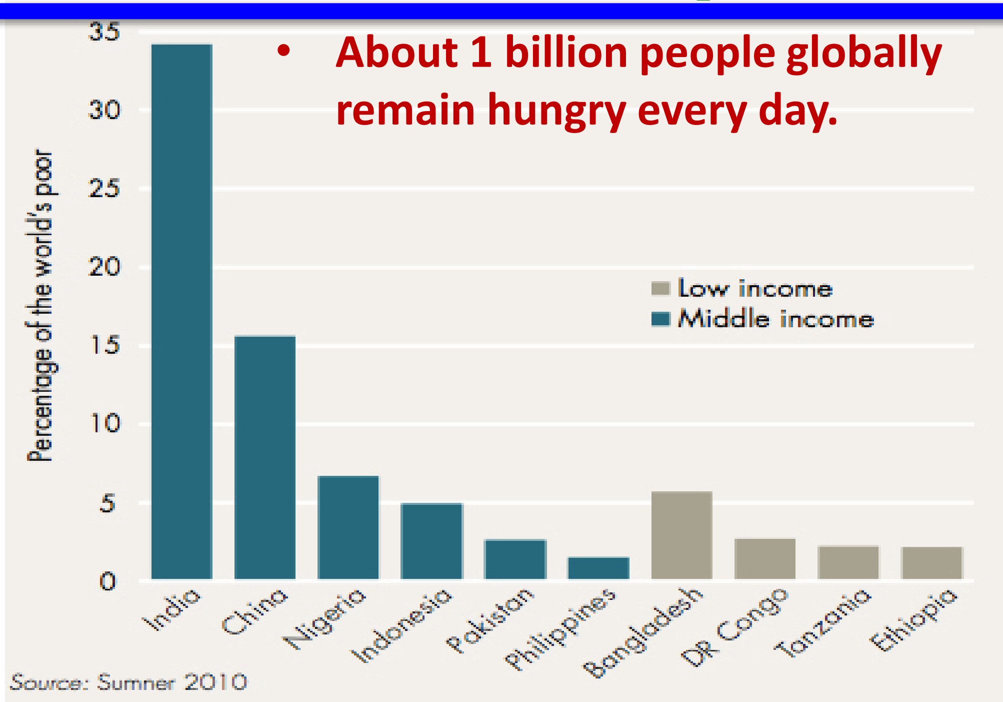
Great Challenges of Agriculture



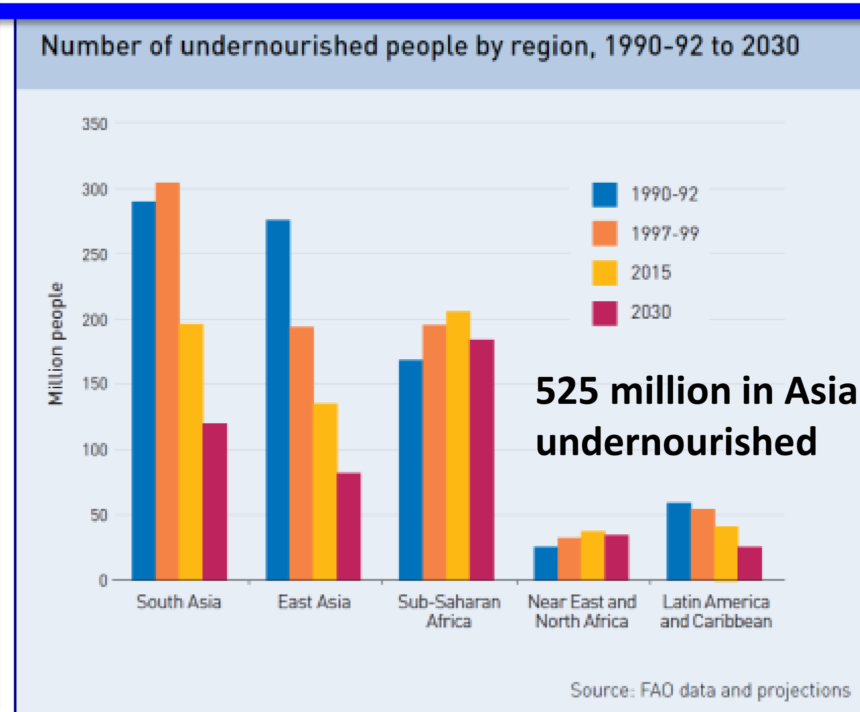
- Growing world population will cause a "serious storm" of food, energy and water shortages by 2050
- Demand for food and energy will jump 70% and 100% and for fresh water by 30%, as the population tops 9 billion
- In the past, only ~12 crops received the major attention of scientific interventions

The Big Challenge: How to expand agriculture output without further constraining natural resources?

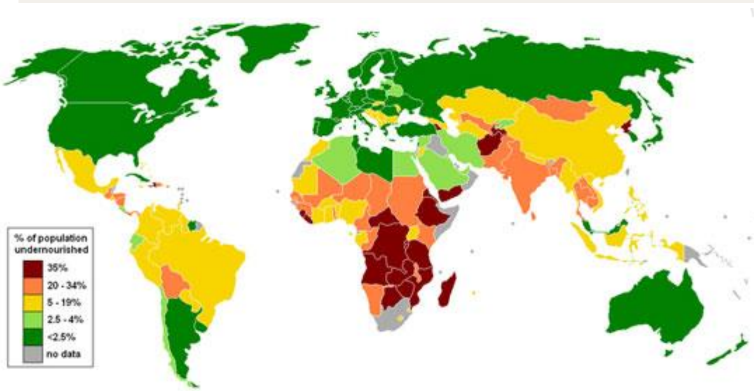
Hungry & undernourished people remains a global concern



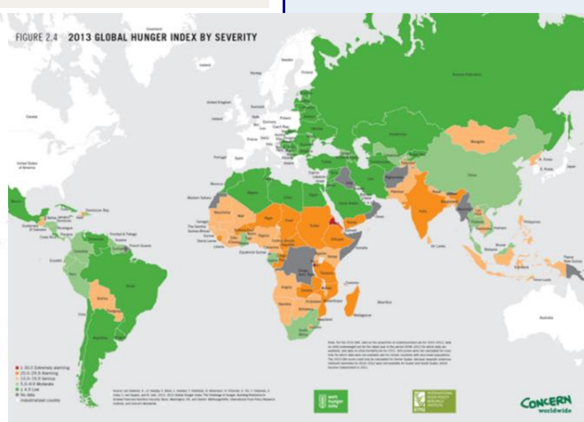
- **About 1 billion people globally remain hungry every day.**



525 million in Asia undernourished



List of countries by percentage of population suffering from undernourishment.



Many Asian countries including India is among the countries with 20-34% populations undernourished and categorized as 'Alarming' in the Global Health Index (GHI)

Underutilized Crops: What are they?

- Underutilized species is commonly applied to refer to species whose potential has not been fully realized. The term itself does not provide any information as to geographical (underutilized where?), social (underutilized by whom?) and economic (underutilized to what degree?) implications*.
- Regarding the socio economic implication of the term, many species represent an important component of the daily diet of millions of peoples in different parts of the world but their poor marketing conditions make them underutilized in economic terms*.

* Padulosi et.al. 2006.

NUS Definitions

- <u>Underutilized crops</u> "*were once grown more widely or intensively but are falling into disuse for a variety of agronomic, genetic, economic and cultural reasons. Farmers and consumers are using these crops less because they are in some way not competitive with other species in the same agricultural environment. The decline of these crops may erode the genetic base and prevent distinctive and valuable traits being used in crop adaptation and improvement"**.

- <u>Neglected crops</u> "*are those grown primarily in their centres of origin or centres of diversity by traditional farmers, where they are still important for the subsistence of local communities. Some species may be globally distributed, but tend to occupy special niches in the local ecology and in production and consumption systems. While these crops continue to be maintained by socio-cultural preferences and use practices, they remain inadequately characterized and neglected by research and conservation"**.

Ipomoea aquatica

By Eric in SF - Own work, GFDL,

* IPGRI

Features Underutilized Crops

It is difficult to precisely define which attributes make a crop "underutilized", but often they display the following features:

- **Linkage with the cultural heritage of their places of origin;**
- ***Local and traditional crops cultivated with indigenous knowledge whose* distribution, biology, cultivation and uses are poorly documented;**
- **Adaptation to specific agro-ecological niches and marginal land;**
- **Weak or no formal seed supply systems;**
- **Locally important with traditional uses in localized areas;**
- **Produced in traditional production systems with little or no external inputs;**
- **Receive little attention from national research, extension services, policy and decision makers, donors, technology providers and consumers;**
- **Scarcely represented in ex situ collection;**
- **A good number are highly nutritious and/or have medicinal properties or other multiple uses.**

Importance of Underutilized Crops

- They play an important role in the subsistence and economy of resource-poor people throughout the developing world, particularly in the agrobiodiversity-rich tropics. Despite their potential for dietary diversification and the provision of micronutrients such as vitamins and minerals, they continue to attract little research and development attention.

- Alongside their commercial potential, many of the underused crops also provide important environmental services, as they are adapted to marginal soil and climate conditions.

Bambara Groundnut

Source: Wikipedia, the free encyclopedia

Global Interest in NUS

- **If the 20th Century witnessed the undertaking of systematic collecting to rescue the genetic resources of staple crops (Pistorius, 1997), the 21st Century has started with the awareness on the need to rescue and improve the use of those crops left aside by research, technology, marketing systems as well as conservation efforts. These underutilized crops (referred to also by other terms such as minor, orphan, neglected, underutilized, underexploited, underdeveloped, lost, new, novel, promising, alternative, local, traditional, niche crops) have been included in world-wide plans of action after having successfully raised the interest of decision makers.**

- **This global "opening" towards underutilized species is the result of a gradual change of attitude towards biodiversity and plant genetic resources by many countries. Instrumental in this awareness raising process have been the 1992 Convention on Biological Diversity and the FAO IV International Technical Conference on Plant Genetic Resources for Food and Agriculture held in Germany in 1996**

Constraints in Underutilized Crops

- limited germplasm available particularly at national level;
- lack of technical information;
- lack of national policy for supporting research and development for improving production;
- lack of interest by researchers, agriculturists and extension workers;
- lack of producer interest.
- Lack of interest of the private sector

Neglected crops are primarily grown by traditional farmers. These species may be widely distributed beyond their centres of origin but tend to occupy special niches in the local production and consumption systems.

They are important for the subsistence of local communities, yet remain poorly documented and neglected by the mainstream research and development activities (IPGRI 2002).

NUS Crops based on Wikipedia Encyclopedia

It should be noted that in any cases where exotic species or diversified species are underutilized at certain region, these are not necessarily underutilized in other parts of the worlds:

- **Cereal and pseudo-cereal crops (13 species)**
- **Fruits and nuts species (33 species)**
- **Vegetable and pulse crops (33 species)**
- **Root and tuber crops (17 species)**
- **Industrial underutilized crops (34 species)**
  - **Oil crops (16 species)**
  - **Latex/rubber/gums (2 species)**
  - **Fiber crops (one species)**
  - **Starch/sugar crops (2 Species)**
  - **Dye crops (3 species)**

Securing and strengthening the work on underutilized crops

Developing and monitoring the work:

- Efforts so far have been directed to raise the awareness on the nutritional importance and other qualities to work on underutilized species and to start redressing their status of neglect.
- It has to be recognized that some efforts on underutilized crops (e.g. kiwi, quinoa which were one of the NUS before they became important commodities commercially)
- There are some of the issues that we should consider to develop a monitoring system for assessing the impact of our promotion process of NUS:

A. Conservation aspects

1. How many accessions should be conserved (in situ and ex situ) to safeguard of the representative genetic diversity of these species and to provide at the same time the variability needed by breeders and users in general?
2. Given the new opportunities brought about by the gene transfer, how broad should be our efforts in the conservation of the gene pool of the species? Should we include the tertiary gene pool in our collecting efforts?
3. What should be the minimum level of knowledge on the eco-geographical distribution of the taxa and its genetic erosion status?
4. How much local traditional knowledge should be safeguarded?

Utilization aspects

1. **What would be the level at which we would consider the economy of the species self-sustainable?**
2. **What is the research threshold, that is the minimum amount of research addressing the economic development of the crop, beyond which we would consider the species "properly addressed"?**
3. **What would be the minimum information needed on nutritional aspects, processing aspects required for successful industrial applications?**

Agronomic aspects

1. What should be the minimum know-how required for enabling a proper cultivation of the species?
2. What should be the basic information required for understanding   the multiplication method and regeneration capacity of the species?
3. What should be the minimum level of information on pests, diseases, parasitic weeds and other cultivation-related problems?

Ulluco tubers for sale in Southern Peru

Policy-Legal aspects

1. What should be a basic policy framework to enable the proper deployment of the species among the farmers?

2. What should be the minimum level of policy attention required to ensure a sustainable use of these resources (particularly for wild species)?

