Review Meeting
Grain Legumes Phase 1 and Extension Phase

Extra Early Varieties of Chickpea and Lentil

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CGIAR RESEARCH PROGRAM ON Grain Legumes

LED BY ICRISAT INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

IN PARTNERSHIP WITH CIAT Centro Internacional de Agricultura Tropical International Center for Tropical Agriculture; ICARDA Science for Better Livelihoods in Dry Areas; IITA Research to Nourish Africa

and public and private institutes and organizations, governments, and farmers worldwide

Leveraging legumes to combat poverty, hunger, malnutrition and environmental degradation

Product Line Description

- **Participating Institutions:** ICRISAT, ICARDA, NARS and ARIs
- **Focus crops:** Chickpea and Lentil
- **Focus regions:** South Asia and East Africa
- **Description:**
  - Vast area left fallow after rice harvest in rainfed regions of South and South East Asia
  - In irrigated areas, rice – boro rice system offers a short window of 90 days
  - Rice fallow requires appropriate variety and specific production technology
  - Managing biotic and abiotic stresses through integrated approach

Extra-early, disease-resistant varieties

- **Intensification of cereal-based CS with legumes as catch crop**
- **Expansion in rice-fallows in South Asia**
- **New niches: spring planted crop in WANA region**
- **Market opportunities**

Objectives 2012-16

Overarching Goal: 10-year target is to bring at least 500,000 ha of rice fallows into double cropping with chickpea and lentil.

Output/Outcome targets:

- Constraints and opportunities for extra-early varieties identified
- Extra-early germplasm resistant biotic, abiotic stresses identified
- Novel genes for earliness and markers linked to genes identified
- Extra-early varieties with improved quality developed – **AR-2014 Highlight**
- Integrated crop management for extra-early varieties developed
- Seed availability of extra-early varieties enhanced – **AR-2013 Highlight**
- Marketing of chickpea for immature green grains as a vegetable
- Capacity of stakeholders strengthened

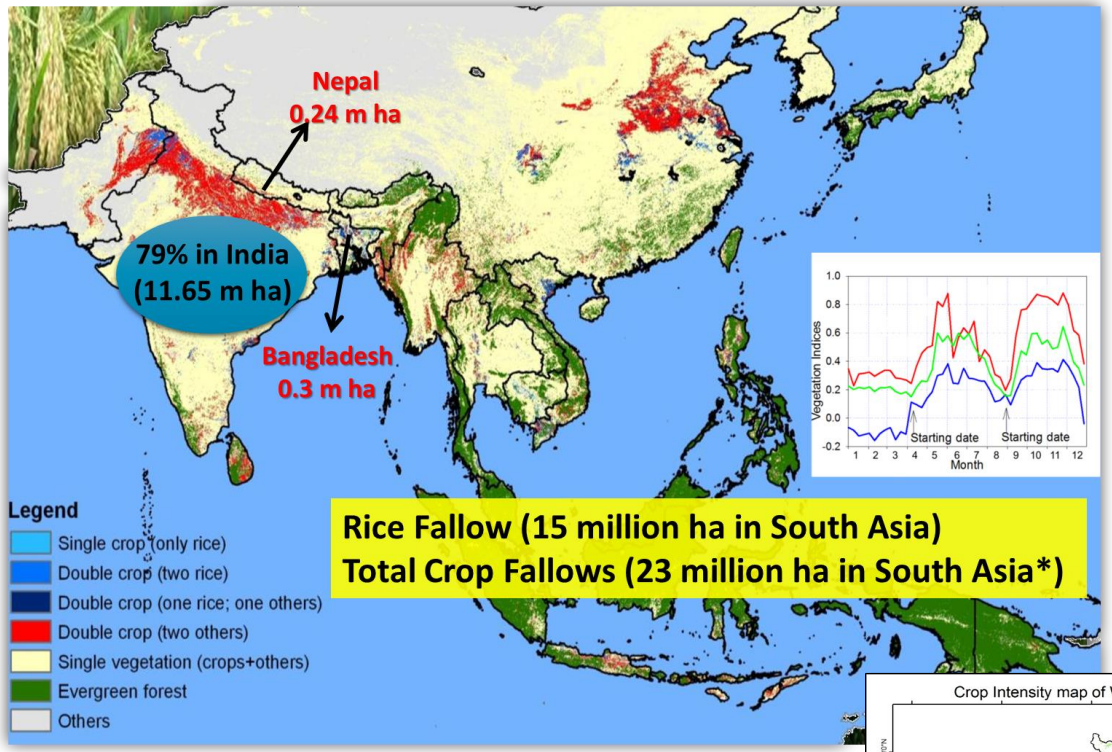
RESULTS Summary

- **Constraints and opportunities for extra-early varieties identified (SC1)**
  - Mapping of rice fallows
  - Crop simulation model for lentil
- **Extra-early germplasm with resistance to key stresses identified (SC2).**
  - Extra early germplasm identified and deployed
- **Novel genes for earliness and molecular markers linked to genes identified (SC2)**
  - New gene Efl-4 and QTLs in chickpea identified
  - Lentil genome sequenced

