Pulses' Research/Development In India

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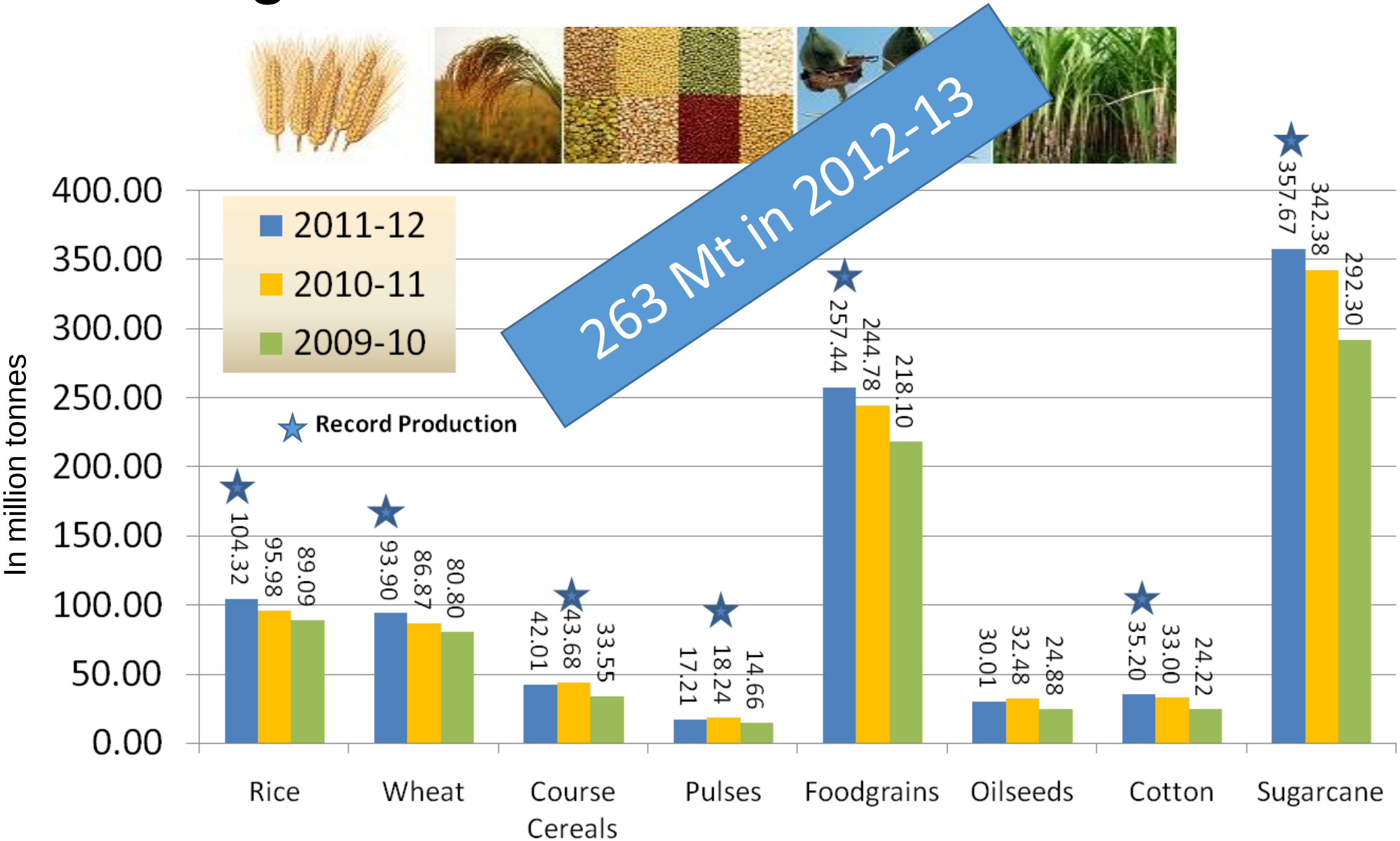
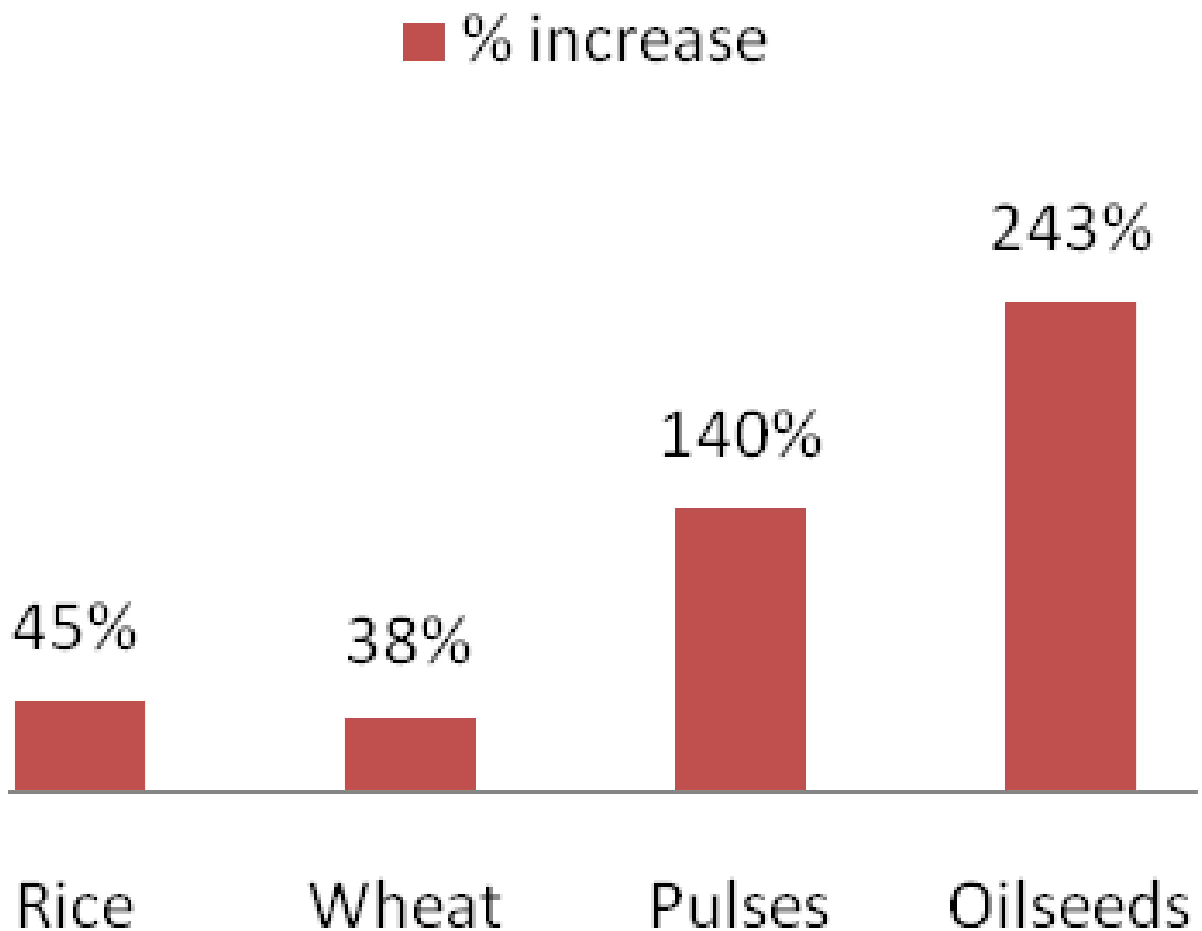
Record Agricultural Production



