International conference on
SUSTAINABLE WATER USE FOR SECURING FOOD PRODUCTION IN THE MEDITERRANEAN REGION UNDER CHANGING CLIMATE

Breeding Food Legumes for Enhanced Drought Tolerance to Revive its Cultivation in Mediterranean Region

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ICARDA

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Agadir, Morocco

Food legumes….

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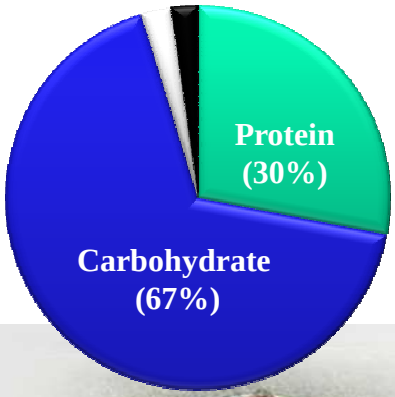
Sustainable Agriculture

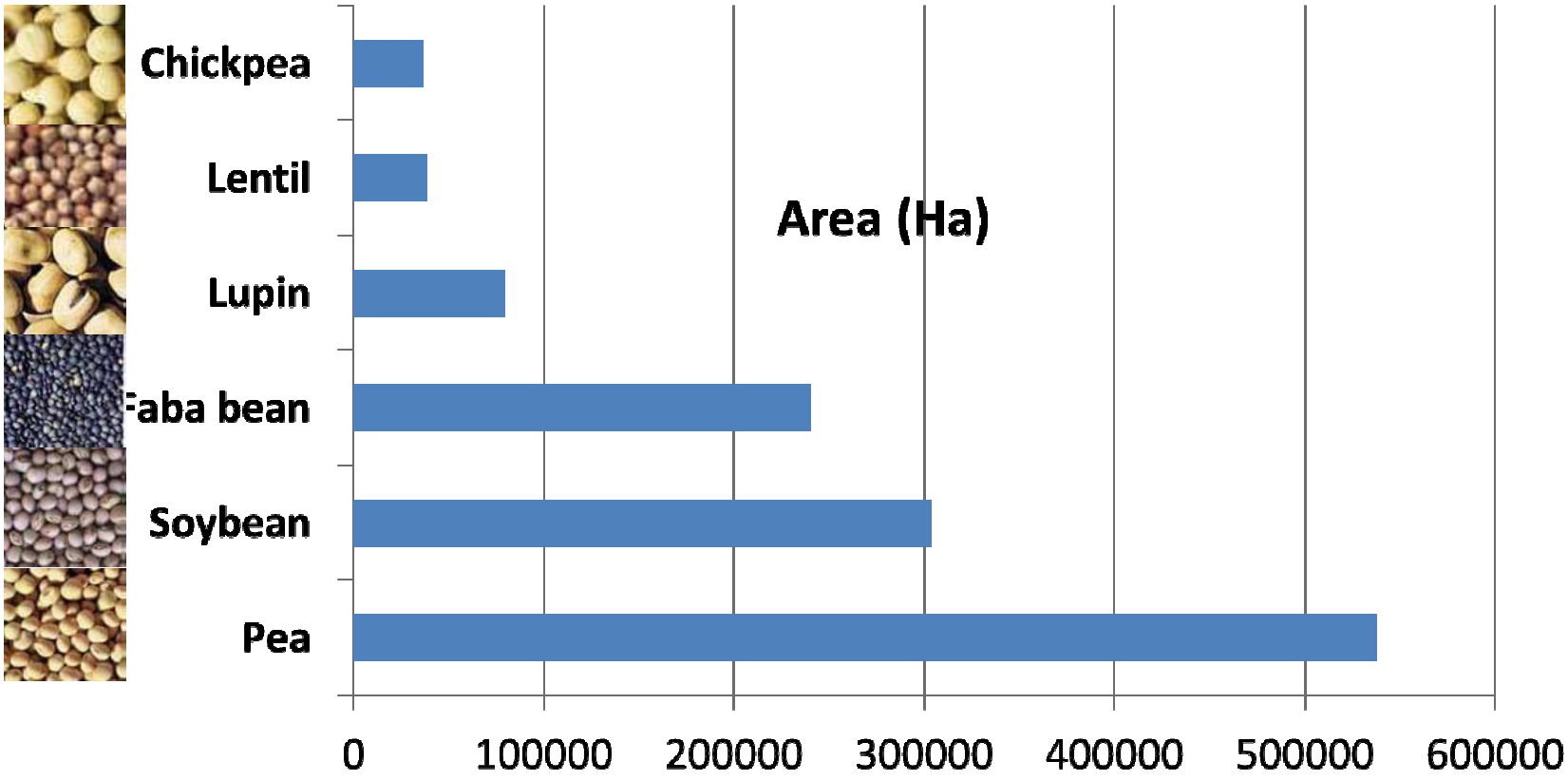


Ecological Security

Nutritional Security

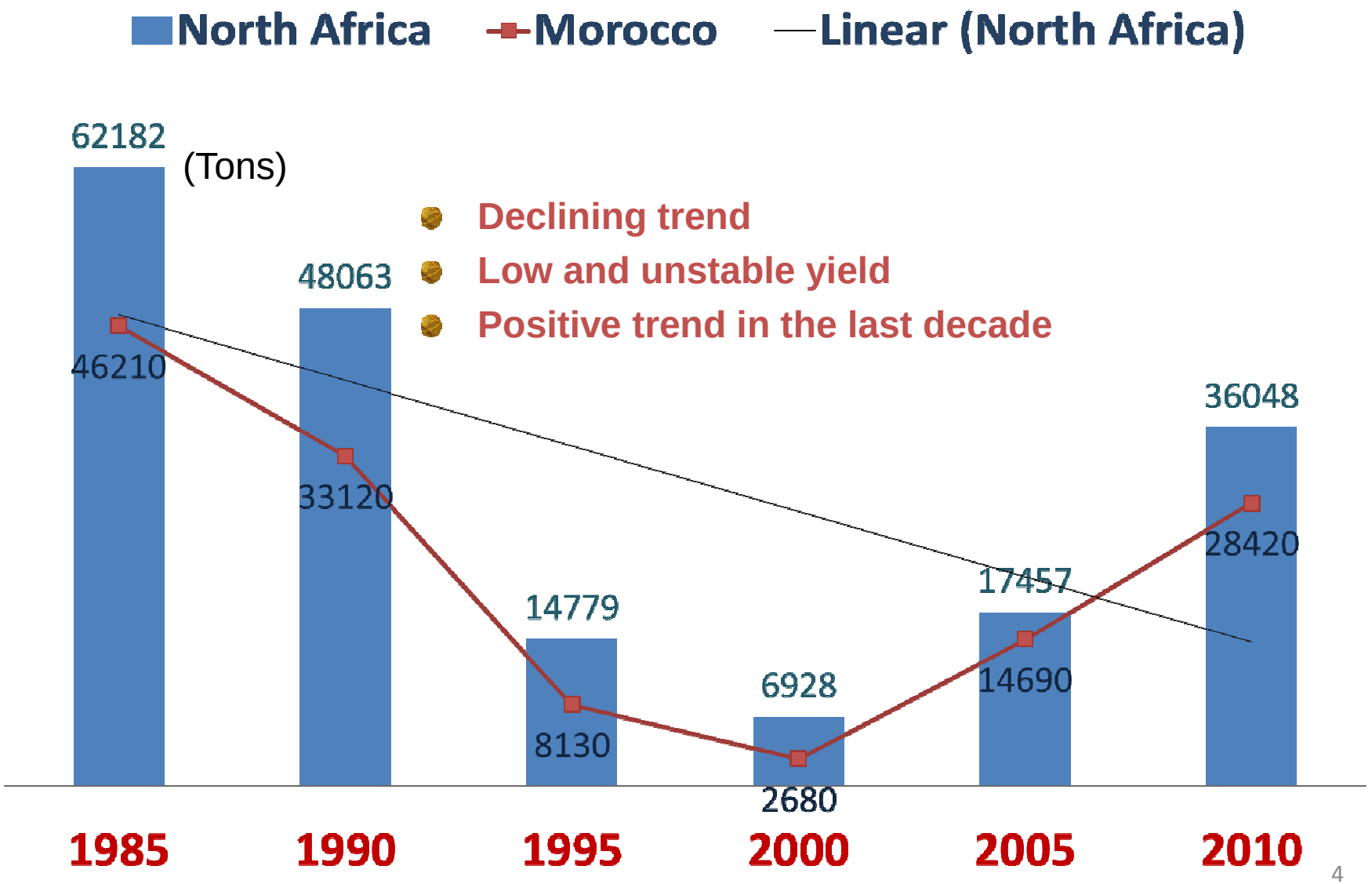
Straw-animal feed

Area under Legumes in Mediterranean Countries is on decline ……



~1 M ha as compared to 59 M ha under cereals in EU