3. What is the role of the public sector and enabling policy environment?

4. What is the role of the civil societies?

5. What is the role of the private sector.

Amaranthus caudatus

Opportunities and Potential

There is an increasing attention at national and international level of the important role of NUS in sustainable farming systems for human well-being of less-used crops and species. Such attention over the last decade have contributed to change the perception of people regarding the importance of NUS species and raised the issue on how best to pursue their promotion. Among the important reasons for these developments include their contribution to:

- **Agrobiodiversity in agricultural development and new tools for using and conserving biodiversity;**
- **Coping with environmental and climate changes and contributing to ecosystem stability;**
- **Increased food security and better nutrition.**
- **Increased attention to indigenous knowledge and their merits.**
- **Increased income of the rural poor due to increased market opportunities including eco-tourism;**

Potential and Opportunities (cont'd)

- Enrich cultural diversity which also brings more income to the rural poor through eco-tourism

Village chief of Boula Téné, [Senegal] Theodore Mada Keita, holds up the fonio grain [White fonio (*Digitaria exilis*)] that helps feed his family in Southern Senegal

By Richard Nyberg, USAID -

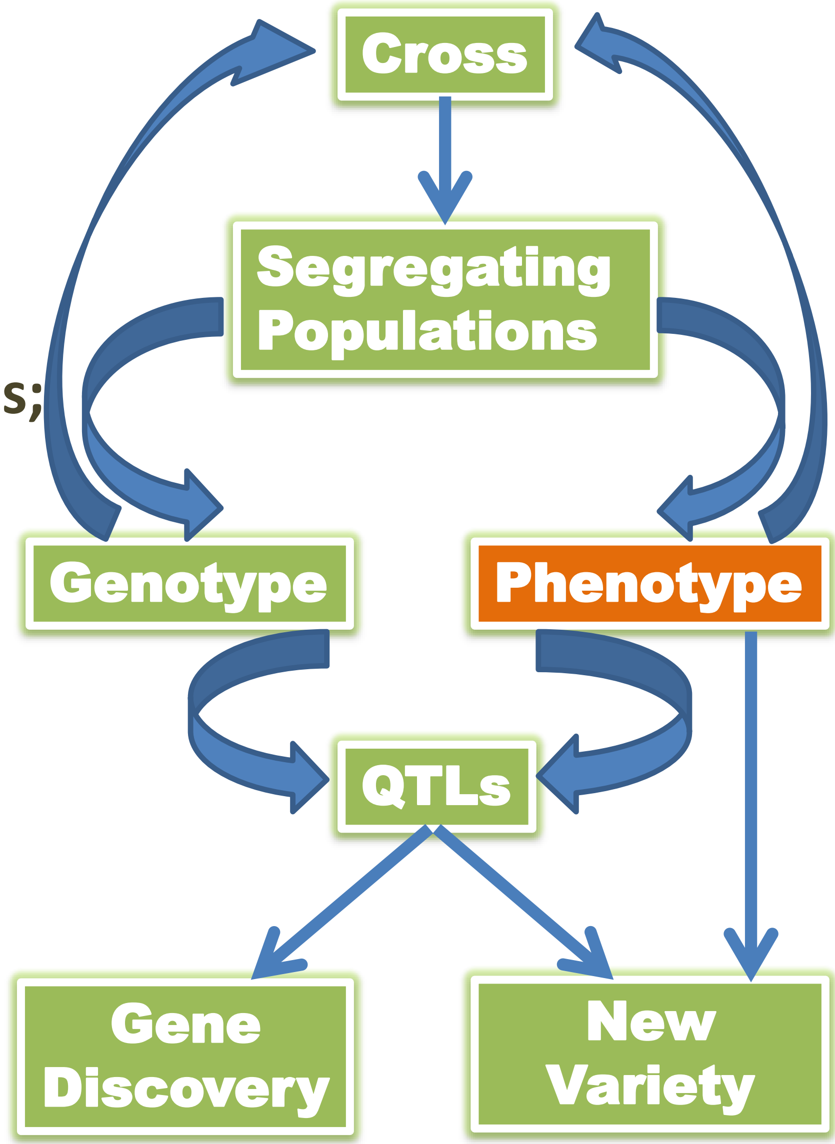
Research Issues for Improvement of NUS

Neglected and underutilized crops are essential to the livelihoods of millions of poor farmers throughout the world. It is essential to approach the problem from this perspective:

- **Develop priority-setting approaches and help stakeholders to establish priorities for research, development and conservation actions on NUS.**
- **Enhance the conservation and use of plant genetic resources of neglected and underutilized species through complementary approaches to the use genetic resources from promoting food, feed and fiber production for consumption.**
- **Strengthen the efforts of other actors working on the documentation, evaluation, improvement, processing and marketing of neglected and underutilized species.**

Crop Improvement of NUS: Traits in Focus

- Higher yield potential;
- Adaptation to low-input agriculture
- Heat and drought tolerance;
- Tolerance to salinity;
- Resistances to diseases;
- Resistance/tolerance to insect pests;
- Resistance/tolerance to parasitic weeds;
- Enhancing biological nitrogen fixation in case of legumes spp;
- Extra short duration;
- Water use efficiency
- Improved plant architecture & machine harvesting
- Herbicide tolerance



Examples on the Evolution of Specific NUS that became Important Commercial Crops: Quinoa, Lentil and Grasspea

Quinoa: A Fast Growing Crop Coming Out of NUC that Became an Important Commercial Crop

Quinoa (Chenopodium quinoa Willd.):
Importance & Evolution as Example of Underutilized Crop

Landscape with quinoa (Chenopodium quinoa), Cachilaya[clarification needed], Bolivia, Province La Paz, Lake Titicaca seen in background and quinoa seeds in commercial bag 2 lb for US$ 6.

Nutritional Value of Quinoa

- First, it takes less time to cook than other whole grains and even cooks quicker than rice: Quinoa takes just 10 to 15 minutes to cook.
- Second, boiled quinoa tastes great on its own, unlike other grains such as millet or teff.
- Finally, of all the whole grains, quinoa has the highest protein content (14%) compared to cereal grains, so it's perfect for vegetarians and vegans. Quinoa provides all 9 essential amino acids, making it a complete protein. Quinoa is a gluten-free and cholesterol-free whole grain and is almost always organic.
- Quinoa seeds are good sources of vitamin B complex, vitamin E and essential fatty acids (linoleic and alpha-linolenic acid) . Also quinoa is an excellent source of iron, copper, calcium, potassium, manganese, magnesium and fiber.

Quinoa Nutritional Value

Nutritional value per 100 g (3.5 oz)

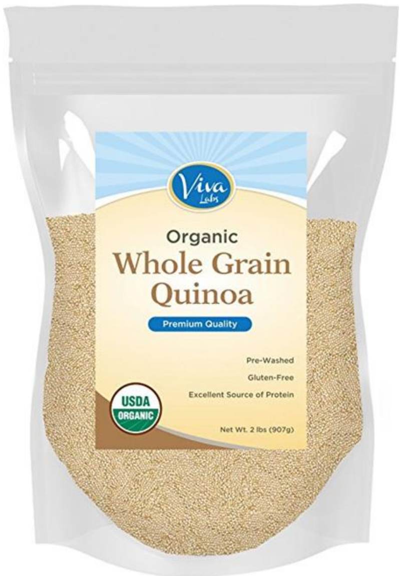
Energy	1,539 kJ (368 kcal)
Carbohydrates	64.2 g
Dietary fibre	7.0 g
Fat	6.1 g
Monounsaturated	1.6 g
Polyunsaturated	3.3 g
Protein	14.1 g
Vitamins	
Vitamin A equiv.	(0%) 1 μg
Thiamine (B1)	(31%) 0.36 mg
Riboflavin (B2)	(27%) 0.32 mg
Niacin (B3)	(10%) 1.52 mg
Vitamin B6	(38%) 0.49 mg
Folate (B9)	(46%) 184 μg
Choline	(14%) 70 mg
Vitamin C	(0%) 0 mg
Vitamin E	(16%) 2.4 mg
Minerals	
Calcium	(5%) 47 mg
Iron	(35%) 4.6 mg
Magnesium	(55%) 197 mg
Manganese	(95%) 2.0 mg
Phosphorus	(65%) 457 mg
Potassium	563 mg
Sodium	(0%) 5 mg
Zinc	(33%) 3.1 mg

Source: Wikipedia, the free encyclopedia

Origin of Quinoa and Marketing

- Quinoa may have been originated in South America, but now quinoa is being grown in North America and Europe as well. Currently, Bolivia is the largest producer of the quinoa followed by Peru. These countries are exporting more than 50% of their produce, however increased international demand has increased the domestic prices of the crop. About 84.2% of global exports originate from Bolivia, Ecuador and Peru, and the remaining from the United States of America, and from the European Union*.

- The United Nations has declared year 2013 as "International Year of Quinoa". The grain is very similar to rice and can be cooked and used in the same way. *.



* Source: Quinoa: Improvement and Sustainable Production Editors: Kevin Murphy, Janet Matanguihan, 2015.

World Quinoa Production

(thousand metric tons)

Evolution of Production and value of Quinoa							
Country	1961	1970	1980	1990	2000	2010	2014
Peru)	22.5	7.3	16.3	6.3	28.2	41.1	114.3
Bolivia	9.2	9.7	8.9	16.1	23.8	36.1	77.4
Ecuador		0.7	0.5	0.7	0.7	0.9	0.8
Total	32.4	17.7	25.8	23.0	52.6	78.1	192.5
Export price USD/kg		$0.080	$0.492	$0.854	$1.254	$3.029	
Source: Food and Agriculture Organization of the United Nations (FAO)							

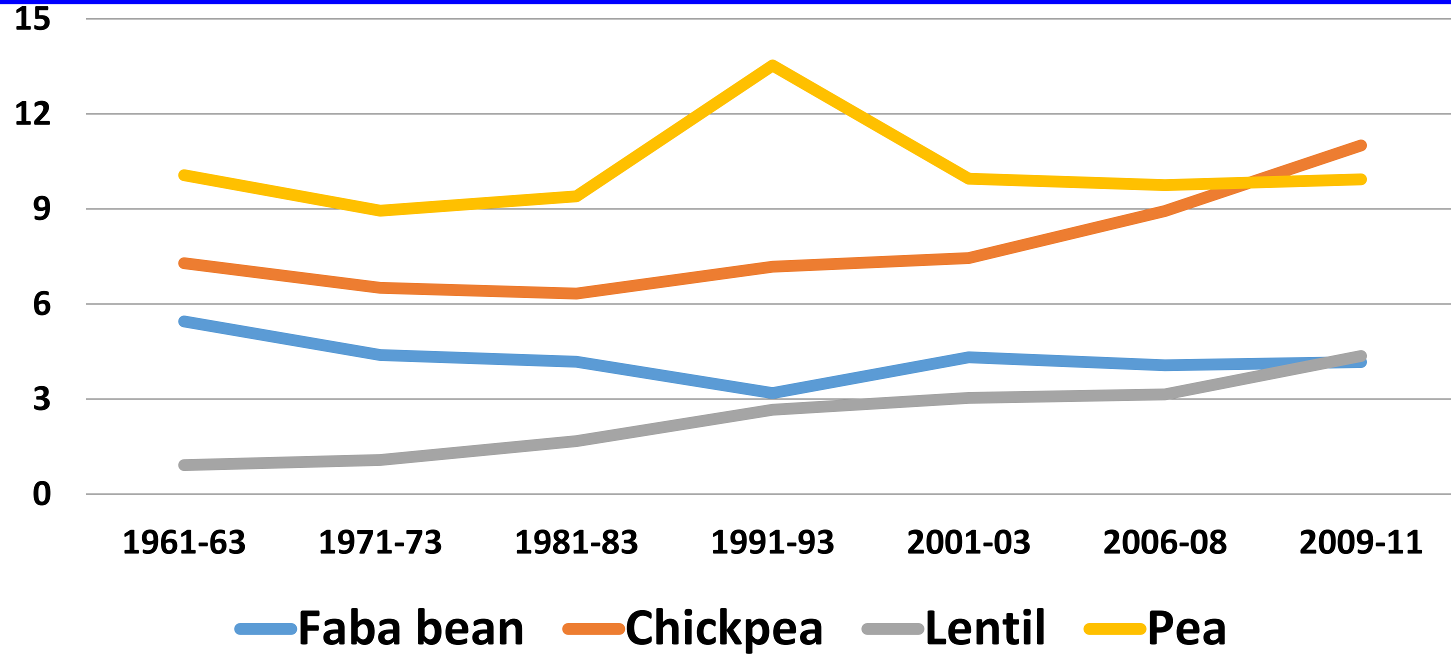
Quinoa Improvement

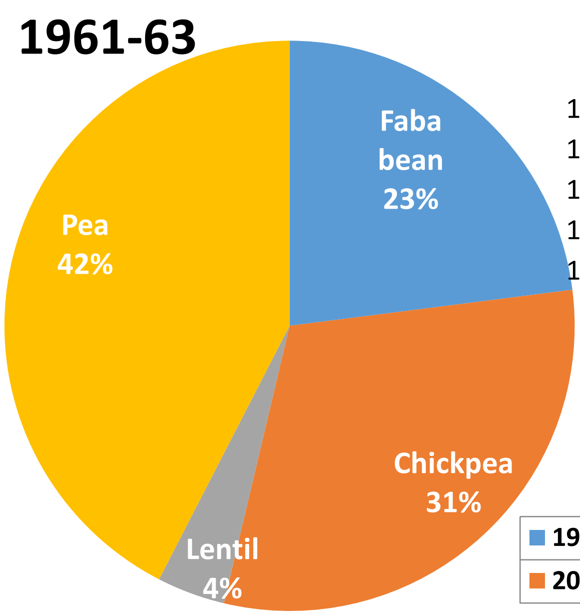
- “The main aim of quinoa breeders is the development of cultivars adapted to diverse agro-climatic regions with high seed yield and good quality components for food and industrial use. Within the quinoa germplasm, significant differences have been found in some qualitative traits that can be used in breeding to improve the nutritional quality of quinoa.
- Several breeding methods have been used with quinoa, such as individual selection and/or mass selection, introduction of foreign germplasm, hybridization, backcrossing, and induction of mutation. Modern techniques that permit the use of markers linked to quantitative trait loci (QTL) in quinoa could be exploited for future cultivar improvement.
- Quinoa is an underutilized crop that could be a valuable alternative crop to help the world face critical challenges such as climatic change, food security, human nutrition, and overdependence on a few plant species for the world food supply”.