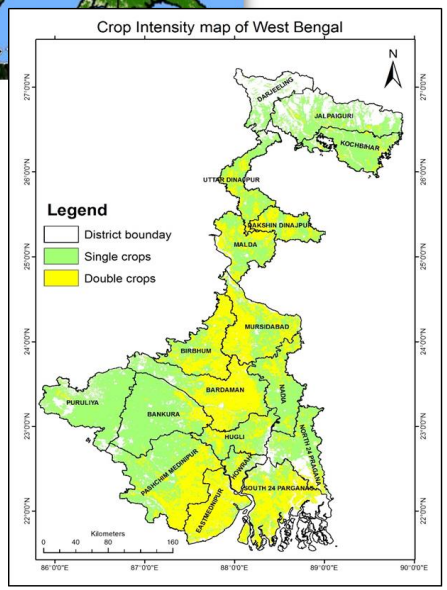
RESULTS Summary Contd.

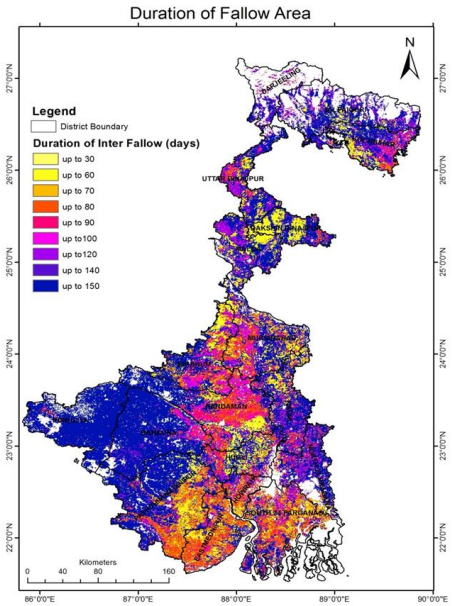
- **Extra-early varieties with improved quality developed (SC2)**
  - Early maturing varieties of chickpea in Myanmar
  - Early maturing micronutrient rich lentils in Bangladesh
  - Early maturing lentil in Nepal
  - Short duration disease resistant chickpea in India
- **Integrated crop management practices for extra-early varieties developed (SC2).**
  - Managing lentil productivity in rice fallows
- **Seed availability of extra-early varieties enhanced (SC3)**
  - Legume seeds in Ethiopia

RESULTS: Mapping of rice fallows in South Asia (SC1)



- Mapping of rice fallows for crop/variety suitability





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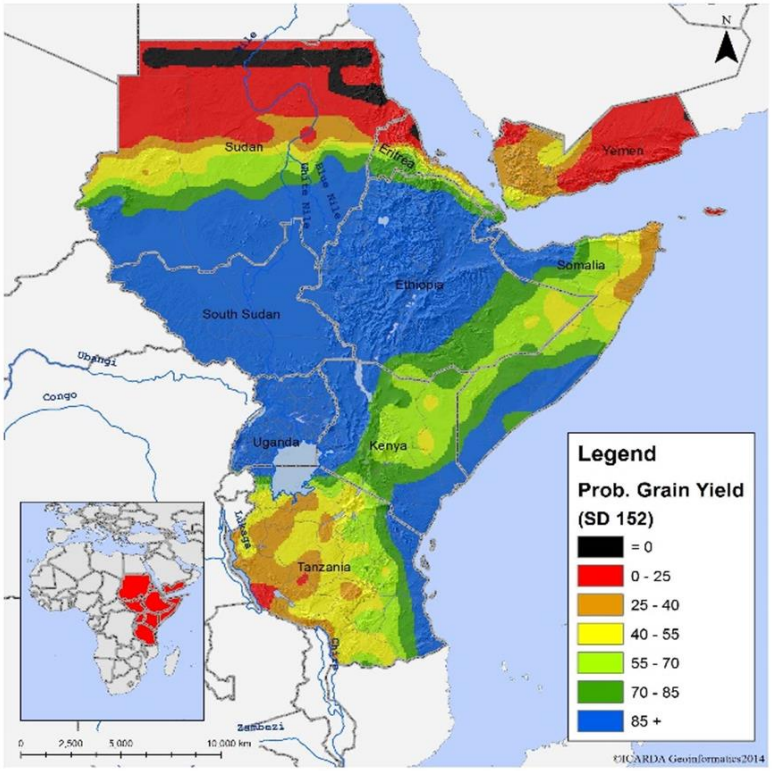
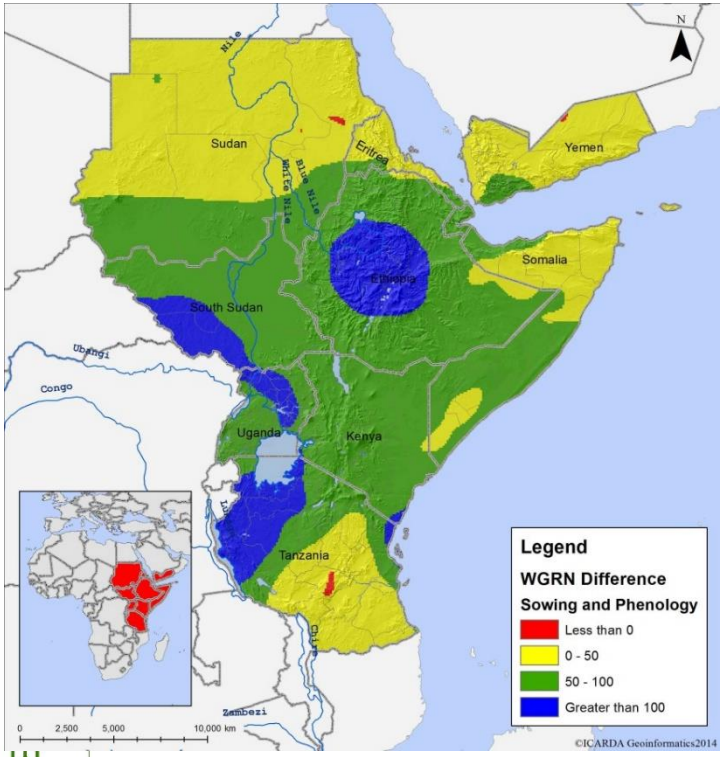
Crop modeling to simulate yield gain of lentil (SC1)