Example: Lentil in North Africa



- Declining trend
- Low and unstable yield
- Positive trend in the last decade

Major Production Constraints

- Frequent drought of varying intensity
- Parasitic weed (Orobanche) menace
- Non-availability of labour with rising cost
- Non-availability of quality seeds
- Inadequate pulses policies

ICARDA Food Legume Crops

Lentil

Faba bean

Kabuli Chickpea

Grasspea

Enhancing economic competitiveness and stability in performance of food legumes - a major challenge

Changing Climate – a reality

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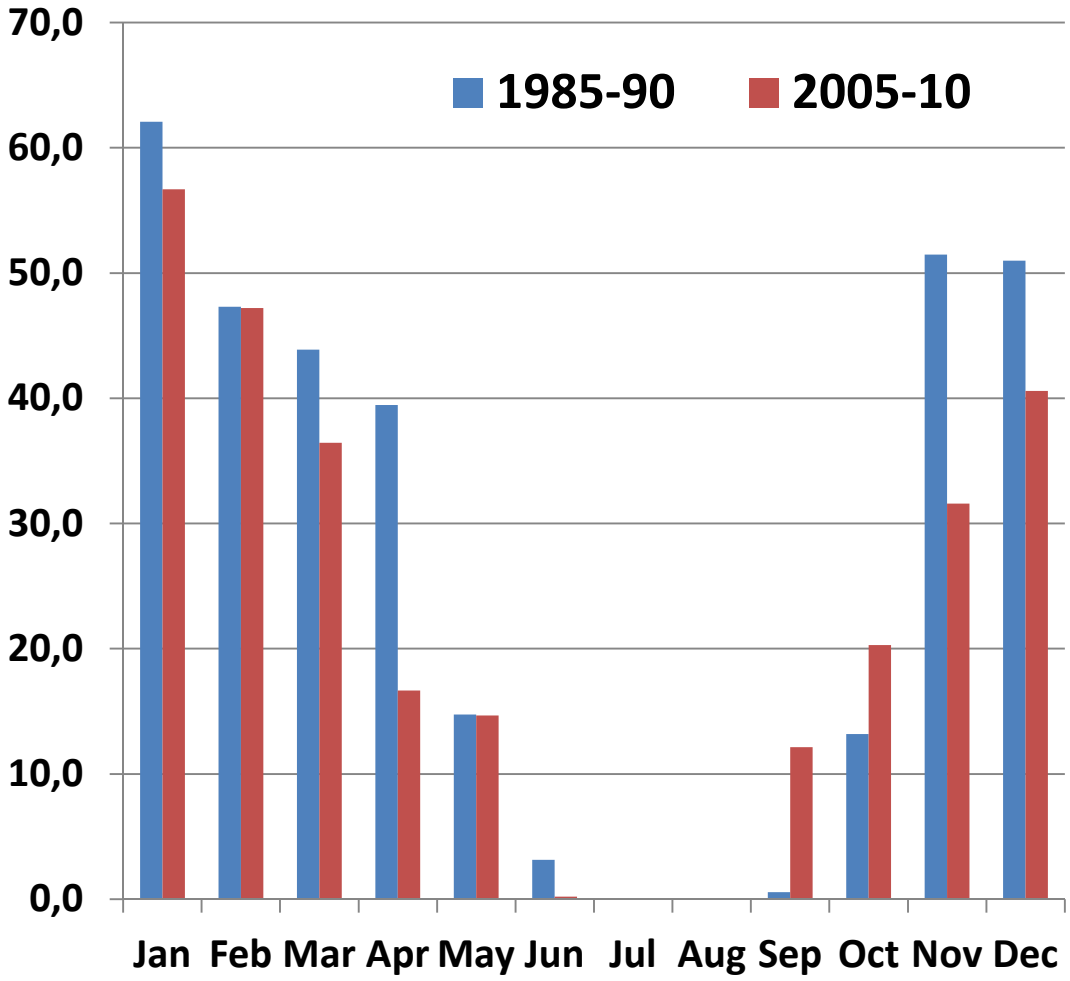
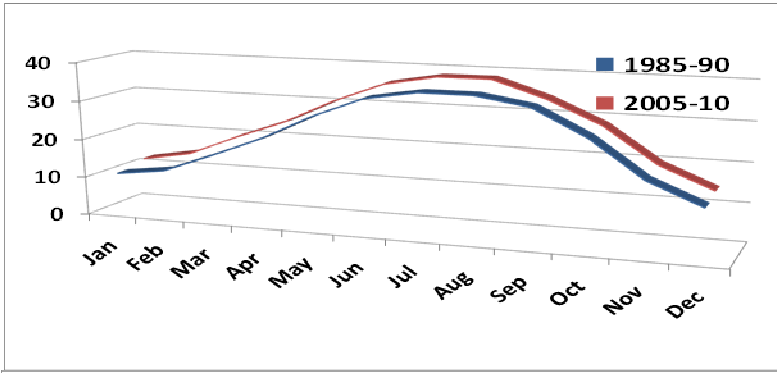
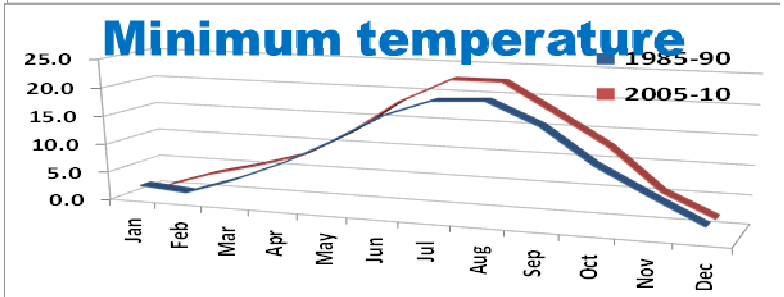
Mean Precipitation (mm) in Tel Hadya