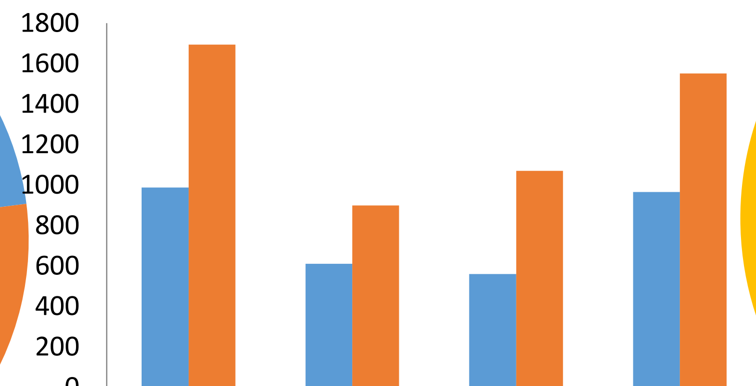
Source: Quinoa: Improvement and Sustainable Production
Editors: Kevin Murphy, Janet Matanguihan, 2015.

Lentil: An Important Crop for Food and Nutritional Security, and Sustainable Agriculture

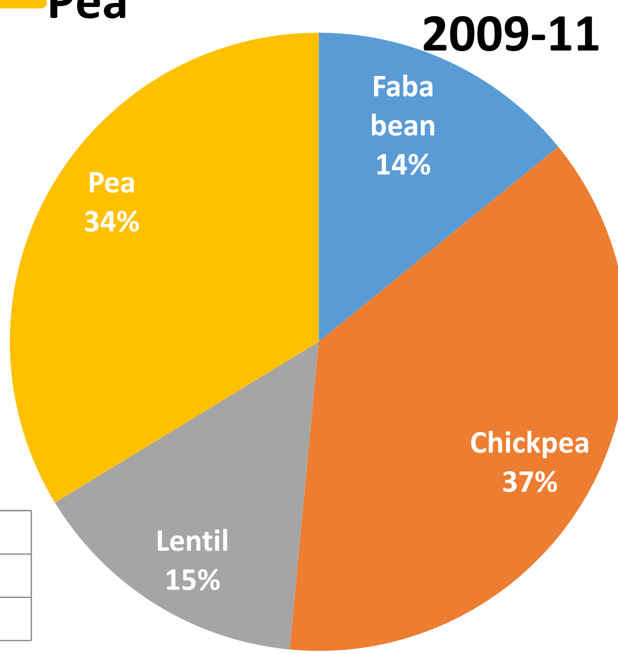
Lentils from a minor crop to an important pulse crop
Global Trends in Lentil Production



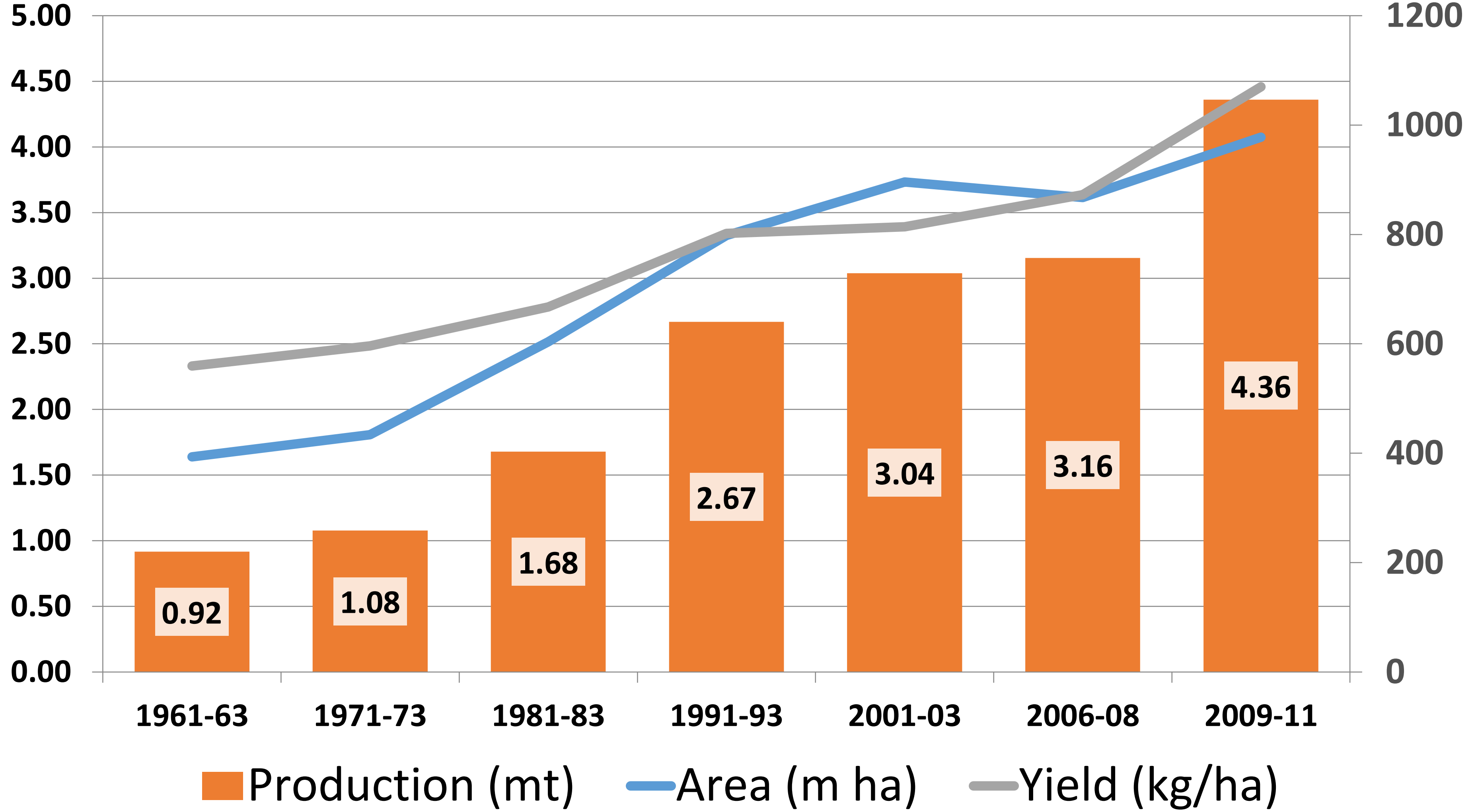




	Faba bean	Chickpea	Lentil	Pea
1961-63	988	610	559	966
2009-11	1695	900	1070	1551

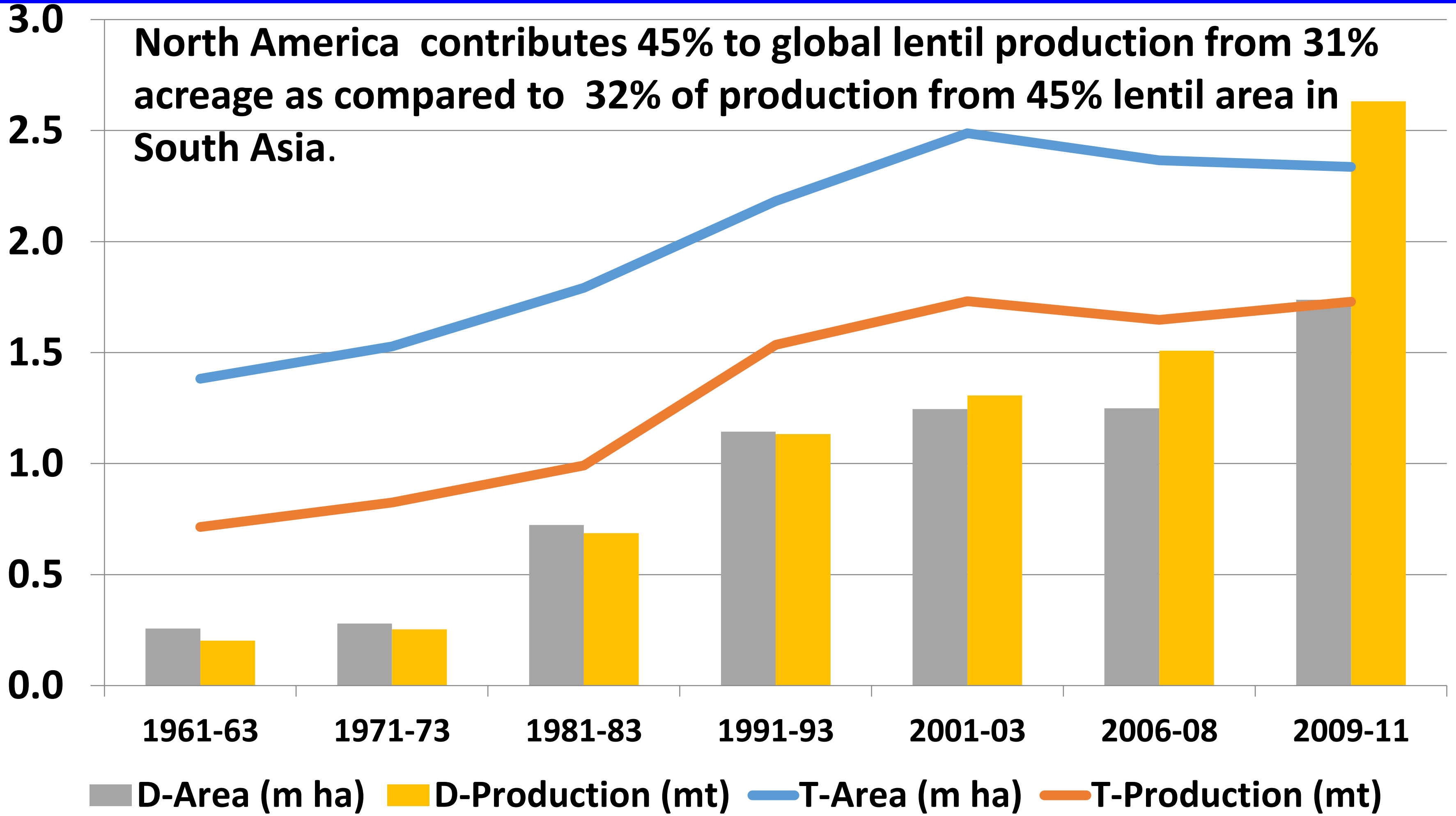


Global Lentil Production is catching up……………..