Long-duration cultivars at current sowing dates have high probabilities of yield increase (40%) in all target regions except desert parts of Sudan, and southwest Tanzania





Changing phenology and sowing date

Simulation of average yield gain of lentil by changing both sowing date and phenology in East Africa can produce as high as 100 % yield gains in some locations

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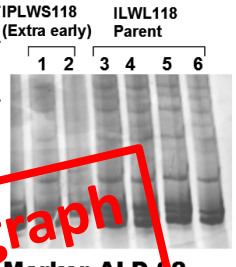
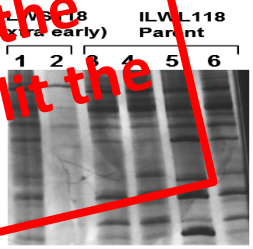
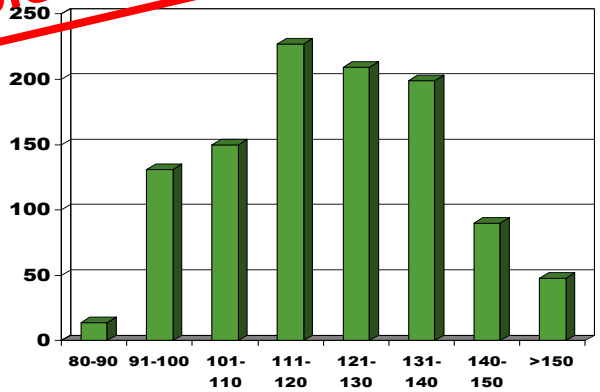
Pre-breeding for early genes in lentil (SC2)

Traits	Timely Sown		Late sown	
	Parent ILWL-118	Selection IPLWS-118	Parent ILWL-118	Selection IPLWS-118
Days to flower initiation	98	30	No Flowering	46
Days to pod initiation	105	37		52
Days to maturity	182	62		80
Pods/plant (no.)	60-90	10-12		200







Please prepare the original table and graph so they stand out. You could remove the top two picture s on the right, and split the table and graph into two slides.

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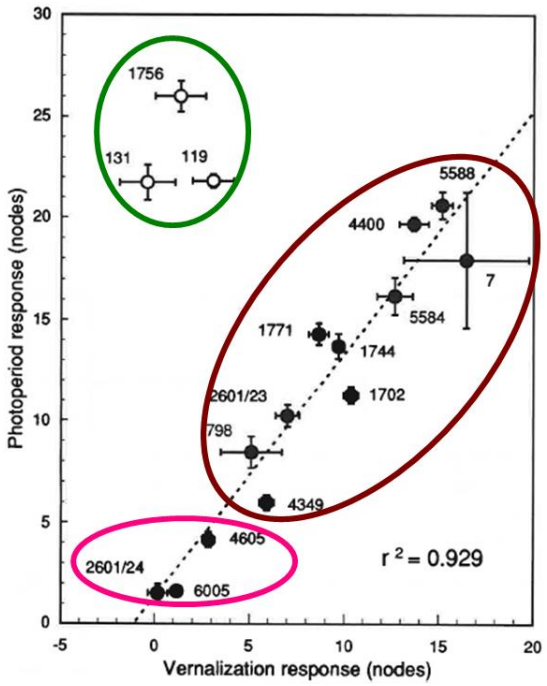
Novel Genes for Flowering Time (SC2)

- **Non-allelic early-flowering gene *efl-4* in chickpea**
- Seven major and three minor QTLs for flowering
- **Sequencing libraries of 50 candidate chickpea varieties completed**
- **New sources for *efl* gene in lentil identified**