Source :
Directorate of Economics and Statistics, 4th Advance Estimates,
Cotton in Lakh bales of 170 kgs each

Food Grains Requirements: A Decade from Now, 2009-10 to 2020-21



(Source: MoA, 2010;)

Pulses

- 111 improved varieties
- 6000 demonstrations across the country
- Summer Moong of 60 days duration
- Short duration Pigeonpea
- Need Pod borer resistant GM Pigeon pea and Chick pea

> 17 mt-25 mt




Lentil: a nutritious grain legume

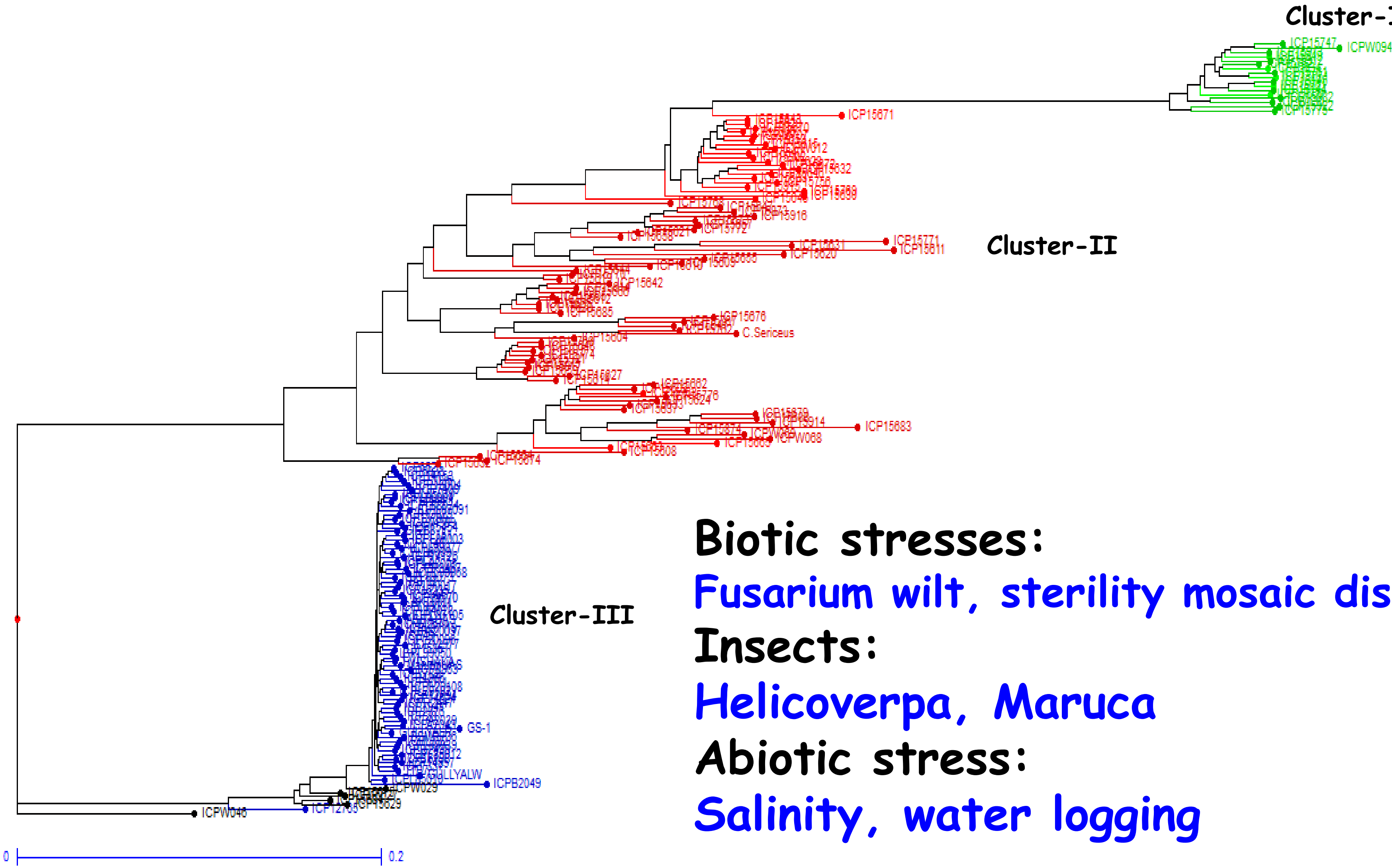
Protein	20-25%
Carbohydrate	50-60%
Fat	0.7-0.8%
Ca	60-70 mg/100g
Fe	7-8mg/100g
Folates	216-290µg/100g

Grain Legume	Folate (µg/100g)
Chickpea	**42-125**
Yellow field pea	**41-55**
Green field pea	**50-202**
Lentil	**216-290**

Status and Demand Projections of Different Commodity by 2020

Crops	1960-61		2009-10		2012-13			2020-21		AGR till 2010-21 (%)**
	Production (mt)	Yield (Kg/ha)	Production (mt)	Yield (Kg/ha)	Production (mt)	Yield (Kg/ha)	Present AGR (%)**	Production (mt)	Yield (Kg/ha)	
Rice	34.58	1013	80.09	2125	104.4	2462	9.8	125	2936	3.9
Wheat	11.00	851	80.80	2839	92.46	3119	4.8	98	3298	2.1
Maize	4.08	926	16.72	2024	22.23	2553	10.9	21	2468	2.6
Pearl Millet	3.28	286	6.51	731	8.74	1214	11.4	12	1441	8.4
Pulses	12.7	539	14.7	630	18.5	786	8.6	28	1100	9.0