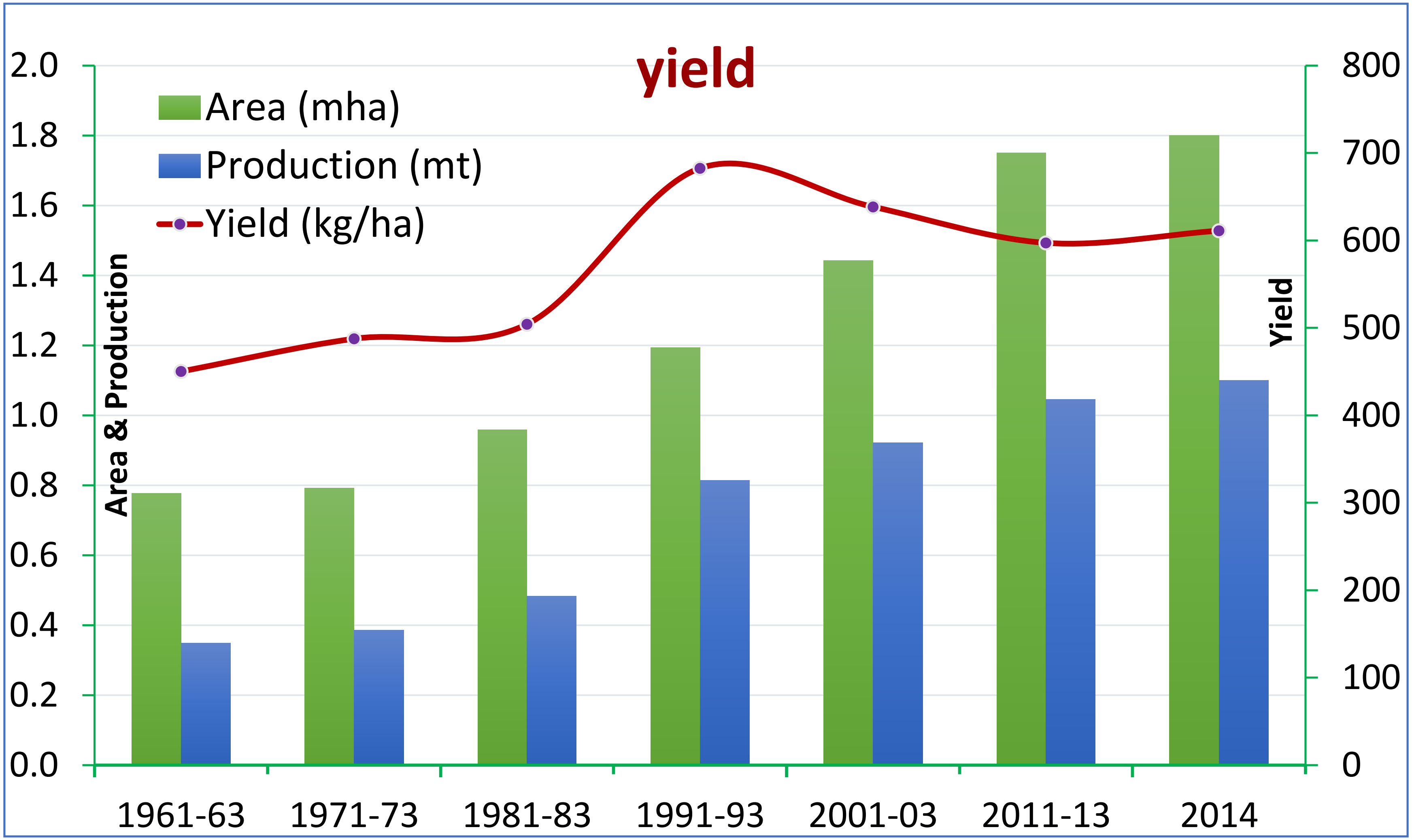


2016 INTERNATIONAL YEAR OF PULSES

But most of the growth in production is in developed countries…….



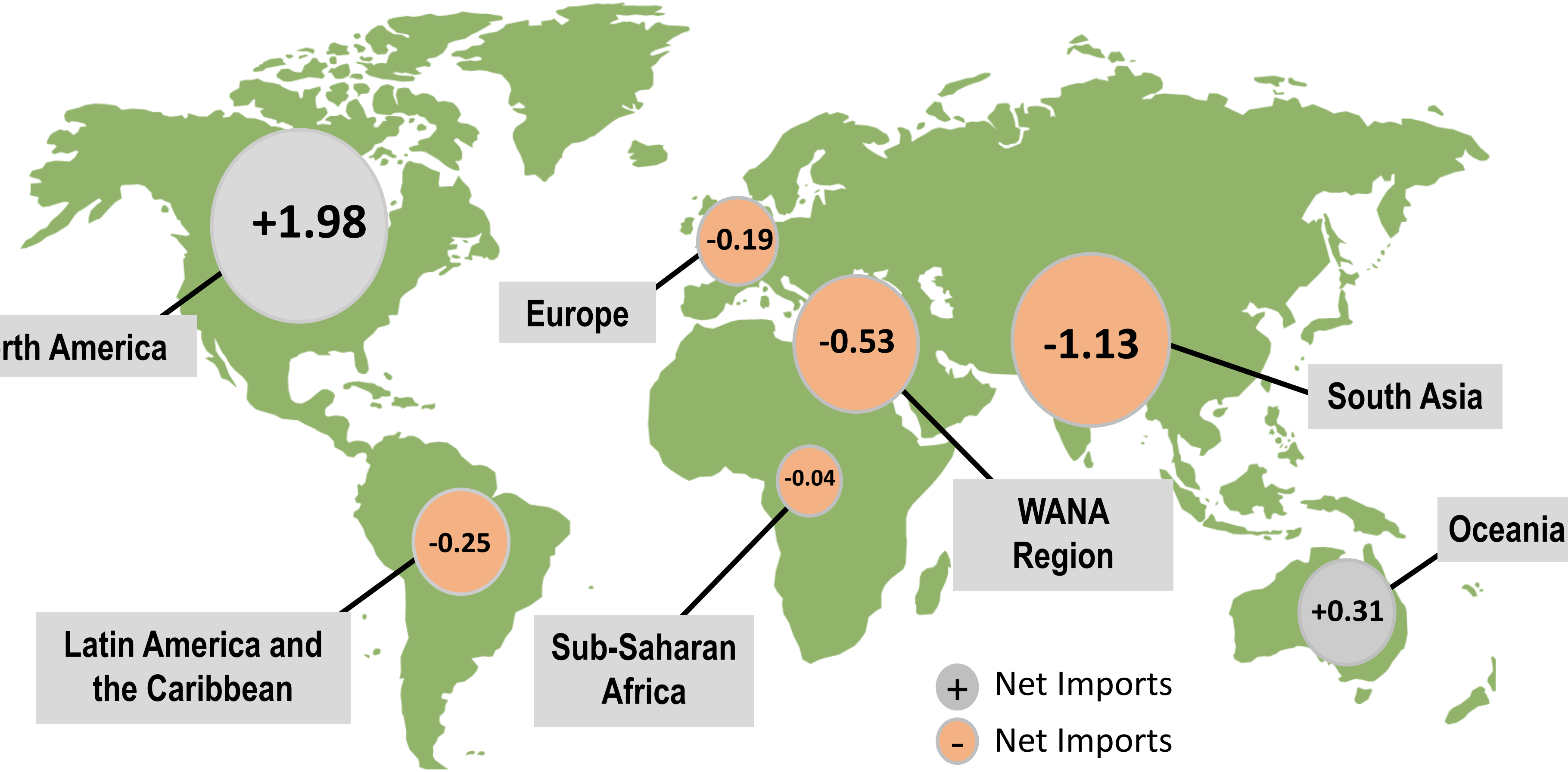
Trends in production of lentil in India



2016 INTERNATIONAL YEAR OF PULSES

Lentil importer and exporter regions of the World

(million metric tons)



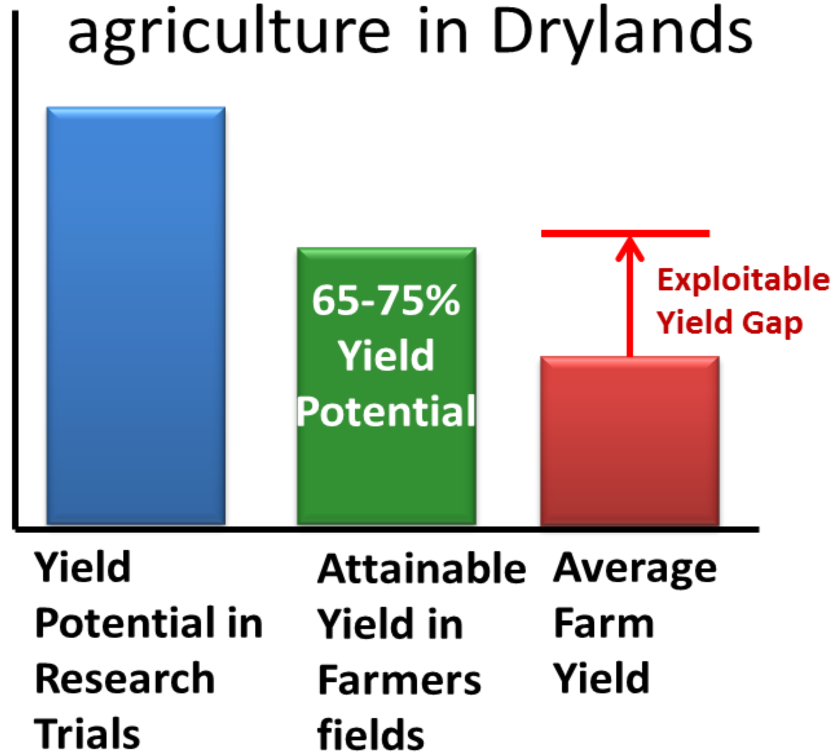
Sources: FAOSTAT (2013)

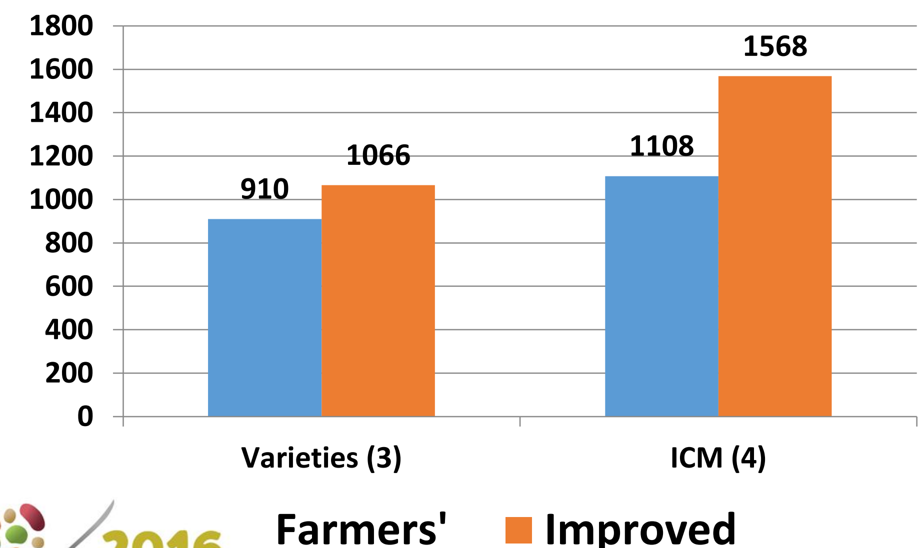
2016 INTERNATIONAL YEAR OF PULSES

Opportunities for Enhancing Lentil Production

- Closing the yield gaps: crop management
- New genetic gains
- Horizontal expansion
- Sustainable Intensification
- Reduced post-harvest losses
- Value addition

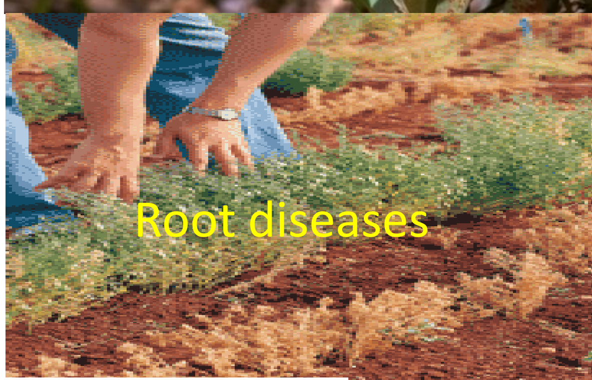
Yield potential for rainfed agriculture in Drylands





Enhancing economic competitiveness and stability

- **Biotic stresses**
- **Abiotic stresses**
- **Problem soils**
- **Socio-economic problems**
- **Government policies**