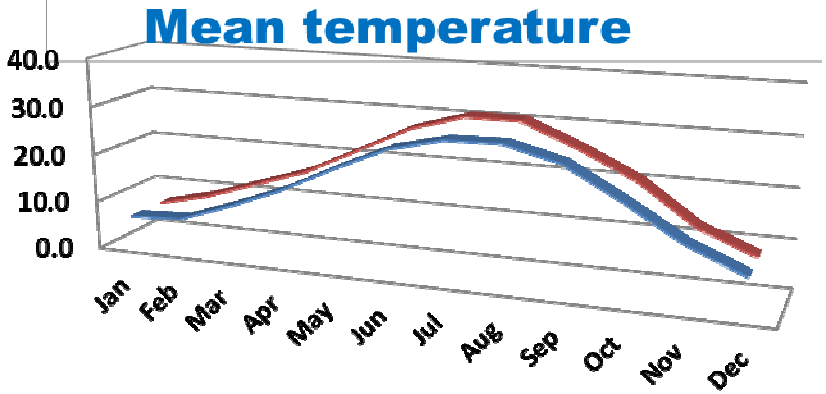
Maximum temperature



Minimum temperature

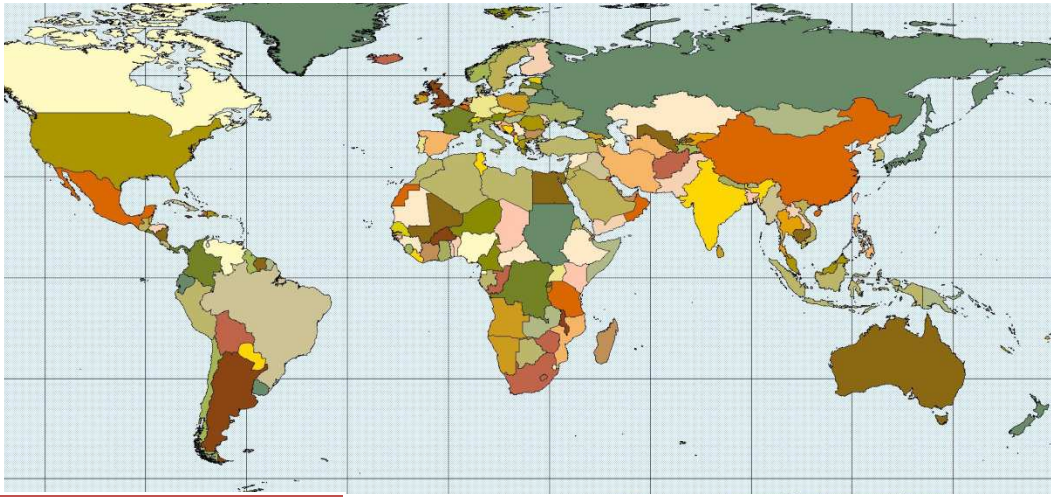


Mean temperature

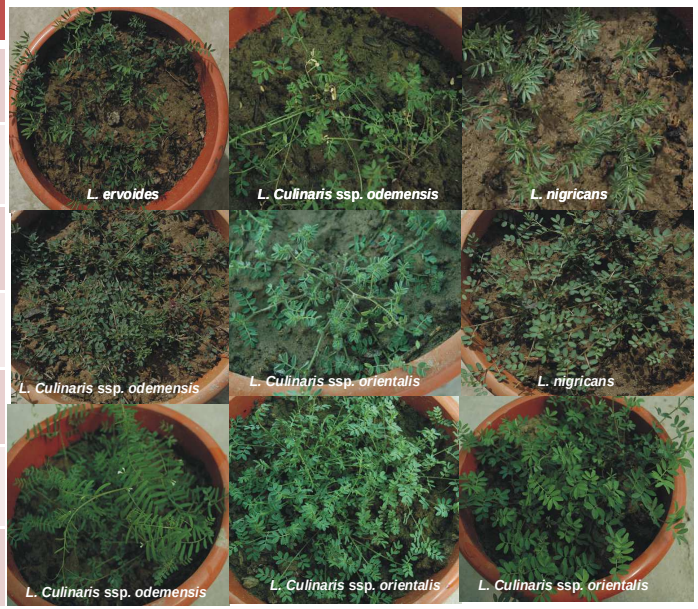


ICARDA – Global Germplasm Collection

Crop	Cultivated	Wild
Lentil	10,652	562
Chickpea	12,021	266
Faba bean	10,723	5,891



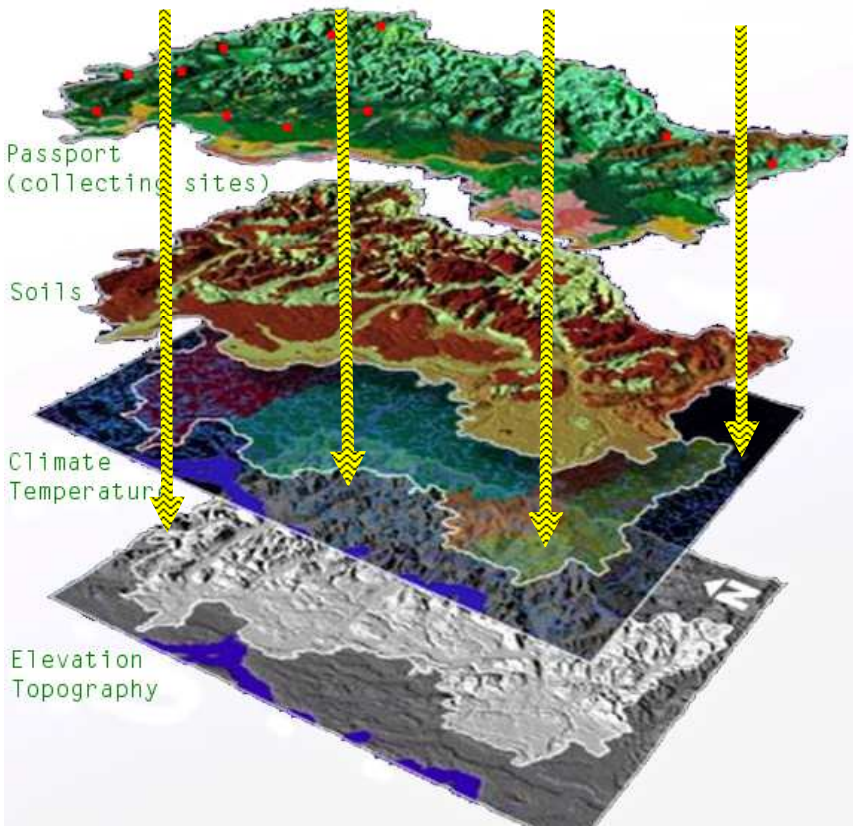
Species	Accession	Origin countries
Lens culinaris ssp. culinaris	10,417	78
L. culinaris ssp. odemensis	66	5
L. culinaris ssp. orientalis	259	15
L. culinaris ssp. tomentosus	21	2
L. ervoides	170	16
L. lamottei	10	3
L. nigricans	62	8



Linking Conservation with Utilization

Focusing on the 'Best Bet' Accessions

Link environmental data to collection sites



Adapted from D T F Endresen (NGB)

FIGS

- Focused
- Identification of
- Germplasm
- Strategy

Choose accessions from environments where selection pressure exists for adaptive traits to stress e.g. drought, heat, salinity.