Narrow genetic diversity; low productivity



Biotic stresses:
Fusarium wilt, sterility mosaic disease
Insects:
Helicoverpa, Maruca
Abiotic stress:
Salinity, water logging

Widening the genetic base

- **Pulses have narrow genetic base**
- **Pre breeding is required using exotic, landraces and wild species to create wide variability in terms of plant types, disease and pest resistance and abiotic stress tolerance**

Wild species of pigeonpea

Bold seeded lentil

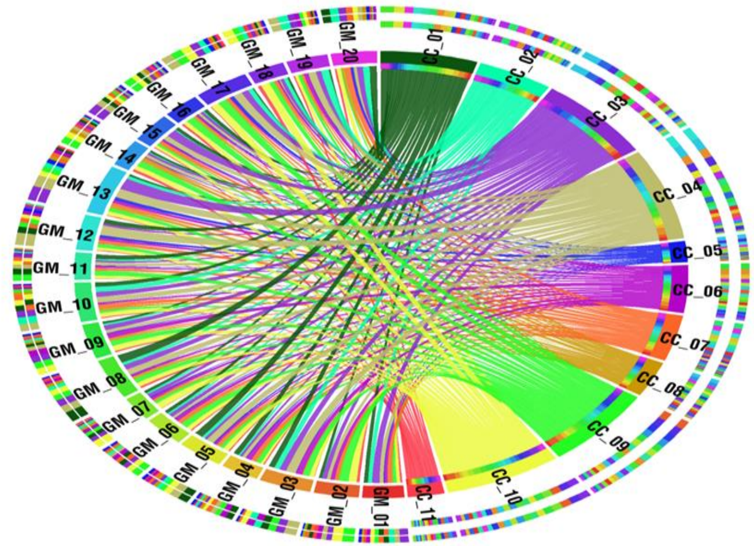
nature biotechnology
ARTICLES

Pigeonpea Genome Sequenced

Draft genome sequence of pigeonpea (*Cajanus cajan*), an orphan legume crop of resource-poor farmers

Rajeev K Varshney[1,2], Wenbin Chen[3], Yupeng Li[4], Arvind K Bharti[5], Rachit K Saxena[1], Jessica A Schlueter[6], Mark T A Donoghue[7], Sarwar Azam[1], Guangyi Fan[3], Adam M Whaley[6], Andrew D Farmer[5], Jaime Sheridan[6], Aiko Iwata[4], Reetu Tuteja[1,7], R Varma Penmetsa[8], Wei Wu[9], Hari D Upadhyaya[1], Shiaw-Pyng Yang[9], Trushar Shah[1], K B Saxena[1], Todd Michael[9], W Richard McCombie[10], Bicheng Yang[3], Gengyun Zhang[3], Huanming Yang[3], Jun Wang[3,11], Charles Spillane[7], Douglas R Cook[8], Gregory D May[5], Xun Xu[3,12] &
Scott A Jackson[4]

Pigeonpea is an important legume food crop grown primarily by smallholder farmers in many semi-arid tropical regions of the world. We used the Illumina next-generation sequencing platform to generate 237.2 Gb of sequence, which along with Sanger-based bacterial artificial chromosome end sequences and a genetic map, we assembled into scaffolds representing 72.7% (605.78 Mb) of the 833.07 Mb pigeonpea genome. Genome analysis predicted 48,680 genes for pigeonpea and also showed tl potential role that certain gene families, for example, drought tolerance–related genes, have played throughout the don of pigeonpea and the evolution of its ancestors. Although we found a few segmental duplication events, we did not obs recent genome-wide duplication events observed in soybean. This reference genome sequence will facilitate the identif the genetic basis of agronomically important traits, and accelerate the development of improved pigeonpea varieties th improve food security in many developing countries.