Laird ILL6005 ILL260



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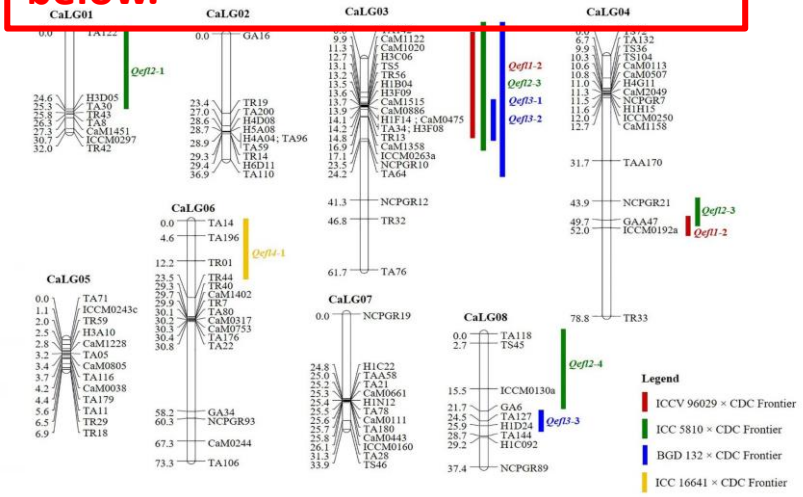

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Lentil Genome Sequence (SC2)

moderately large genome
~6-8x size of model species or crops
(Rice; legumes Medicago, Chickpea)

LenGen project
(2013-2016)

Goal:

Accelerate lentil breeding via ***molecular tools*** from **genomics + germplasm.**

Approach/ Activities:

1. Develop a ***draft*** genome for lentil by combining:
   - Shotgun Whole Genome Sequencing (Illumina Hiseq short reads)
   - High density molecular marker linkage maps (RAD-GBS)

     ICARDA funded project; 2013-2015
   - Assemble larger-order scaffolded sequences (PacBio & Mate-pair library sequencing)
2. Survey global lentil germplasm

Status:

- **Draft genome v1.0 completed.**
  Scientific journal article in preparation.
- **Molecular Diversity of Germplasm completed.**
  434 accessions spanning global collections.
- **Data available via on-line portal**:
  http://knowpulse2.usask.ca/portal/project/Lentil-genome-sequencing-%28LenGen%29%3A-establishing-a-comprehensive-platform-for-molecular-breeding

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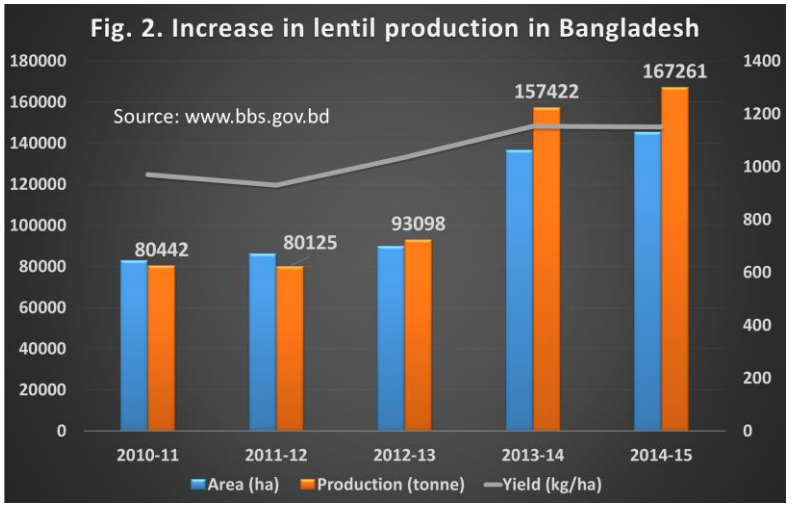
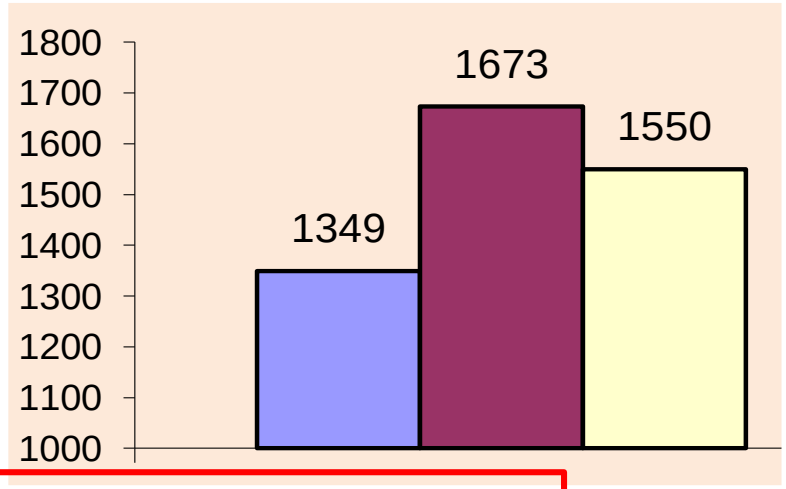
Lentil in Rice system in Bangladesh (SC2)

- Improved varieties (BARI-M4, M5, M6, M7, M8) with disease resistance and rich in Micronutrients developed
- Production increased from 80442 ton in 2011 to 167,261 ton in 2015 with an AGR of 10.9%
- Mainly through productivity increase from 1349 kg/ha to 1673 kg/ha
- Magura & Jessore districts: 25 & 15% AGR





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Extra early lentils for Rice-lentil-boro rice system (SC2)