For diseases and pests, select material from environments that favor high pest populations

Germplasm Screening

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FW and salinity screening in hydroponics


Wilt sick plots for Fusarium wilt


AB screening


Orobanche screening


Drought and heat screening


Cold screening

Breeding Scheme for Drought Tolerance

Screening and evaluation of germplasm (TH, Bread, Terbol S+W)

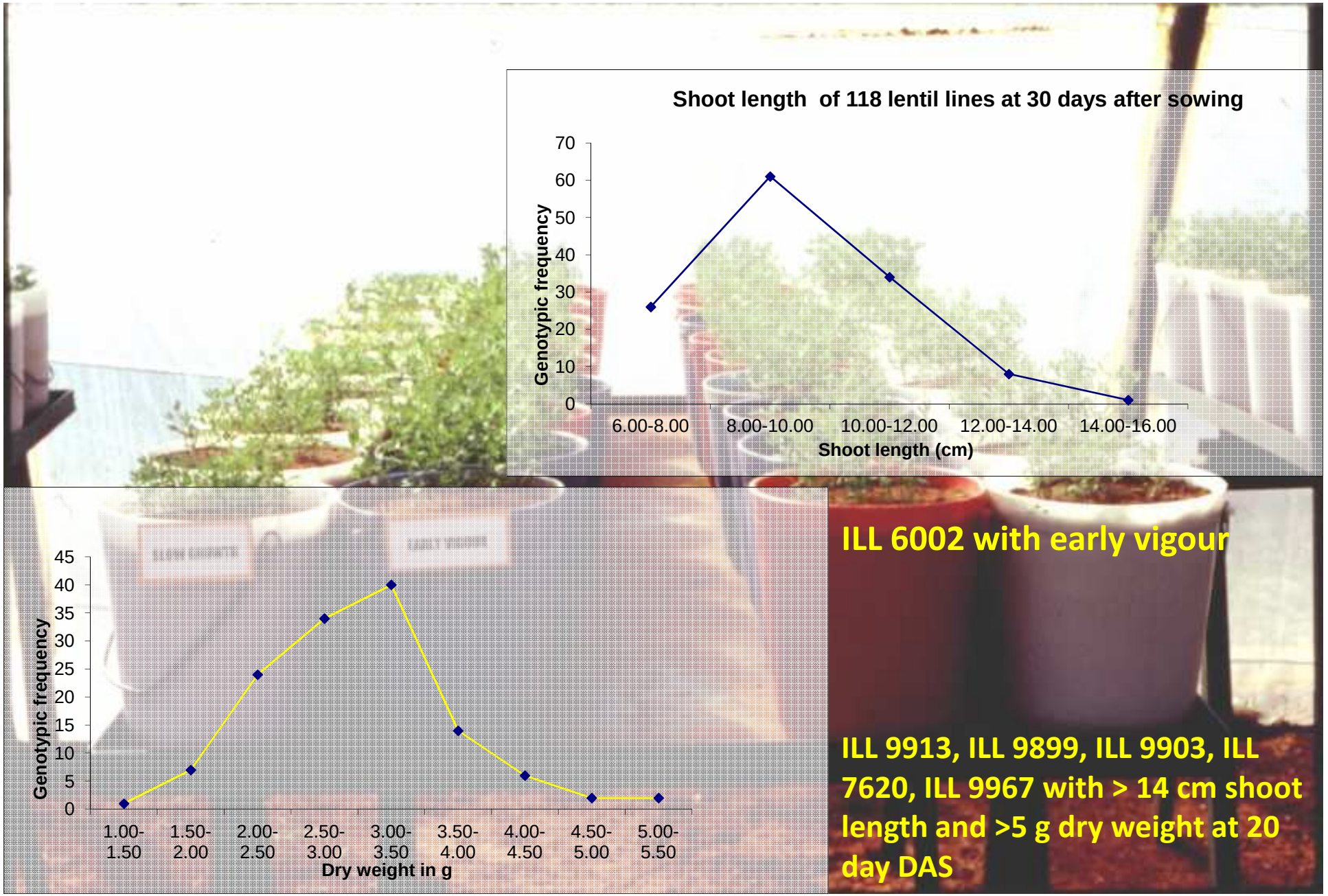
- **Donor** → • Hybridization
- **F1** → • Offseason at Terbol
- **F2-F3** → • Bulk populations
- **F4** → • SPS as pedigree
- **F5-F6** → • Progeny Selection and disease screening
- **F7-F8** → • multi-environment yield trials

International nurseries → **NARS evaluation** → **Variety Release**

Traits associated with Drought Tolerance

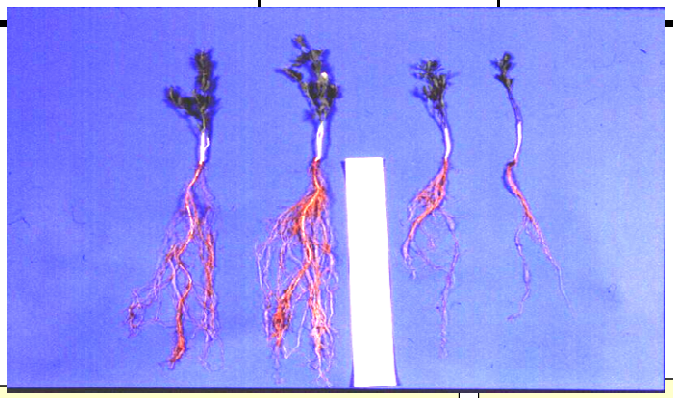
- Canopy temperature
- Stomatal Conductance
- Carbon isotope discrimination (^{13}C)
- Chlorophyll content and Chlorophyll Fluorescence
- Early flowering
- Early vigor
- Early maturity
- Root length
- Biomass/NDVI
- Yield and yield components

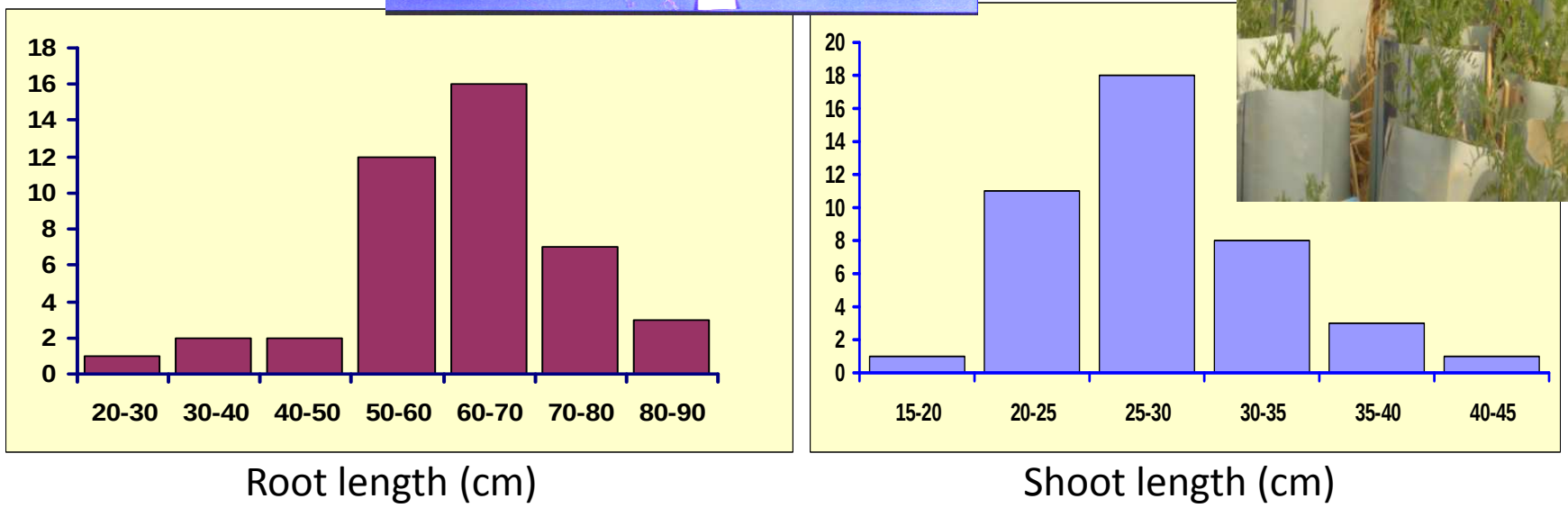
Evaluation of Lentil Germplasm for Seedling Vigor