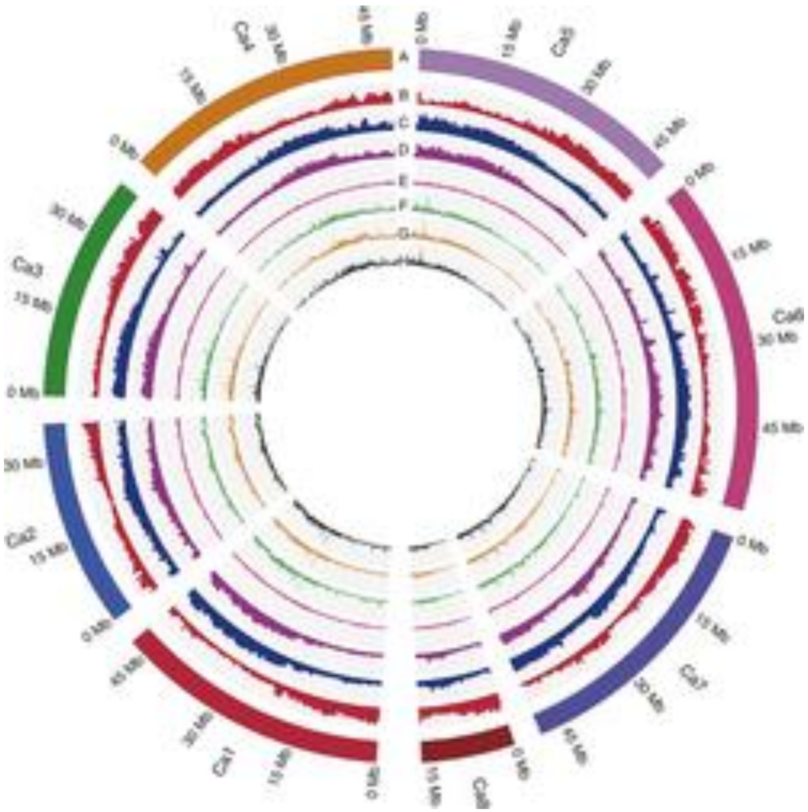
J. Plar
DOI 10.1007/s13562-011-0088-8

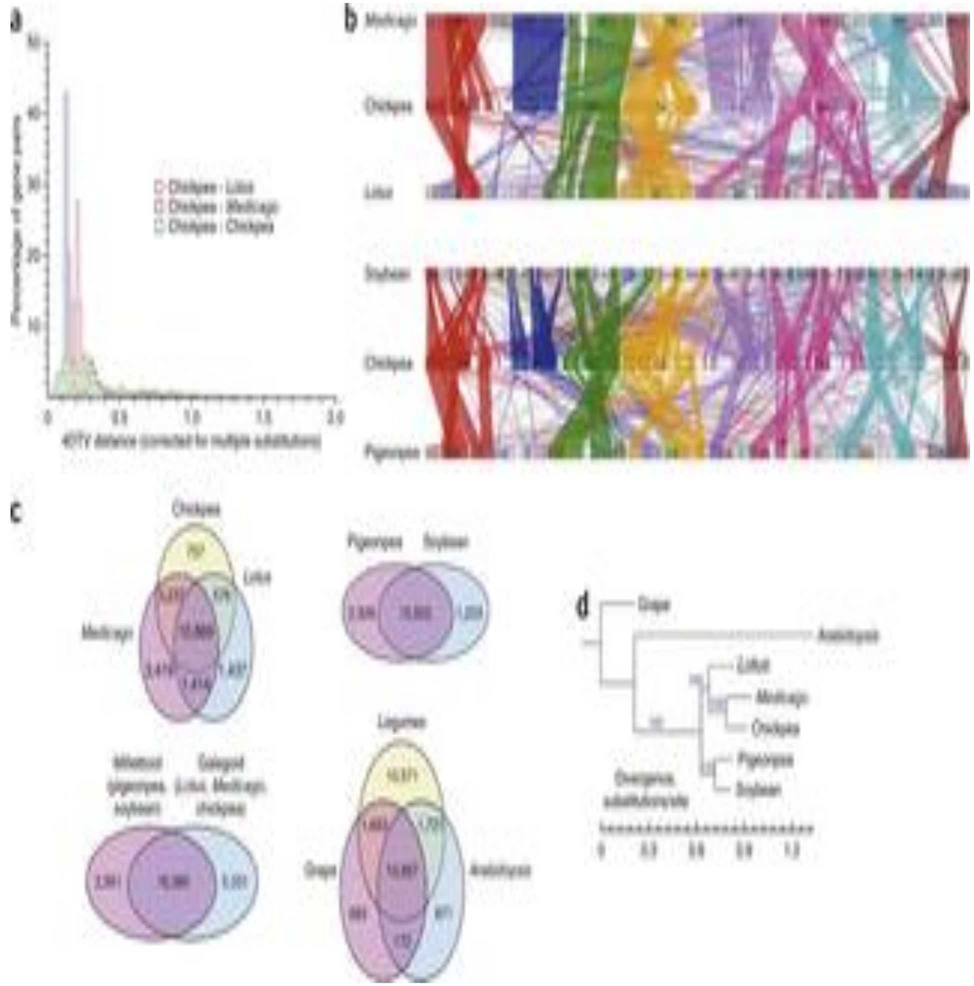
The first draft of the pigeonpea genome sequence