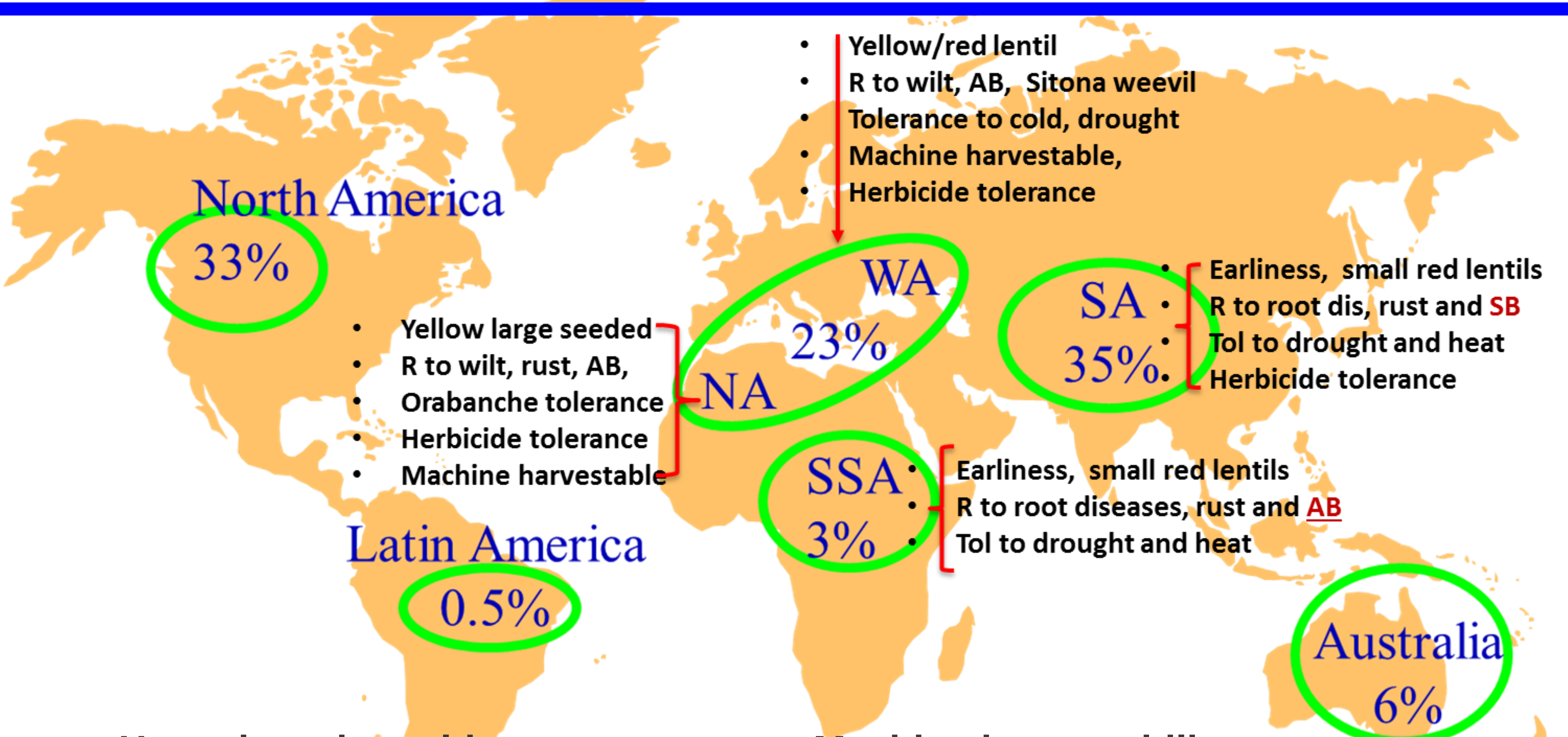


2016 INTERNATIONAL YEAR OF PULSES

Courtesy of Dr. Shiv Kumar Agrawal, ICARDA

ICARDA Science for Better Livelihoods in Dry Areas

Target Environments and Trait Prioritization



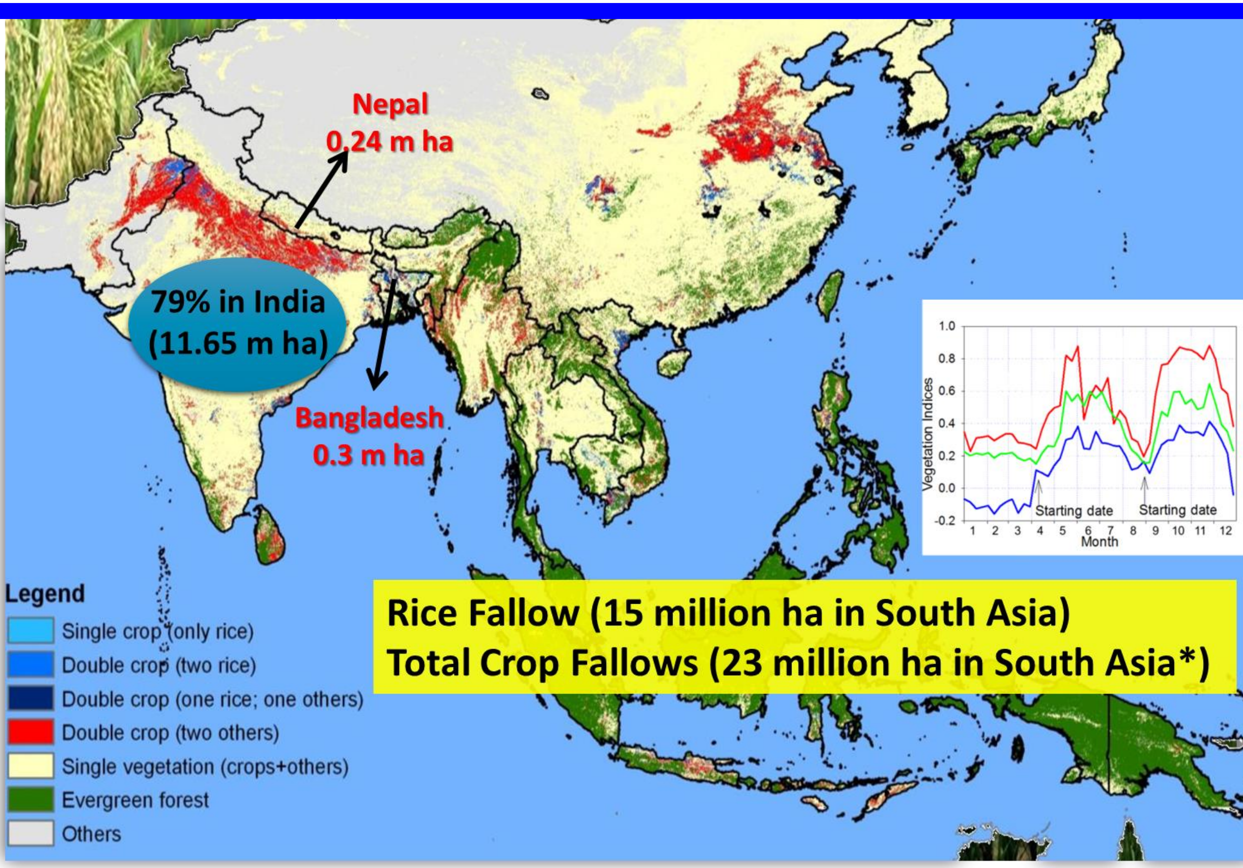
- Heat, drought, cold
- Key diseases and insect pests
- Orobanche tolerance
- Herbicide tolerance
- Machine harvestability
- Extra short duration
- Plant architecture traits
- Quality/nutrition traits

2016 INTERNATIONAL YEAR OF PULSES

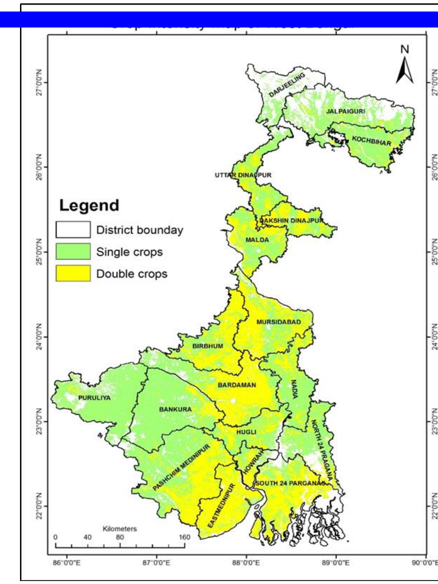
Courtesy of Dr. Shiv Kumar Agrawal, ICARDA

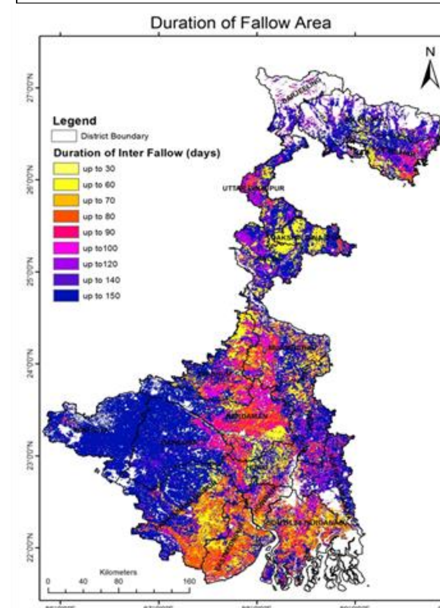
ICARDA
Science for Better Livelihoods in Dry Areas

Mapping of Rice Fallows in South Asia



Rice Fallow (15 million ha in South Asia)
Total Crop Fallows (23 million ha in South Asia*)





Lentil in Rice-based Cropping Systems

- **Irrigated**
  - Rice – EE Lentil – Boro rice
  - Rice – Relay E Lentil – Boro rice
- **Rainfed**
  - Rice – EE Lentil
  - Rice – Relay E Lentil

2016 INTERNATIONAL YEAR OF PULSES

ICARDA Science for Better Livelihoods in Dry Areas

India- Short duration lentil varieties in rice fallows

State	Area covered (ha)	No. of villages	No. of farmers
Assam	154	19	521
Bihar	150	19	221
	148	28	377
Manipur	60	10	109
Meghalaya	70	23	255
Tripura	88	15	199
Uttar Pradesh	150	30	470
West Bengal	100	20	554
	14	11	836
Total	1067	175	3542

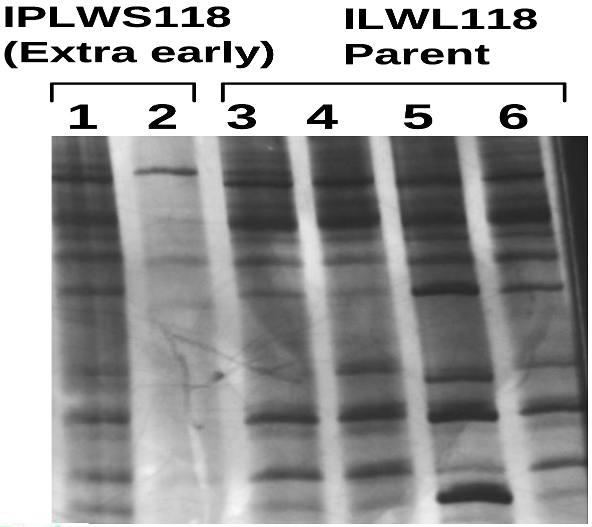
- Yield in farmers' fields: up to 1.8 t/ha (Moitree, NDL-1, HUL-57)
- Seed Hubs Established at Patna and Jehanabad
- 970 ton seed produced

2016 INTERNATIONAL YEAR OF PULSES

ICARDA Science for Better Livelihoods in Dry Areas

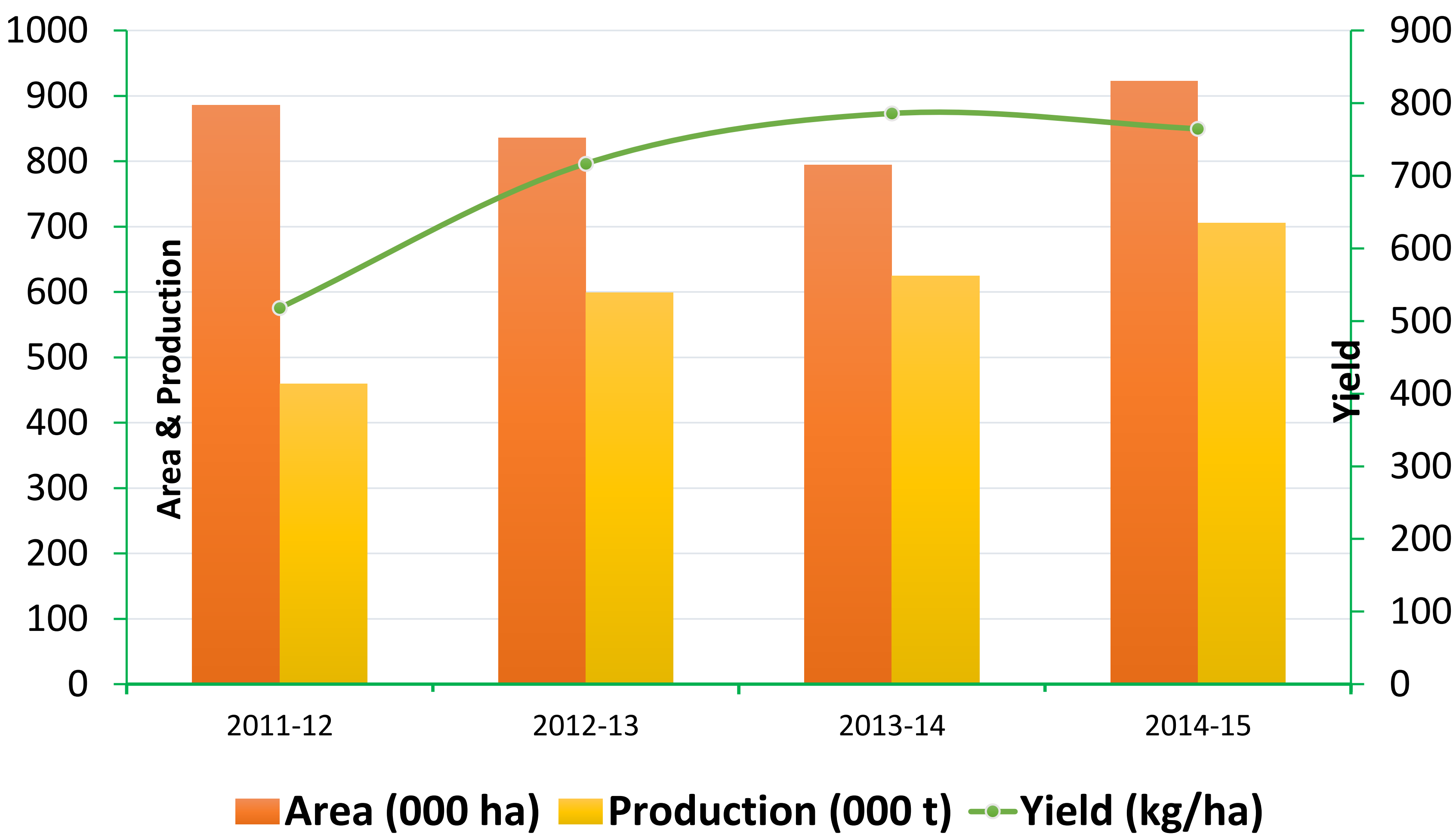
Pre-breeding for Early Genes in Lentil

Traits	Ist Sowing (Oct 21, 2011)		IInd Sowing (Dec 28, 2011)	
	Parent ILWL-118	Selection IPLWS-118	Parent ILWL-118	Selection IPLWS-118
Flower initiation	98	30	No flowering	46
Pod initiation	105	37		52
Days to maturity	182	62		80
Pods/plant	60-90	10-12		200



Marker ALD-21

Impact of improved lentil varieties in the target states in India



2016 INTERNATIONAL YEAR OF PULSES

ICARDA Science for Better Livelihoods in Dry Areas

Machine harvestable lentil cultivars

- Screened breeding lines for good standing ability, Erect tall, more height of the first pod, no pod drop and shattering and prominent tendrils
- Two lines with above traits, 08S41102 and 08S41137, identified .