Bangladesh

Genotype	Duration (Days)	Gn Yield (Kg/ha)
BLX-05008-15	77-82	1316
BLX-05008-05	77-84	1283
BLX-05008-22	84-89	1267
BLX-05008-02	77-81	1125
LRIL-22-70	92-110	2267
LRIL-21-68	93-103	1867
LRIL-22-133	90-102	1697
LRIL-22-61	88-101	1467
LRIL-22-205	93-100	1353

Breeding lines IPL 534, L 4717 and RKL 607-01 mature in 100 days under MET in India

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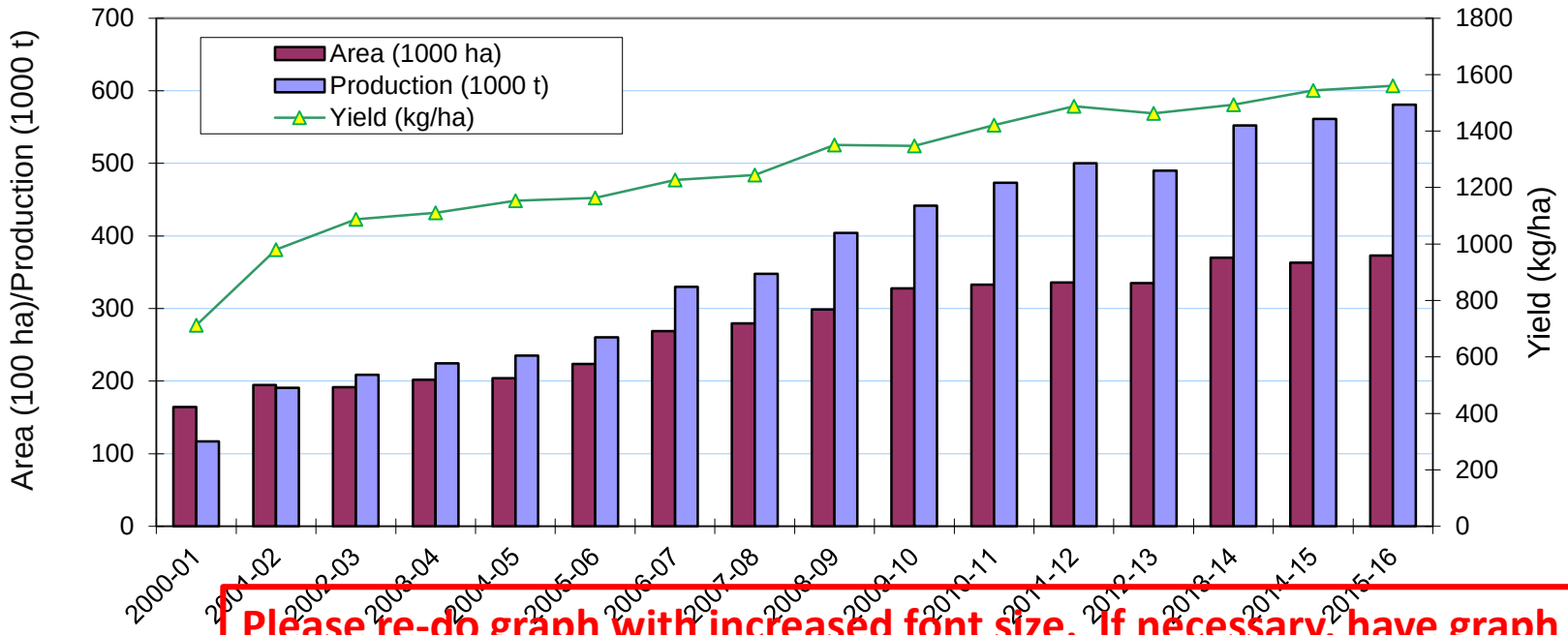
Early varieties of chickpea in Myanmar (SC2)

- 7 varieties released from ICRISAT germplasm
- 96% chickpea area under 5 varieties
- Compound AGR of 5.6% for yield during past 15 years
- Production increased 5-fold (117,000 to 581,000 tons) due to 3.3-fold increase in area and 2.2-fold increase in yield
- Myanmar - annual export of 47,500 tons (US$ 24 million)



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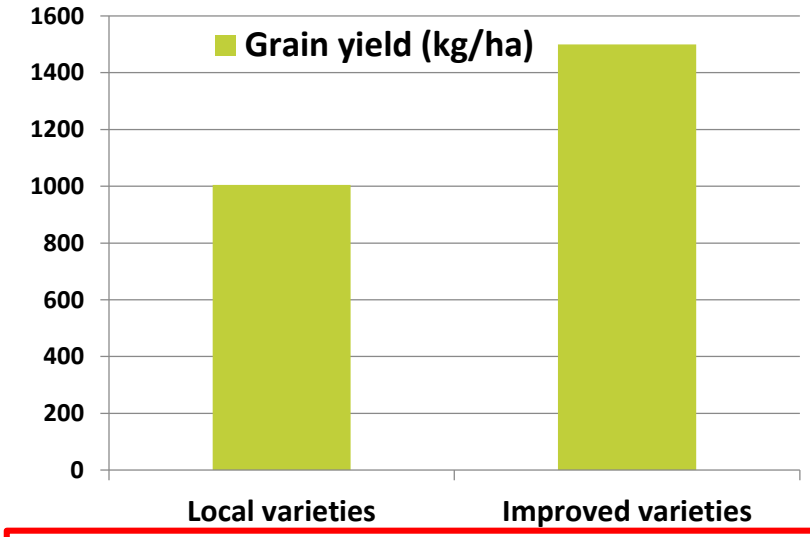
Early varieties of Chickpea in Andhra Pradesh (SC2)