Nagendra K. Singh · Deepak K. Gupta · Pawan K. Jayaswal · Ajay K. Mahato · Sutapa Dutta · Sangeeta Singh · Shefali Bhutani · Vivek Dogra · Bikram P. Singh · Giriraj Kumawat · Jitendra K. Pal · Awadhesh Pandit · Archana Singh · Hukum Rawal · Akhilesh Kumar · G. Rama Prashat · Ambika Khare · Rekha Yadav · Ranjit S. Raje · Mahendra N. Singh · Subhojit Datta · Bashasab Fakrudin · Keshab B. Wanjari · Rekha Kansal · Prasanta K. Dash · Pradeep K. Jain · Ramcharan Bhattacharya · Kishor Gaikwad · Trilochan Mohapatra · R. Srinivasan · Tilak R. Sharma

Received: 2 July 2011 / Accepted: 7 October 2011

Draft genome sequence of chickpea (*Cicer arietinum*) provides a resource for trait improvement
Varshney et al 2012 NATURE BIOTECHNOLOGY

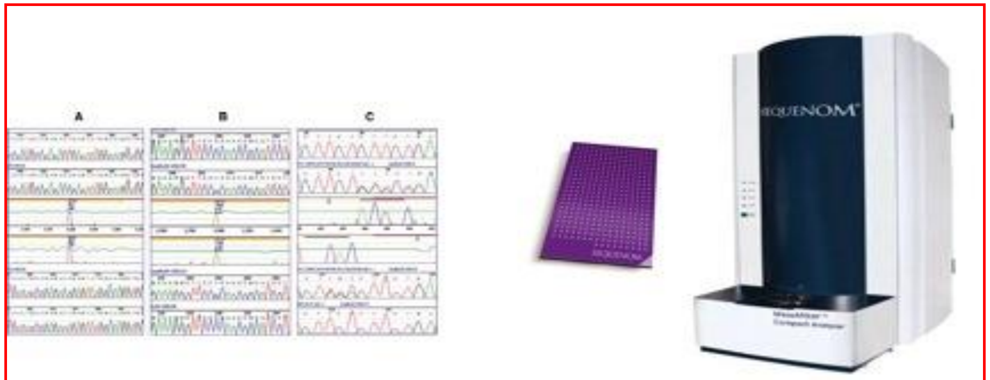




10,000 rice genome is being sequenced at BGI by IRRI + partners

Emerging Technologies

- Whole genome sequencing of lentil, mungbean and urdbean
- Next Generation sequencing for enriching molecular markers (SNP & SSR markers) in pluses
- Development of high throughput genotyping facilities and phenotyping platforms
- Development of markers associated with desirable traits and their use in marker assisted breeding
- Transgenics in pigeonpea and chickpea
- Microarrays or DNA chips and transcriptome analysis (for identification of the network of genes underlying the agronomically important traits)
- Strengthening tissue culture facilities for harnessing alien genes through pre breeding



Making Pre-breeding functional

- Understanding the value of PGR
- Pre-breeding 1:
  - Base broadening
  - Wide hybridization

  Pre-breeding 2:
  - Gene discovery: genotyping, phenotyping, GWAM

  Economic incentive: Traditional/Perception/HYV-VA

  Feel good nature-appeal /Exploitation/Trade-off
  - Benefit sharing

Germplasm Characterisation and Evaluation

Priority crops : 15 (58% of total holding)

Wheat 22,000 accs., CCSHAU, Hissar

Chickpea 18,500 accs., MPKV, Rahuri

Source: NBPGR, Pusa campus, New Delhi

Priority crops

- Rice
- Wheat
- Maize
- Finger millet
- Pearl millet
- Sorghum
- Chickpea
- Pigeonpea
- Rapeseed mustard
- Brinjal
- Okra
- Cucumber and Melons
- Mango
- Citrus
- Banana