2016 INTERNATIONAL YEAR OF PULSES

ICARDA
Science for Better Livelihoods in Dry Areas

Weeds are major yield constraints in lentil production

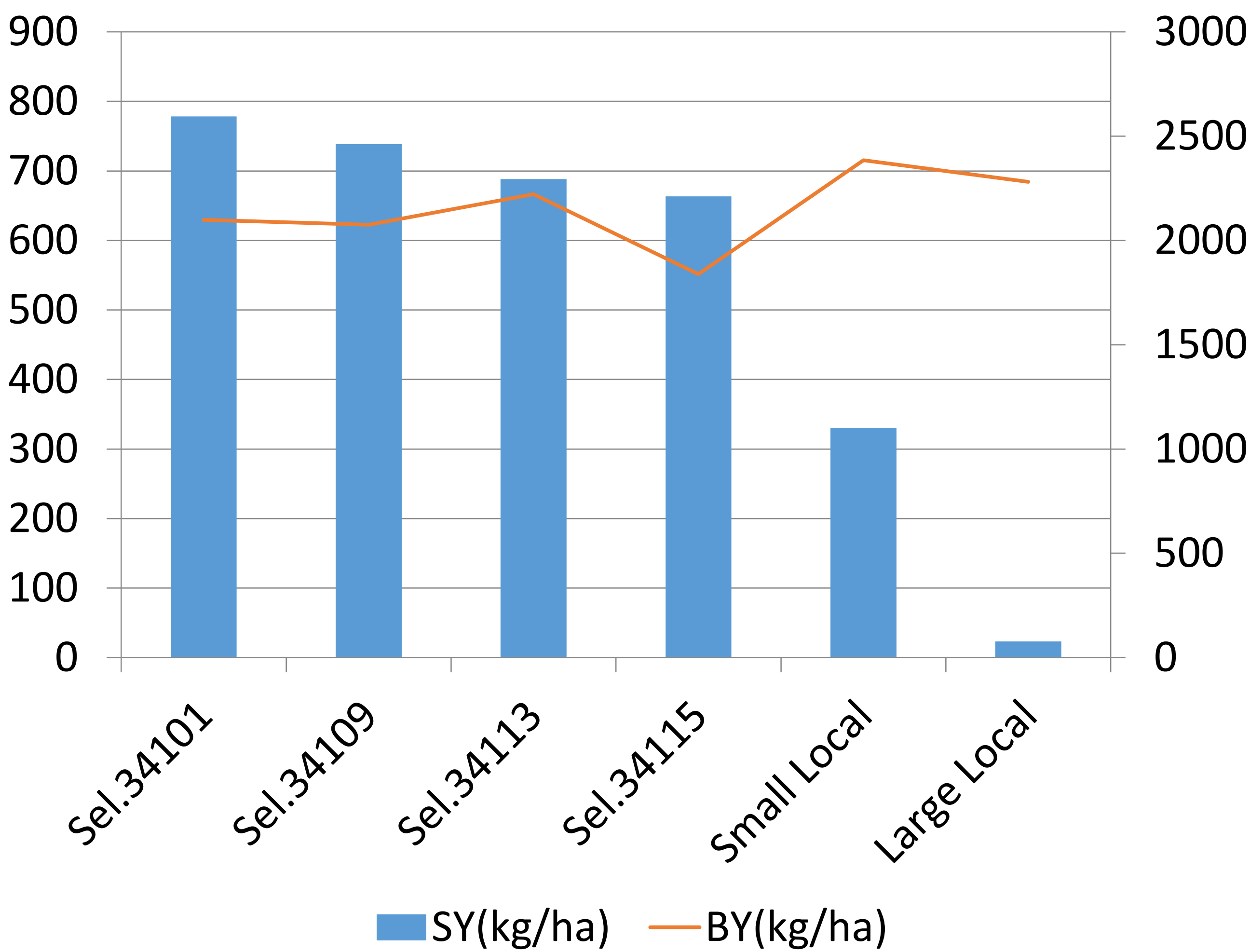
- Weeds causes serious yield losses;
- No effective post emergence chemical control;
- Screening lentil germplasm for post-emergence herbicide tolerance;
- Serious phyto-toxicity;
- Some genotypes recovered from the initial shocks.

Herbicide tolerance in lentil

- **Over 700 germplasm lines screened for tolerance to Imazethapyr and Metribuzin**
- **Delay in flowering, poor pod setting and reduction in plant height observed in herbicide treated plot.**
- **Germplasm lines tolerant to both herbicides identified**

Herbicide	Genotype	Tolerance score
Metribuzin	ILL6434	2
	ILL89517	2
	ILL10810	2
	ILL10833	2
	ILX87075	2
Imazethapyr	ILL8009	2
	ILL5988	2
	ILL4994	2

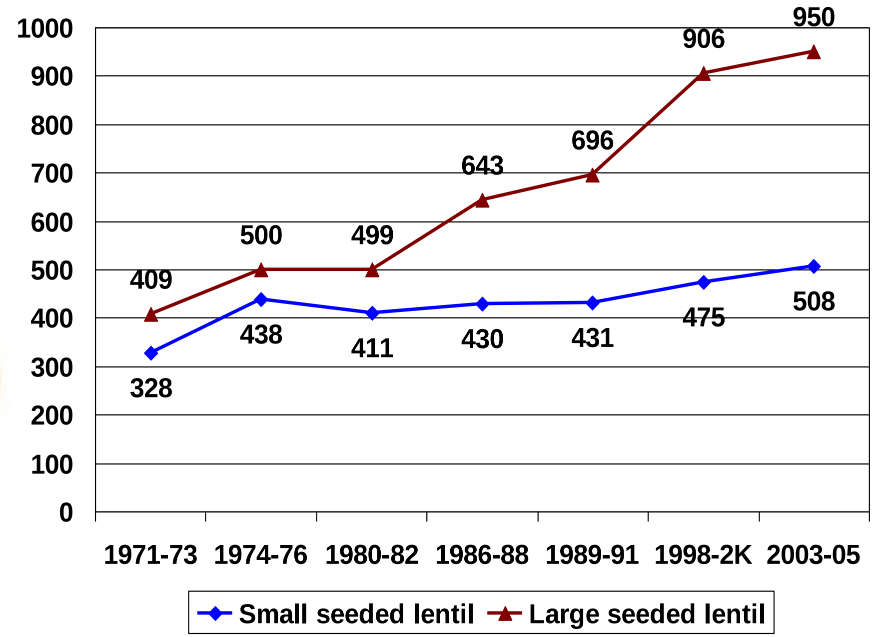
Performance of Heat and drought Tolerant Lentil Lines



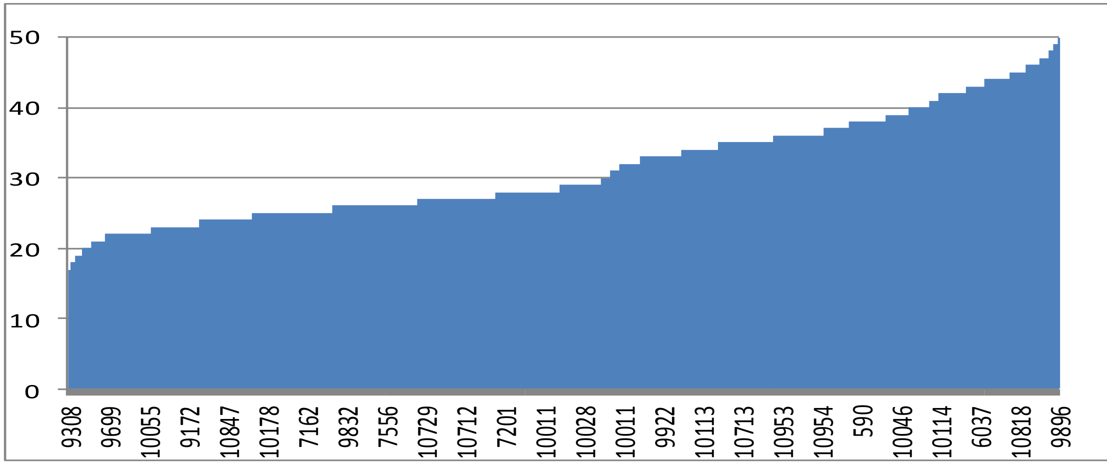
2016 INTERNATIONAL YEAR OF PULSES

ICARDA
Science for Better Livelihoods in Dry Areas

Large seeded cultivars for market opportunities



- **Large genetic variability for cooking time (17-50 min in lentil-** Fast cooking, an energy saving technology
- **Positively correlated with seed size**



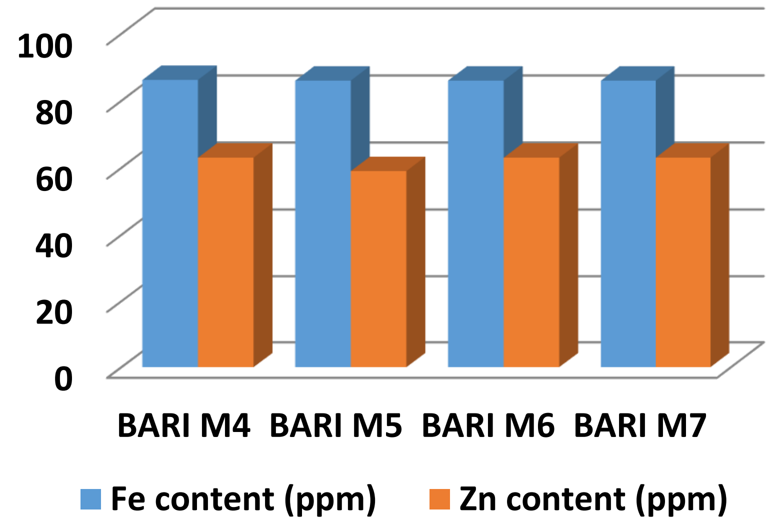
2016 INTERNATIONAL YEAR OF PULSES

ICARDA
Science for Better Livelihoods in Dry Areas

Biofortified lentils for hidden hunger in Bangladesh & India

- **Five bio-fortified varieties (BARI M4, M5, M6, M7 and M8) released and now cover ~90,000 ha area**
- **Average production 1.3 t/ha**
- **Producing 115,000 ton micronutrient dense lentil**

Fe and Zn contents of lentil varieties released in Bangladesh

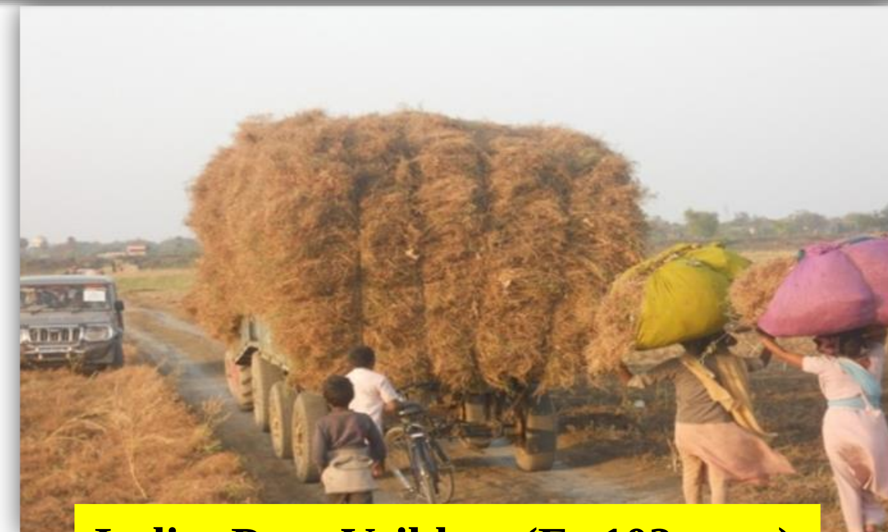


India: Pusa Vaibhav (Fe 102 ppm)