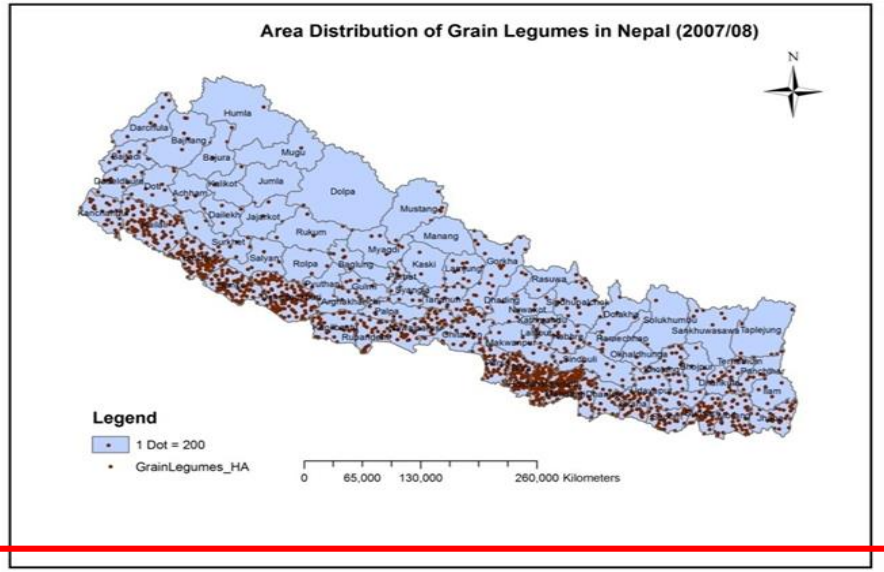
- High-yielding, fusarium wilt-resistant varieties developed
- Manifold increases in area, production and productivity in short-season environments
- Geographical shift in chickpea cultivation in India

The graph here is a very important one, please give it more space and redo as original so the fonts are clear

Nepal – exporter of lentil in South Asia (SC2)

- **10 varieties** released
- **~60% (124,578 ha) area** under improved varieties
- **124,952 tons seed** of improved varieties produced
- **USD 61.92 MM** additional annual income
- **> 3x export value** at present than in 2001





Could you enlarge the graph and figure with larger font; they are very critical , it will be great if they get the space they deserve

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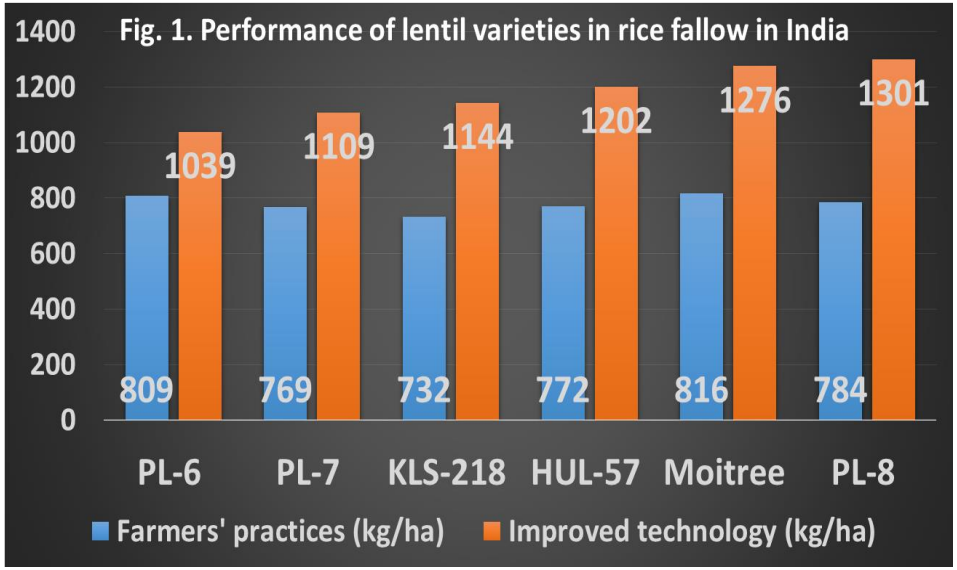
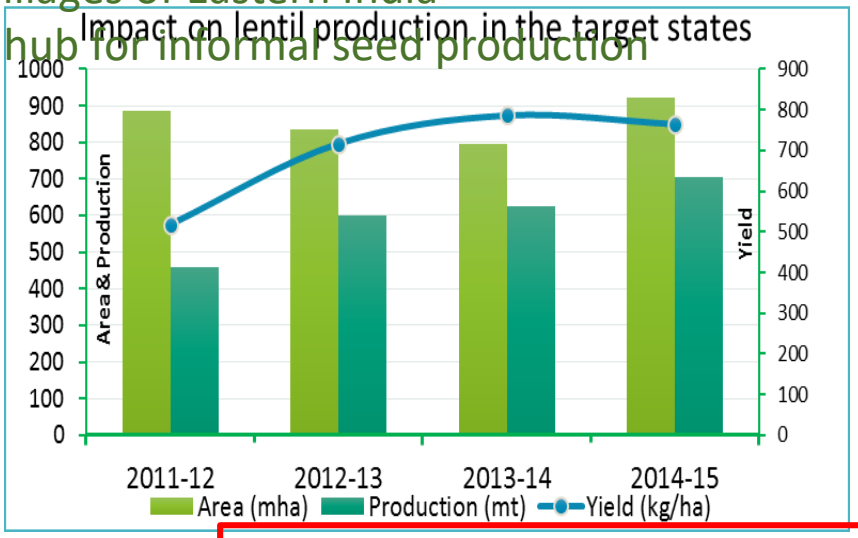
Managing Lentil Productivity in Rice Fallow: India (SC2)