Root and Shoot Length Variation in lentil

	Mean	Range
Root length (cm)	62.25	28.2 - 86.28
Shoot length (cm)	28.28	19.4 - 41.43

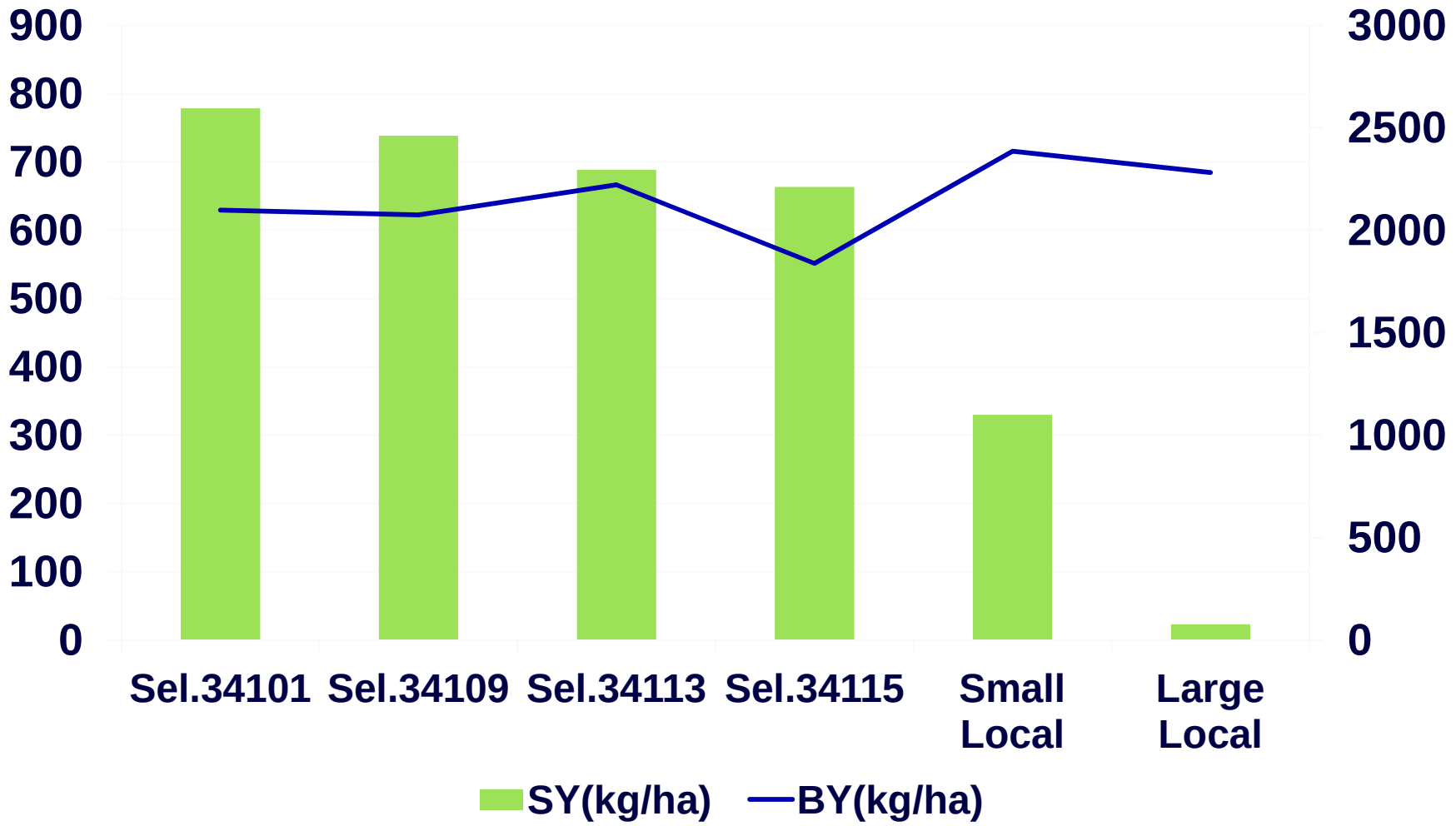




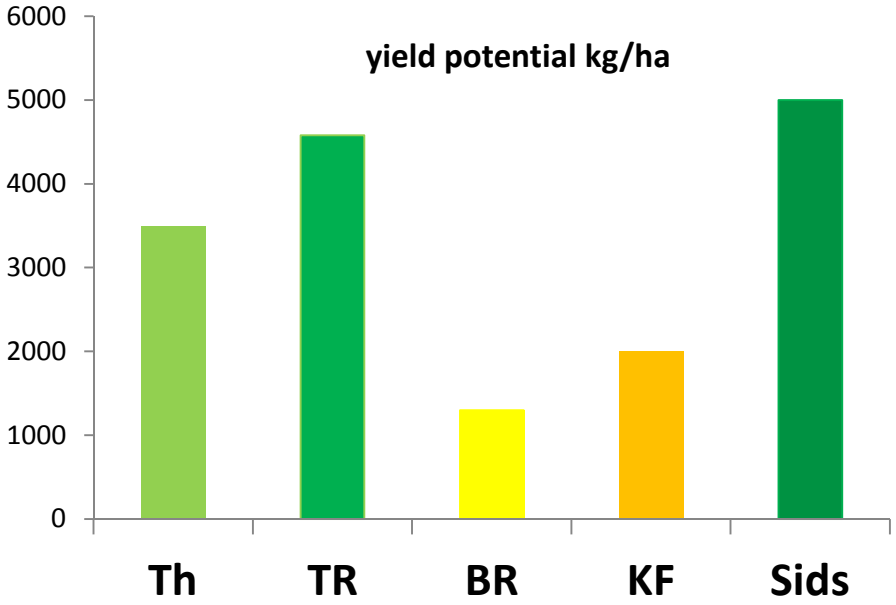
Earliness – Escaping the Drought

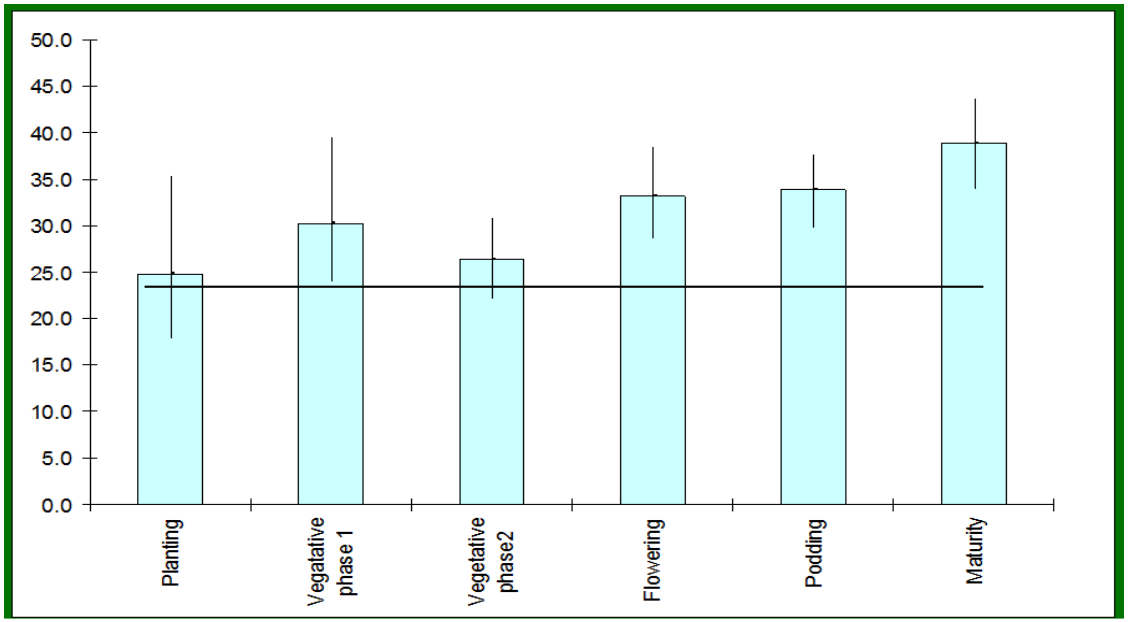
Yield of Drought Tolerant Lines

(173.6 mm rainfall)