2016 INTERNATIONAL YEAR OF PULSES

ICARDA
Science for Better Livelihoods in Dry Areas

High Iron- & Zinc-rich Lentil Varieties



India: Pusa Vaibhav (Fe 102 ppm)

Bangladesh: Barimasur-4 (Fe 86 ppm; Zn-59 ppm

Nepal: Shekhar (Fe-78 ppm; Zn-68 ppm)

Ethiopia: Alemaya (Fe-98, Zn-64 ppm)

2016 INTERNATIONAL YEAR OF PULSES

ICARDA Science for Better Livelihoods in Dry Areas

Lentil cultivars with high concentration of Fe & Zn are in 'fast-tracking' seed dissemination

- Ethiopia: Alemaya
- Bangladesh: Barimasur-4, Barimasur-5 and Barimasur-6, Barimasur-7, Binamasur-7
- India: Pusa Vaibhav
- Nepal: Sisir, Shital, Shekhar, Khajurah-1, Khajurah-2
- Syria: Idlib-2, Idlib-3 and Idlib-4
- Turkey: Myveci-2001
- Portugal: Beleza

2016 INTERNATIONAL YEAR OF PULSES

ICARDA
Science for Better Livelihoods in Dry Areas

Lentil: A potential whole food solution

Effect of lentil diet on anemic Sri Lankan Children after 60 Days

Indicator	0 days	60 days	% improvement
Hemoglobin (g/dL)	11.1	11.8	6.3
Serum Fe (µg/dL)	51.5	89.8	74.4
Total Fe binding capacity (µg/dL)	405.3	377.6	-6.8
Trans ferritin saturation (%)	12.8	24.3	89.8
Serum ferritin (ng/mL)	29.5	41.2	39.7

50g of pulses is a good source of Fe, Zn, and Se

Nutrient	Lentil	Field pea	Chickpea	Rice
Protein (%)	20 – 27[a]	20 - 23[d]	19-20	2.9
Se ($\mu g\ kg^{-1}$)	425 – 672[a]	373-519[d]	450-850	93
Fe ($mg\ kg^{-1}$)	73 – 90[b]	44-55	50-55	2.4
Zn ($mg\ kg^{-1}$)	44 – 54[b]	20-30	20-32	3.7
Phytic acid ($mg\ g^{-1}$)	1.8 - 4.4[c]	2.2 – 8.2	4.9 – 6.1	7.2-11.9

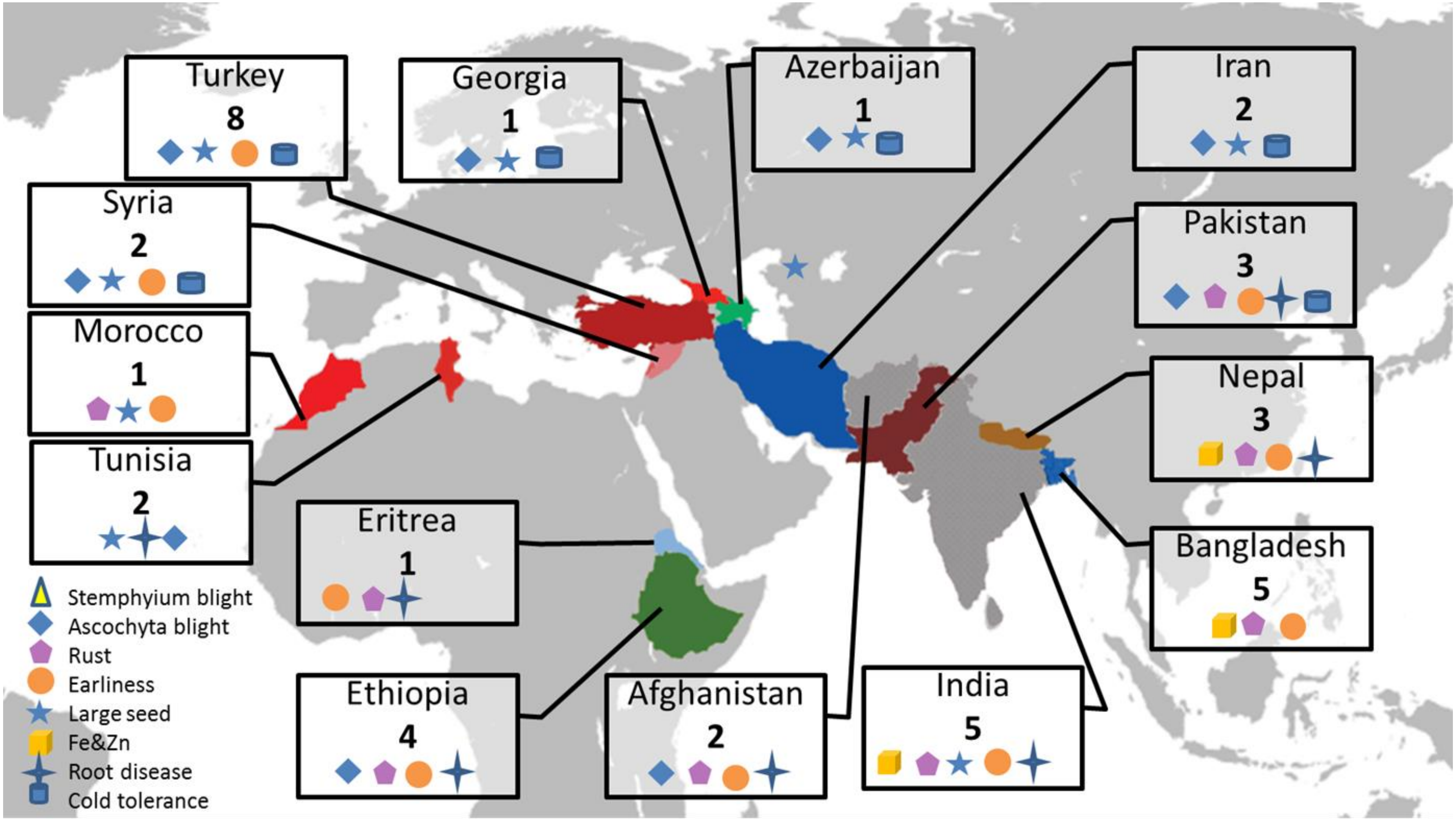
- Three times richer in protein as compared to rice
- Complementary Amino acid profile with cereals
- Micro-nutrient rich grains
- Rich in probiotic carbohydrates

2016 INTERNATIONAL YEAR OF PULSES

Source; Pallemulle, Thavarajah, Thavarajah et al. unpublished data, 2013

Lentil varieties released during the last 10 years

41 varieties in 14 countries



2016 INTERNATIONAL YEAR OF PULSES

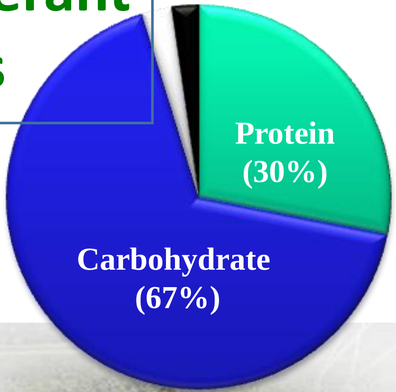
One Variety, BINAMasur 10 released recently in Bangladesh

Grass pea: a NUC of Great Potential to for Nutrition Coping with Climate Change Implications and Harsh Environments

Why Grass pea is an important NUC ….

One of the most drought tolerant and water logging crops

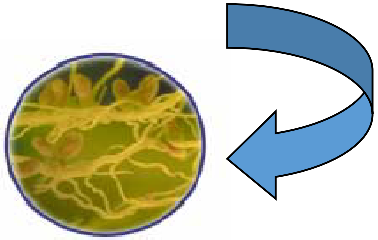
Sustainable Agriculture



Food & Nutritional Security

Straw-animal feed

N2



Ecological Security

Grass pea: A promising crop for food and feed security in dry and wet areas

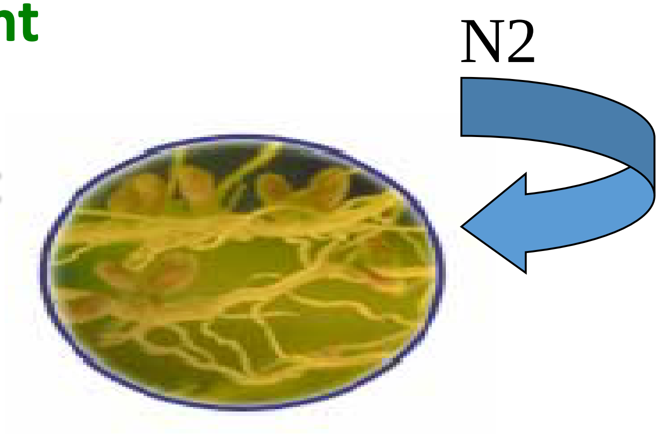
- Survives drought spell (WUE of 11-27 kg/ha/mm water)
- Tolerate moderate salinity
- Perform well in cool highlands
- Tolerate high temperatures
- Tolerate waterlogging
- Perform well in marginal land
- less management
- less diseases and insect problems

Important As Animal Feed…..

Its residues as animal feed improve livestock production increasing human access to products that diversify diet.

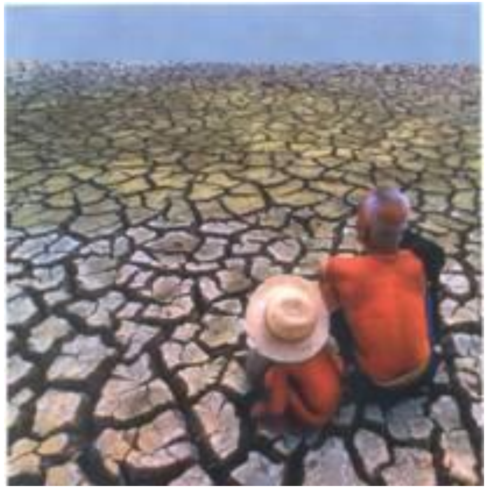
Ecological Sustainability

- N from BNF (40-210 kg/ha) (187,000 ton Nitrogen);
- Less dependence on Industrial N2;
- Thrives well under limited water availability (200 mm)
- Reduces pests and pathogen load to following crop, thus saving environment from chemical pollution;
- Soil-N saving effects and residual effect on cereal crops (30kg N);
- Improved availability of other mineral nutrients;
- Improved soil structure and root growth environment.



Grass pea well adapted to Climate Change Implications

- Temperatures rise by 2 - 3.5 ^{o}C
- More heat waves
- Wetter winters, drier summers
- Between 20% less and 20% more rainfall
- Rainfall comes in fewer but stronger spells.
- Flooding and landslides more frequent
- Sea level rises

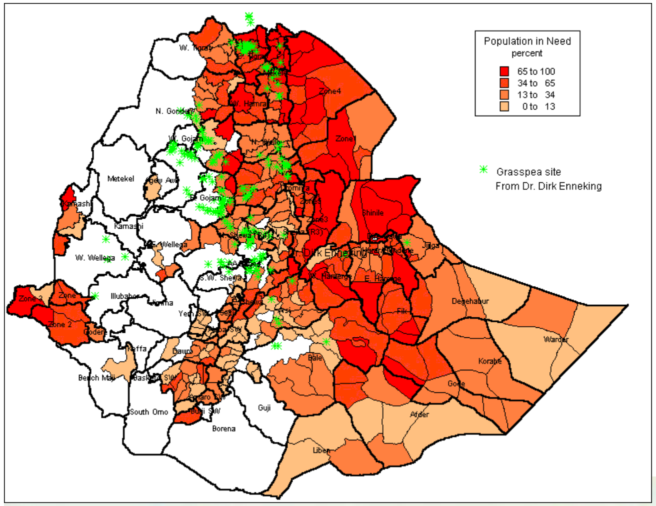


Lathyrism in Grass pea …. A tough choice between starvation and a health hazard

- When other crops fail under adverse agro-climatic conditions, grasspea is the only available source for the poor as a survival food

- However, although its seeds are protein rich, prolonged over consumption (>30% diet continuously for 3 months) can cause neuro-lathyrism in some people

- An irreversible paralysis of lower limbs



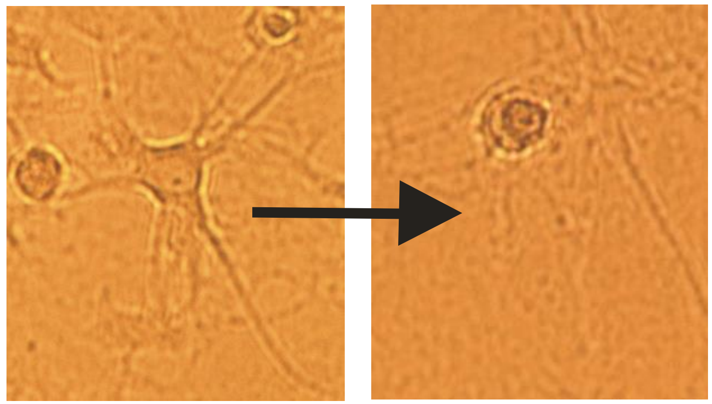
High content of β-ODAP in its seeds…..