- **Improved varieties:** PL6, PL7, PL8, KLS218, HUL57, Moitree
- **Production technologies:** Seed priming and treatment, Metasystox against aphids, SAAF foliar fungicide, Application of 2% urea/DAP, Boron and Lime in acid soils, ZnSO4
- **Production technology demonstrated:** 9202 farmers covering 3253 ha area in 460 villages of Eastern India
- Seed hub for informal seed production

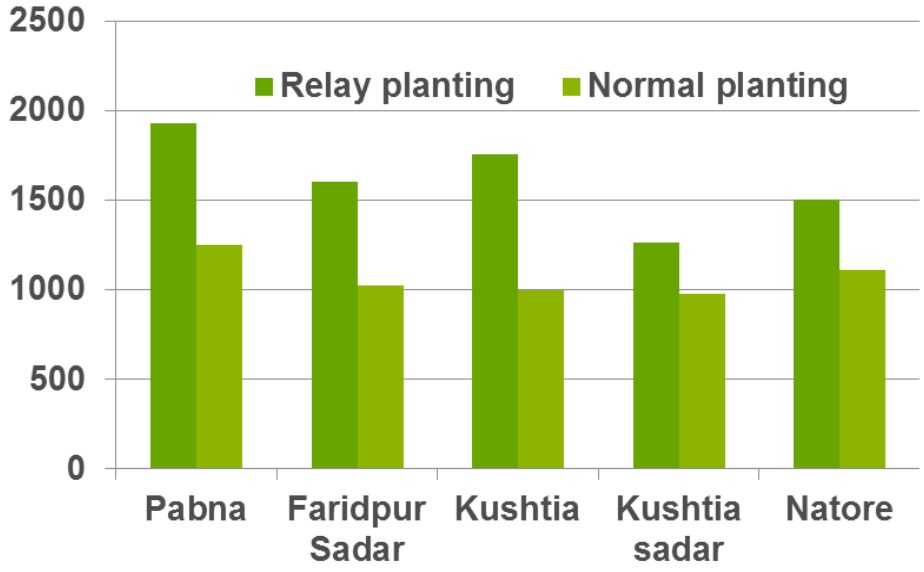




Great slide! Please split into two, with one graph and the text in this slide, and the black graph on the next slide. Best to remove the photograph

Relay Planting of Lentil in Bangladesh (2012-15) SC2

- Higher grain yield by planting lentil 15 days before rice harvest than sowing lentil after rice harvest
- Seed priming with water
- Production cost reduced by 45%
- Seed rate of 50 kg/ha (66 to 133 plants/m^2) increased grain yield
- Lentil variety PL6 can be relay cropped with LD rice, Swarna; DPL15 with MD rice, Satabdi