Faba bean: drought tolerance





Early planting in faba bean – Drought Mitigation

Chickpea Variety Survived 2007 Drought in Turkey

Gokce is used on about 85% of the chickpea production areas (over 550,000 ha). With a yield advantage of 300 kg/ha over other varieties, and world prices over USD 1000/t, this represents an additional USD 165 million for Turkish farmers, in 2007 alone.

The Kabuli chickpea, 'Gokce', developed by ICARDA and Turkish national scientists, has withstood severe drought in Turkey and produced when most other crops failed in 2007.

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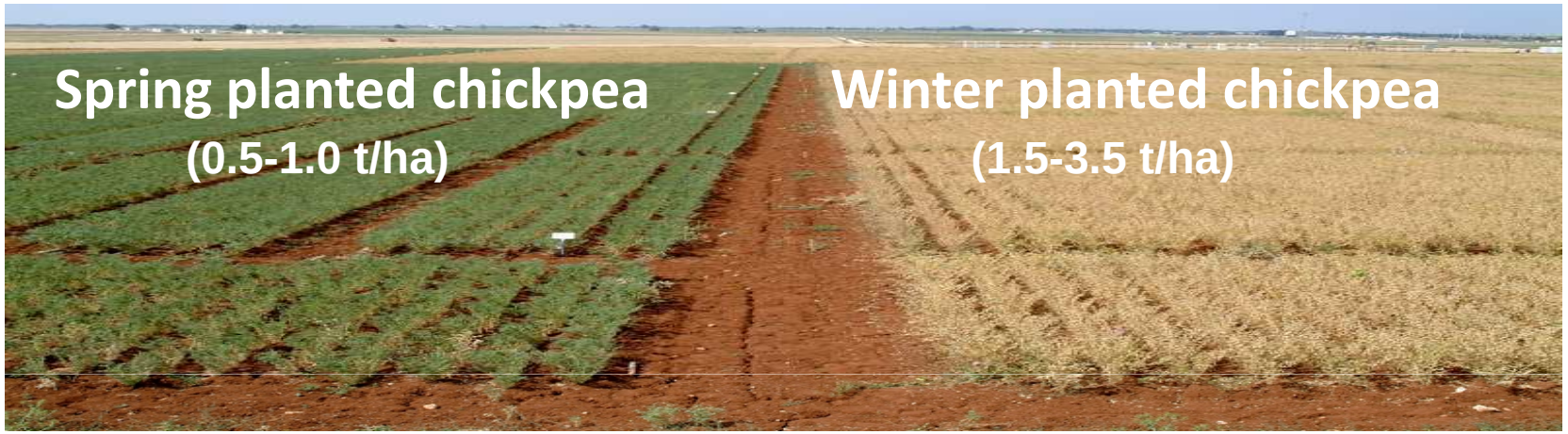
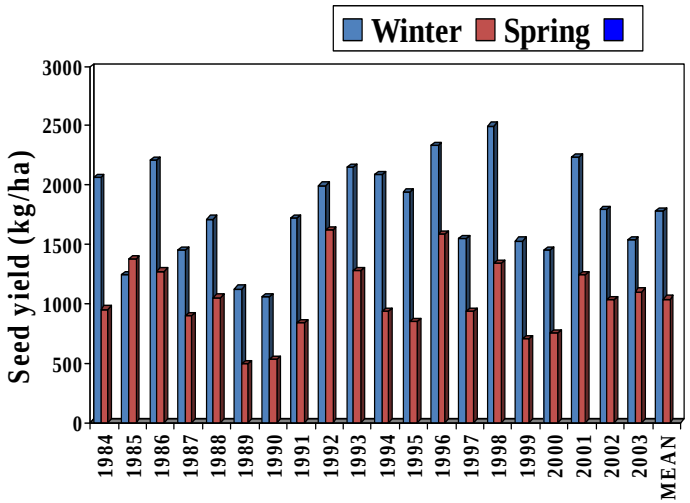
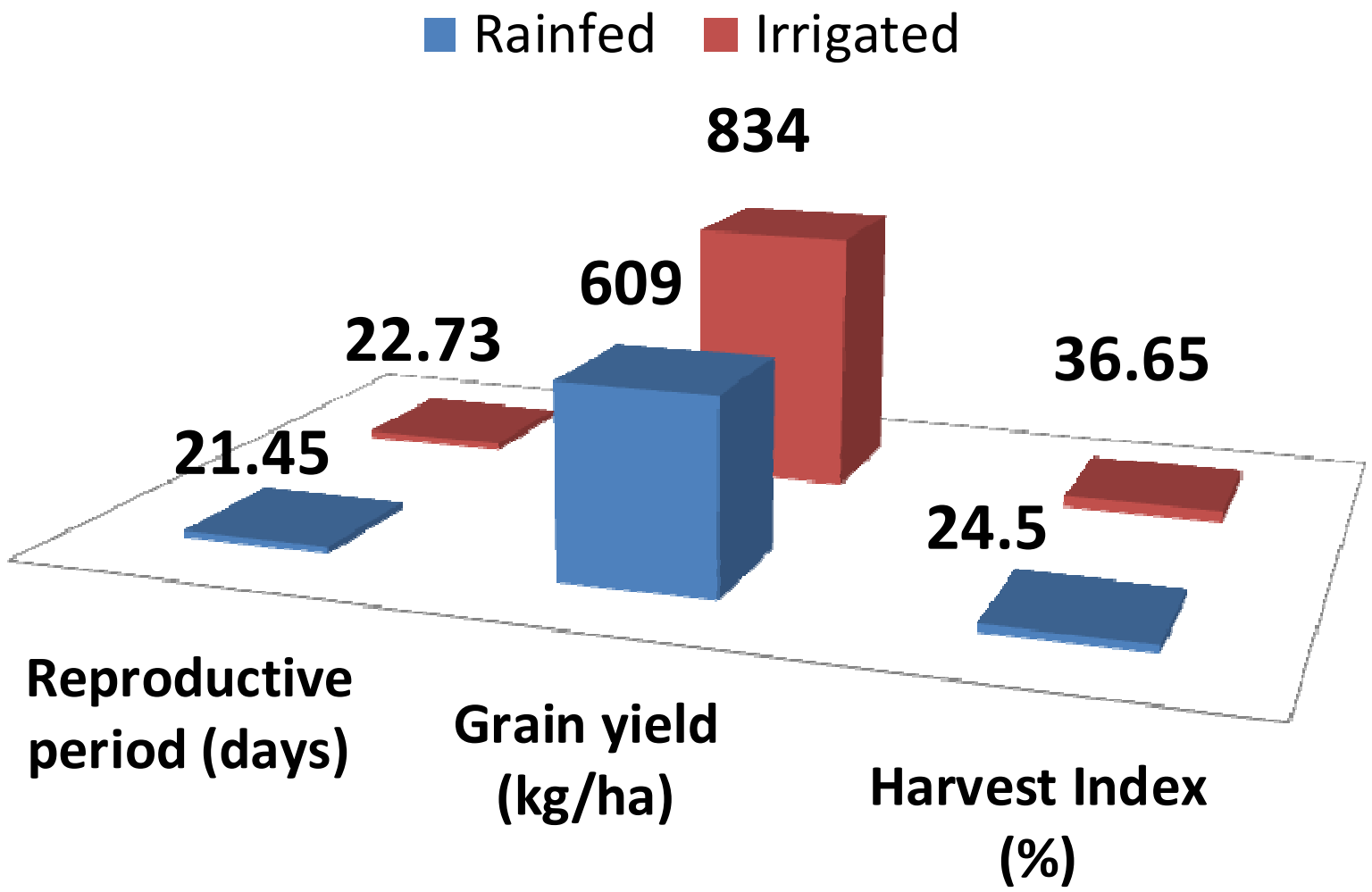
Winter Sowing of Chickpea