Neurolathyrism

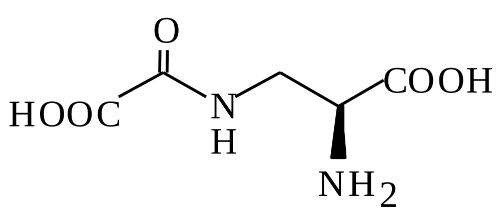
Grass pea
L. sativus

Motor neuron degeneration

Neurolathyrism



β-ODAP
Met/Cys deficiency

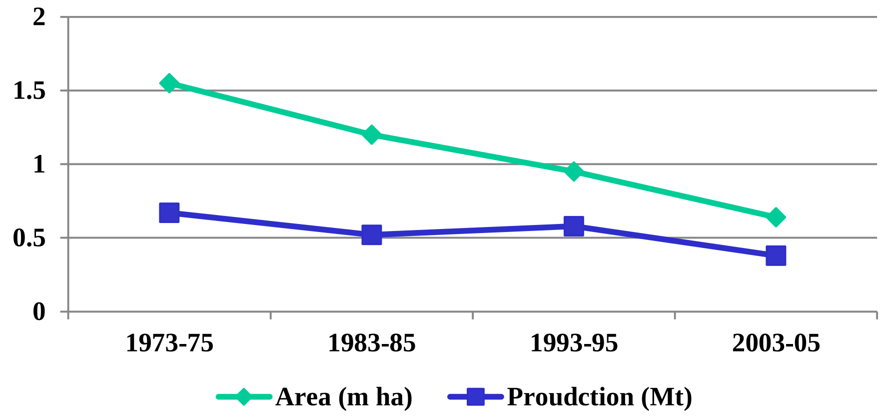


L-β-ODAP

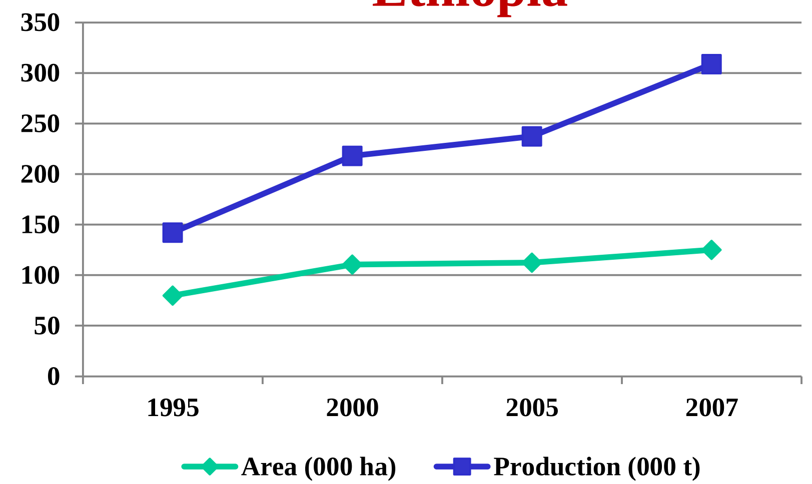
Ban on Trade: Boon or Bane?

- Global acreage: 1.50 m ha
- Global production: 1.20 m t
- India, Bangladesh and Ethiopia: 70% of global output

India



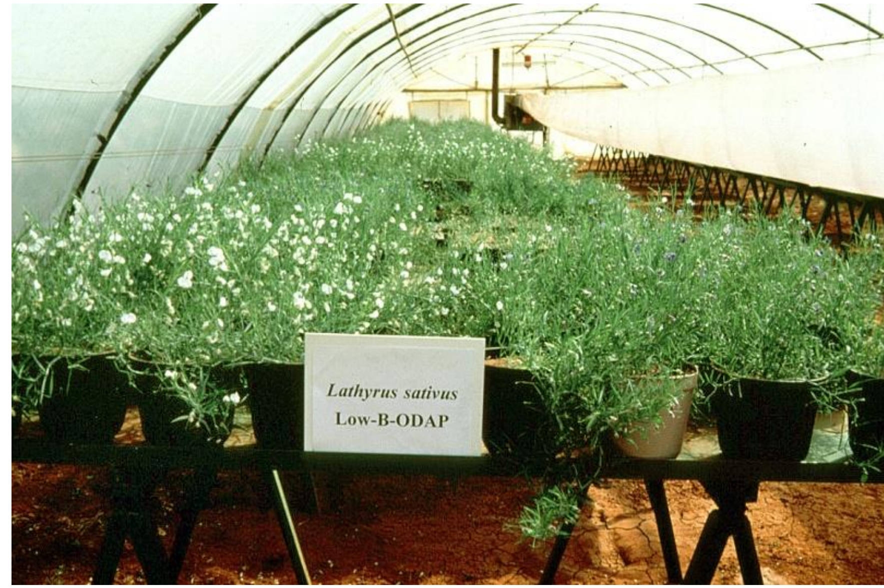
Ethiopia



Potential of Grasspea Unexploited...

How to Enhance Economic Competitiveness of Grass pea?

- Improve intrinsic yield potential and reduce the ODAP content
- Enhance adaptation to diverse niches and cropping systems
- Enhance BNF to increase contribution to the system
- Enhance end-use quality and diversify the use
- Reduce the yield gaps



Challenges in Grass Pea Improvement

- Limited knowledge on genetics of ODAP
- Linkage drag with ODAP
- High GE interaction – slow progress
- Often cross-pollination
- Crossing barrier to utilize the wild relatives
- Improvement of nutritional profile & bio-fortification for Sulphur rich amino acid and anti-oxidants
- No linkage map

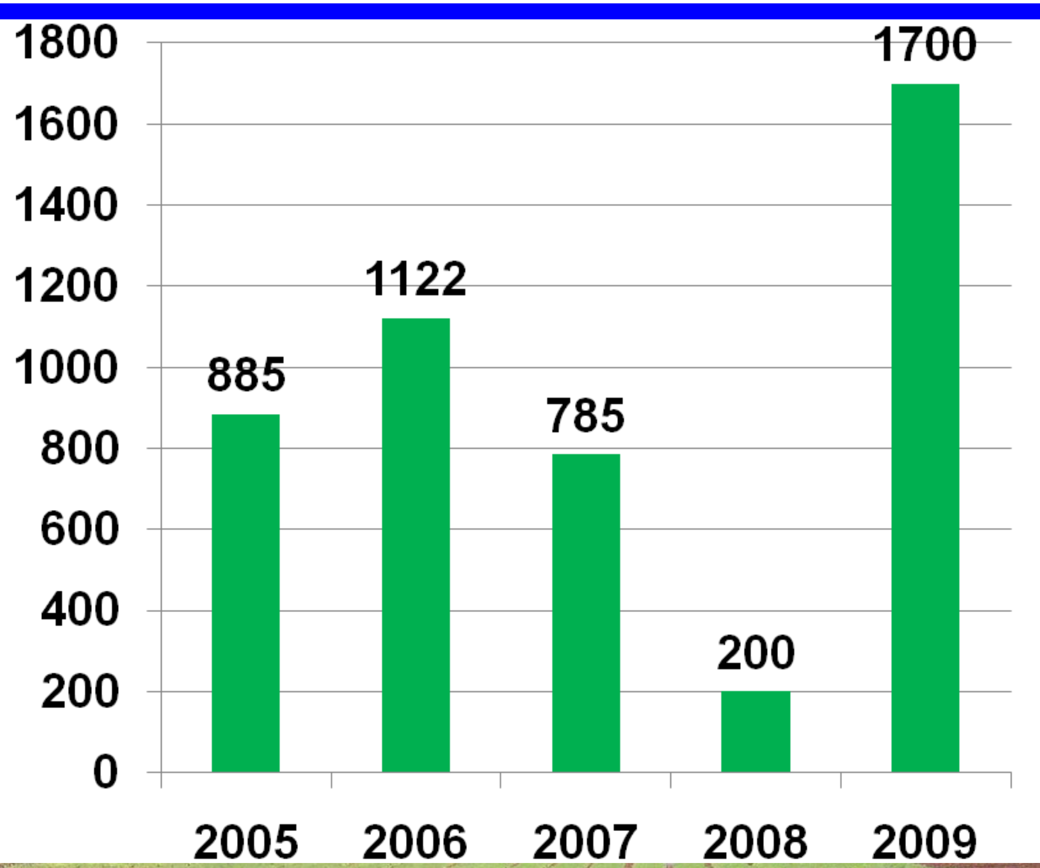
Present Research Programs

- **Focussed identification of germplasm (FIGS) for low ODAP**
- **Combining low ODAP, high biomass and earliness in high yielding background**
- **Development of molecular markers and linkage map**
- **Mapping and tagging of genes/QTLs associated with low ODAP content**

Assessment of ODAP Content in Wild Relatives

Species	Min	Max	Mean
L. sativus	**0.07**	**0.75**	**0.49**
L. cicera	**0.10**	**0.22**	**0.16**
L. ochrus	**0.40**	**0.71**	**0.62**

- **Toxin content : L. cicera < L. sativus < L. ochrus**
- **A wide range of variability for ODAP content (0.02 to 1.5%)**



Region-wise Variation for ODAP

Country of origin	Accessions evaluated	ODAP Content (%)			Environments
		Minimum	Maximum	Mean	
Bangladesh	317	0.376	0.699	0.482	18
Ethiopia	98	0.067	0.848	0.341	21
Nepal	47	0.403	0.531	0.487	13
Pakistan	62	0.336	0.517	0.466	13
Europe	115	0.125	0.908	0.458	2

Breeding Scheme at ICARDA

Screening and evaluation of germplasm

Donor
- Hybridization in plastic house

F1
- Offseason at Terbol

F2-F3
- Bulk populations

F4
- SPS as pedigree

F5-F6
- Progeny Selection and evaluation

F7-F8
- multi-environment yield trials

International nurseries (3) → NARS evaluation → Variety Release

Improved Varieties

Country	Varieties
India	Pusa 24, Prateek , Mahateora, Ratan
Bangladesh	BARI K 1, BARI K 2, BARI K3 and BARI K4
Nepal	Local (CLIMA 2 pink, 19 A, 20 B, BARI K2)
Pakistan	Italian
Ethiopia	Wasie
Turkey	Gurbuz 1 0.08% B-ODAP

Grasspea replacing fallow in rice-fallow in West Bengal




Low-ODAP Grass pea varieties in Bangladesh and India

2016 INTERNATIONAL YEAR OF PULSES

Variety Nirmal produced 0.8-1.7 t/ha

Enhancing farmers’ income and house-hold nutritional security through intensification in Rice – Fallow Replacemen

A farmer, Mr. S H Khunou earned Rs 80,000 ($ 1230) in 2 ha rice-fallow land in Manipur state of India from lentil

A farmer, Mr. P. Das earned Rs. 24,600 ($ 378) from lentil in 0.48 ha rice fallow land


Conclusions

Conclusions & Recommendation

- NUCs will remain an important crop in the fragile eco-system and harsh environments;
- Multi-disciplinary research employing conventional and molecular tools has the potential to develop high-yielding cultivars of NUCs to improve food security, environmental health and industrial use such as dyes.
- NUCs will remain important crop in specific niches and traditional communities.
- A very good number of NUCs have great potential and are very important for Food & Nutritional Security:
  - Contributing directly & indirectly through high protein content.
  - Major source of micro nutrients such Mg, Fe and Zn.
  - Important source of dietary fibre.

Conclusion & Recommendations (cont'd)

- A good number NUCs are adapted to harsh environments very important for environmental benefits and mitigation of Climate Change:
  - Most of them are low input crops that can be of high commercial values;
  - A good number of NUCs can enhance soil N content and soil health and soil productivity;
  - Production of some of the NUCs has lower greenhouse gas emissions than crops that require N-fertilization;.
  - They also require less water and are tolerant to drought, water logging, heat and salinity.

- NUCs will continue to be important to increase income traditional communities particularly in rural areas thus their improvement will improve livelihoods to traditional communities and rural areas.

Conclusions & Recommendations (cont'd)

- **There is an urgent need to invest more in the improvement of NUCs to enhancing their productivity, production and enhance their commercial value to capitalize on all the potential on and benefits of these crops.**

- **Besides the attention given by UN, international and regional research organization/ centers to NUS, Governments/public sector, civil societies and private sector should give special attention to promote NUS with high potential to realize their benefits particularly those important to the resource- poor and neglected rural communities.**

.

How to raise awareness about the benefits of NUS?

- **Inclusion of NUCs benefits in school curricula in different countries and/or region focusing on on those with high potential & benefits;**
- **Innovations in NUCs products and ready to use at products;**
- **Messages by celebrities and eminent personalities about the benefits of NUCs in electronic media and print;**
- **National, regional and global events involving the importance and potential of NUCs;**
- **Short documentary films on benefits on NUCs.**

Thank you