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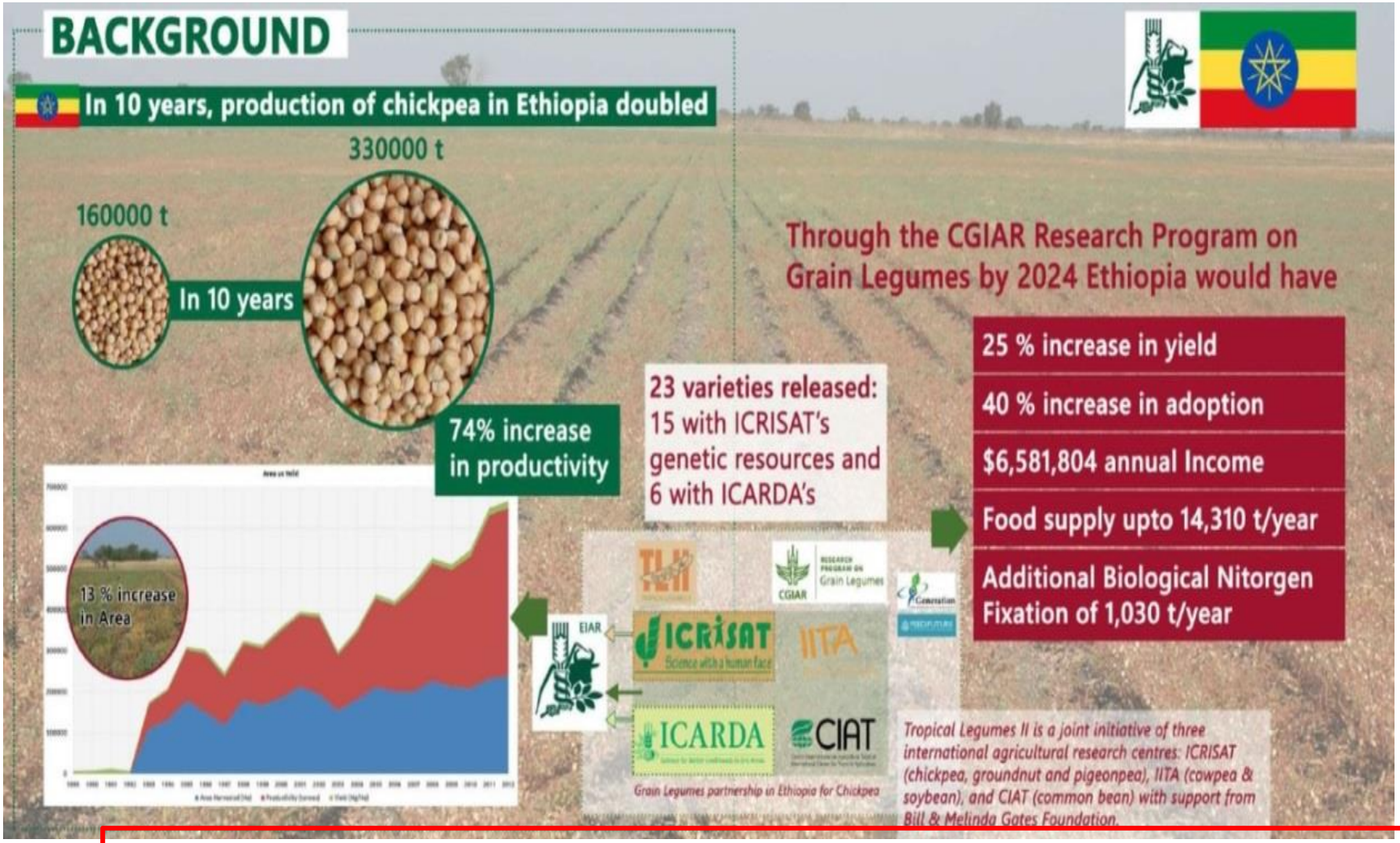
Legumes Seeds in Ethiopia (SC3)



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IMPACT

Chickpea

- **11 varieties** (Kenya, Ethiopia, India, Afghanistan)
- **72,479 t quality seed**
- **14,169 demonstrations on-farm** in S Asia & E Africa

Lentil

- **10 varieties** (Bangladesh, Ethiopia, India, Afghanistan)
- **3792 t quality seed**
- **9202 OFTs** covering **3253 ha** area in **460 villages** of E India

- 40,367 farmers and extension workers trained
- **** Short and long term training for NARS partners
- 13 PhD and 9 Master students guided
- 50 publications

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Lessons Learned, Challenges, Concerns

- Research-for-development network with different stakeholders is essential for effective delivery of research outputs
- Drastic reduction in W1+W2 funding
- Maintain critical staff to deliver on POWB
- Discontinuation of competitive grants and partnership support
- Raising fund through bilateral projects

Areas suggested for continued R4D

- Comprehensive studies on phenological adaptation (Genetic basis for adaptive changes in flowering time)
- Further insights from comparative genetics on flowering time genes in legume species
- Biofortification and nutrition quality
- Contribution of legumes to carbon and water foot prints
- Multi-stress resistance and their interaction
- Seed system research for information seed delivery
- Socio-economic studies for outcome and impact analysis of research outputs

Contributing Bilateral Projects

- Tropical Legumes II & III
- ICAR-ICARDA Collaborative Research projects
- USAID project
- GRDC project
- EU IFAD project
- OCPF project
- ACIAR project as co-partner
- Government of India-NFSM project on lentil production for sustainable rice based production systems
- Government of India-NFSM project on Pre-breeding lentil and chickpea

Summary

List of Posters

- Impacts of early maturing chickpea varieties in Myanmar - **Mar Mar Win**, Kyi Shwe, Thin Maw Oo and Pooran M Gaur
- Lentil for Rice-based Cropping Systems in South Asia - **Jitendra Kumar,** Harsh Dikshit, Omar Ali, Rajib Nath, A. Sarker and Shiv Kumar
- Genetics of flowering time in chickpea - **Srinivasan Samineni**, Bingi P Mallikarjuna, Mahendar Thudi, Sobhan Sajja, Rajeev K Varshney, Pooran M Gaur

Thank you for your kind attention

Shiv Kumar Agrawal

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ARIs:
University of California, Davis, USA
University of Saskatoon, Canada
North Carolina State University, USA
WSU, Pullman, USA

NDSU, Fargo, USA

South Asia: ICAR (IIPR, Kanpur; PAU, Ludhiana; BCKV, WB; JNKVV, MP)

WANA: National partners of Sudan, Egypt, Morocco

SSA: Ethiopia

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