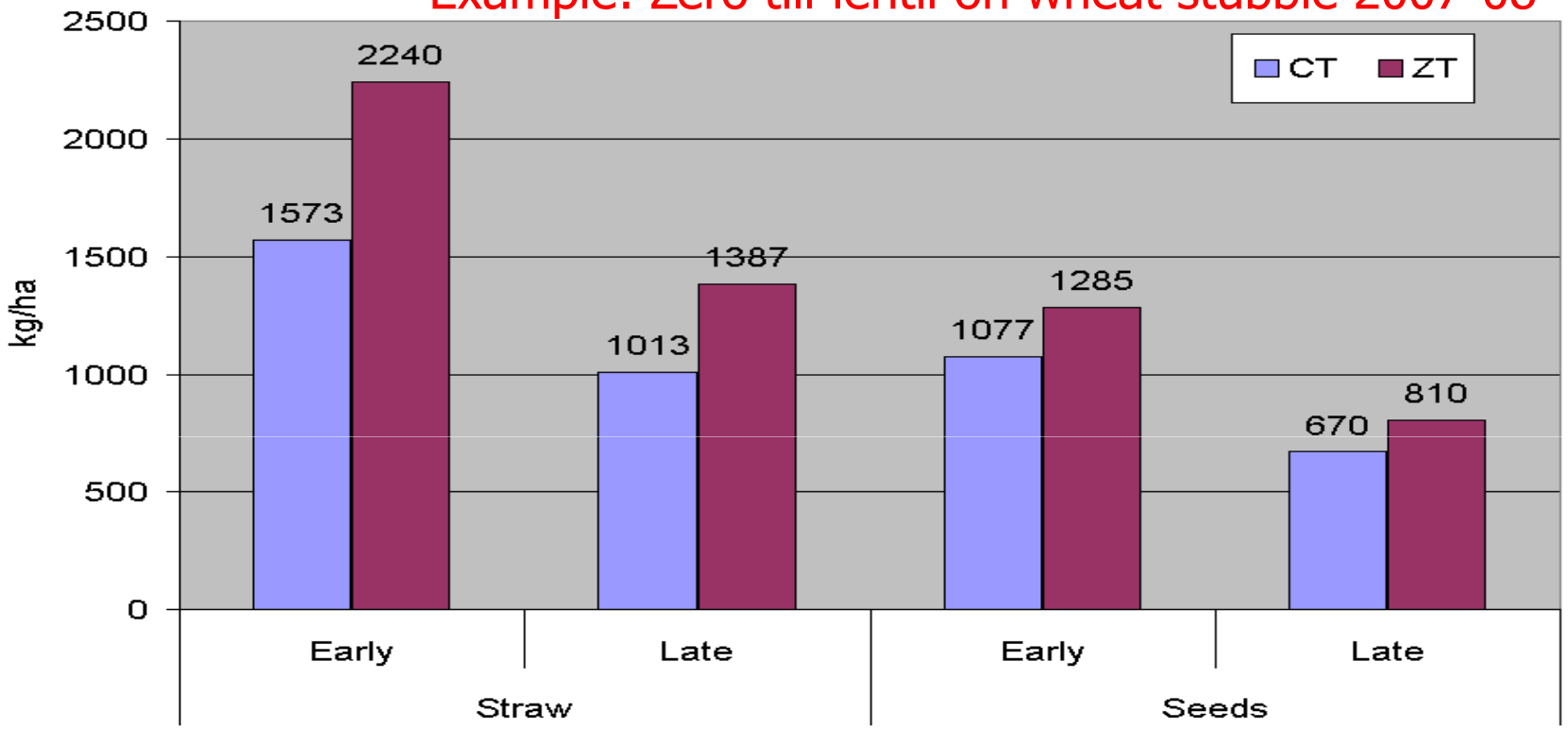


Supplemental Irrigation



Zero Tillage for Drought prone Environments

Example: Zero till lentil on wheat stubble 2007-08



<u>For straw and grain yield</u>

ZT > CT

Early > late planting

<u>Farmer practice</u>: CT, late sowing

670kg/ha

<u>Improved practice</u>: ZT, early sowing

1285kg/ha

Dissection of Drought Tolerance - a key method

Yield is too complex – particularly under different drought scenarios – for a direct association mapping study approach

- Need for targeting under controlled conditions less complex processes and traits genetically related to yield

Genetic variability of

- ***Physiological Processes****: transpiration, growth*
- ***Traits:*** *leaf growth/architecture, root architecture, seed abortion, water use efficiency*
- ***Yield, components***

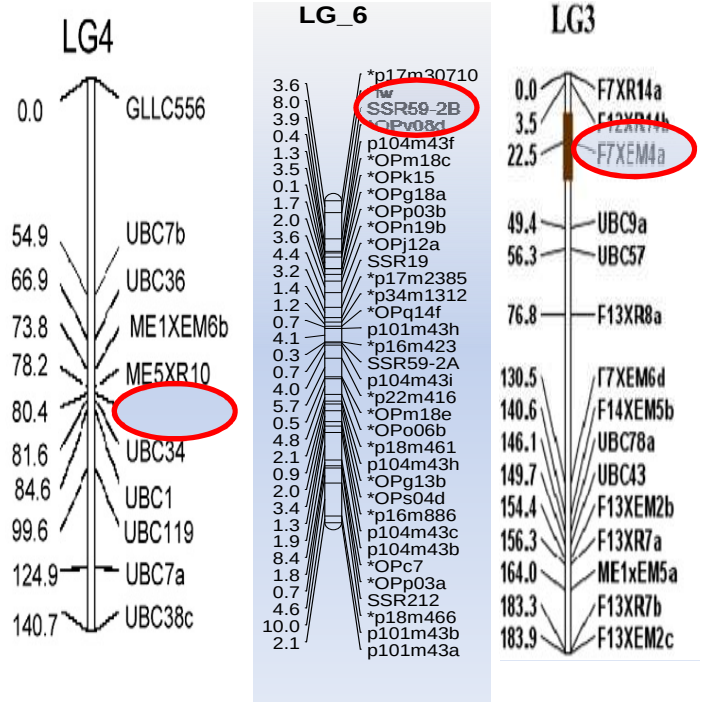
Biotechnology

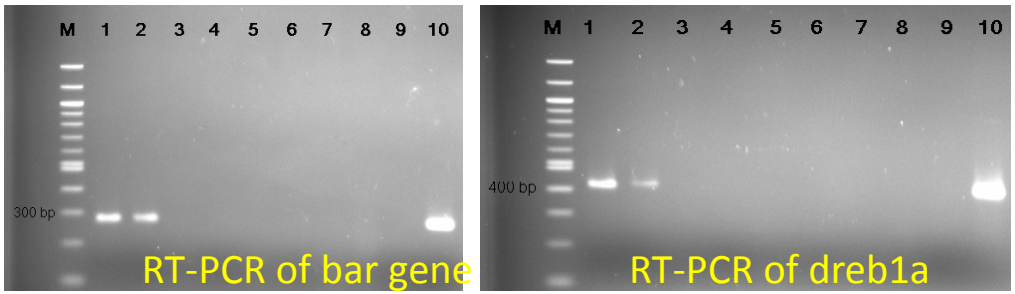
Molecular Breeding

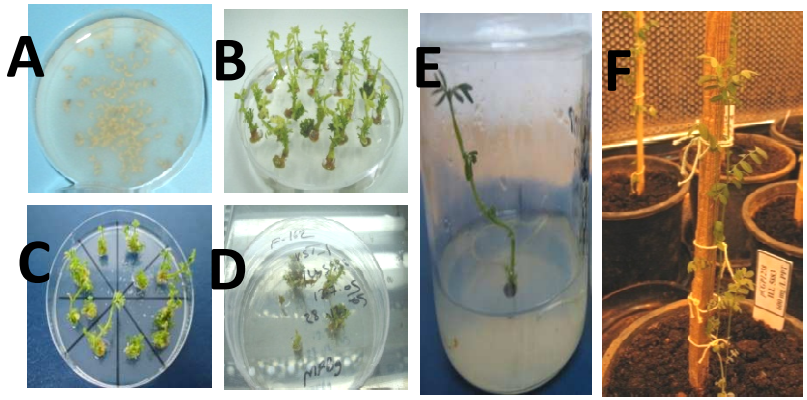
- Molecular markers technology
- Association mapping

Genetic engineering

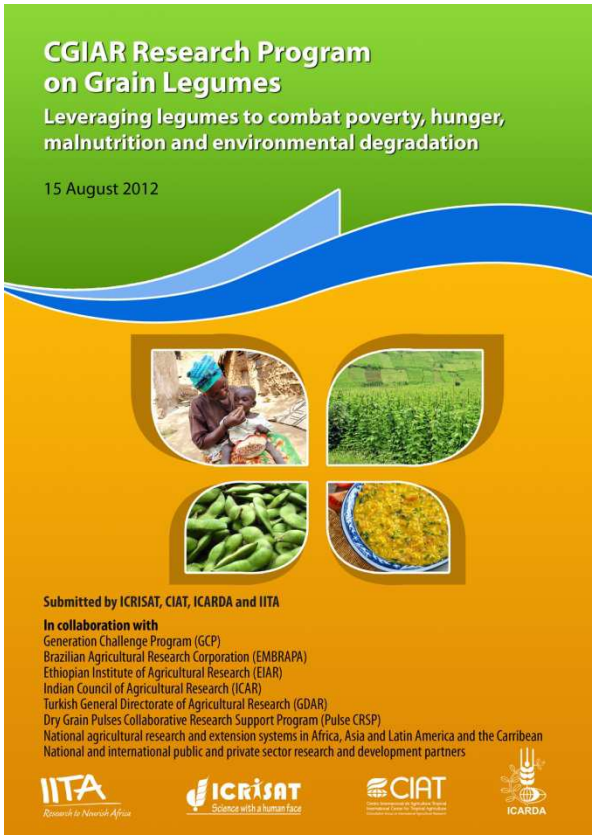
- Chickpea and lentil transformation for biotic and abiotic stresses







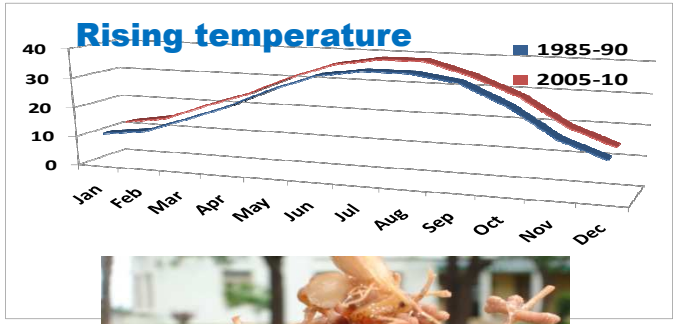
CGIAR Research Program On Grain Legumes



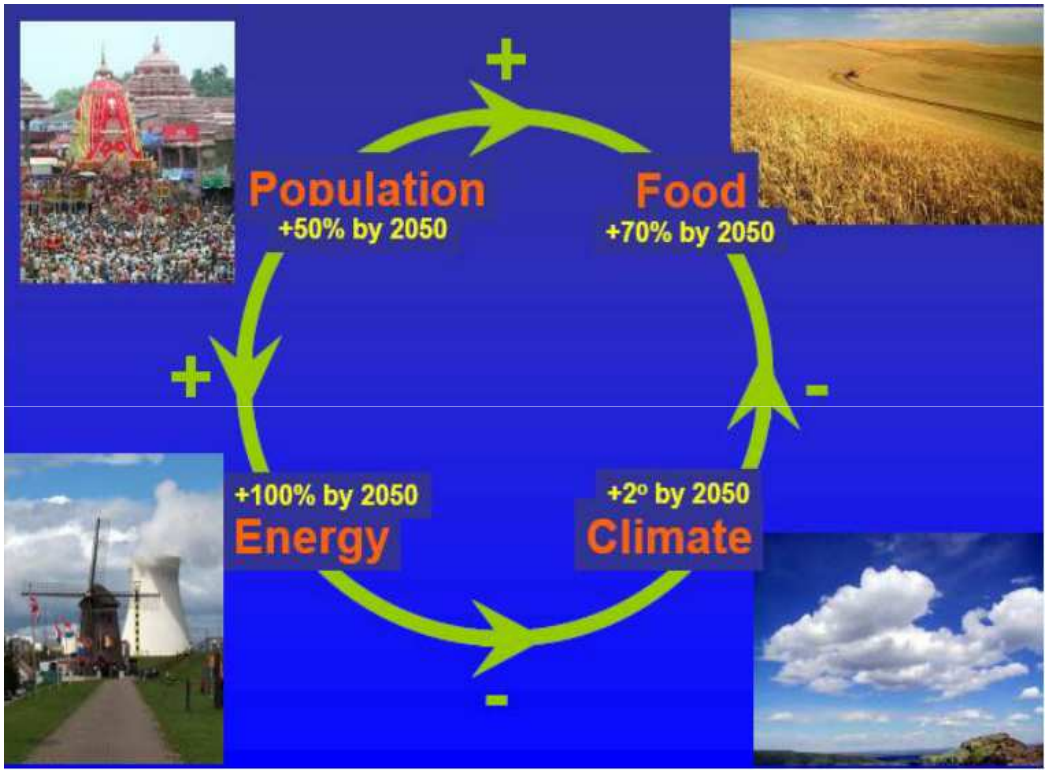
Discovery & deployment of traits/genes....

- Heat stress with terminal drought
- Biological nitrogen fixation
- Extra short duration
- Post-emergence herbicide tolerance
- Orobanche tolerance
- Machine harvestability
- Biofortification

In addition to key diseases and insect pests of the target region



This is required to meet the Great Challenges of Agriculture….



Growing world population will cause a "perfect storm" of food, energy and water shortages by 2030

Demand for food and energy will jump 50% by 2030 and for fresh water by 30%, as the population tops 8.3 billion

How to expand agricultural output without any extra burden on climate, and natural resources

There is an urgent need for crops and their varieties that use less water, fertilizers or other inputs

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Thank you