Share of Indian Pulses in Global Production

- **India's contribution in total global pulse production is 25% followed by China (2.97%), Brazil (2.76%), Canada (2.49 %)**
- **Contribution of beans (dry) is 34% followed by chickpea (17%), cowpea (14%) and peas (dry) (14 %)**
- **Pigeonpea, lentil and cowpea contribute approximate 7% each and contribution of other pulses is 14%.**


Chickpea


Pigeonpea


Mungbean


Urdbean


Lentil

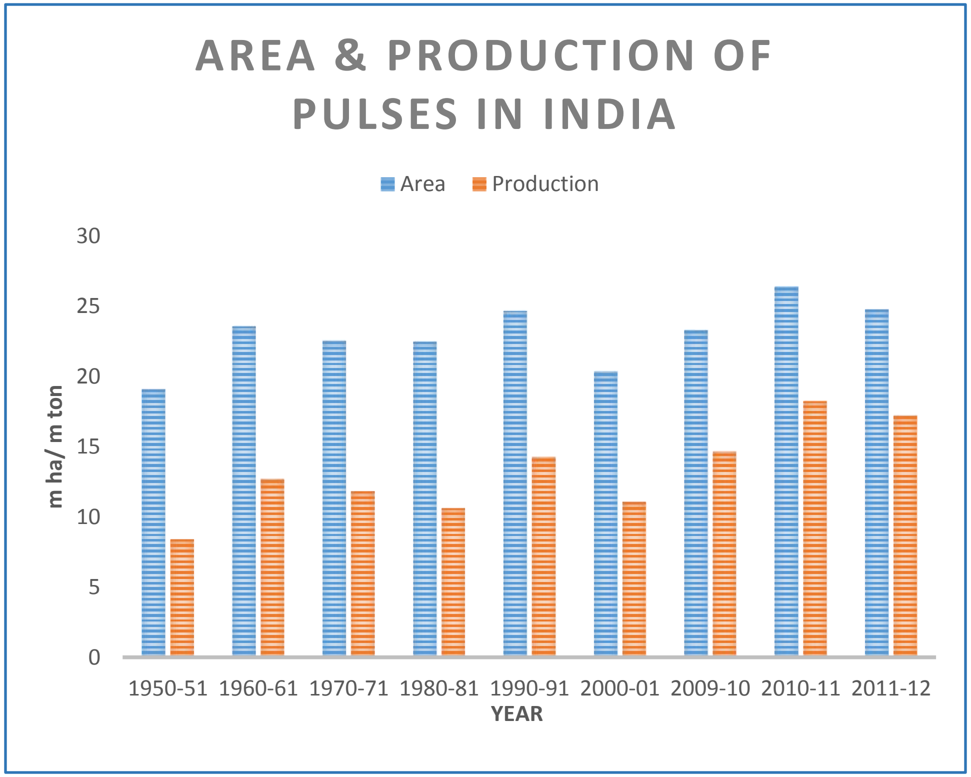

Lathyrus

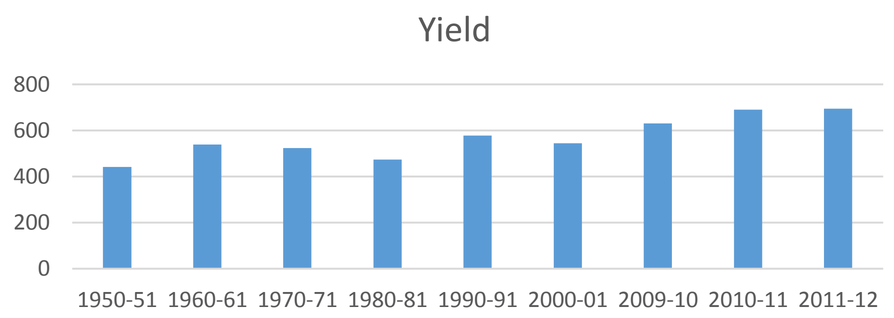

Rajmash

Fieldpea

Area, Production & Yield of Pulses in India

Year	Area (m. ha)	Production (m.ton)	Yield (Kg/ha)
1950-51	19.09	8.41	441
1960-61	23.56	12.7	539
1970-71	22.54	11.82	524
1980-81	22.46	10.63	473
1990-91	24.66	14.26	578
2000-01	20.35	11.08	544
2009-10	23.28	14.66	630
2010-11	26.40	18.24	691
2011-12	24.78	17.21	694
2012-13	-	18.45	-





Government Programmes for Pulses' Development in India

1970 : National Pulses Development Programme

1991 : Technology Mission on Oilseeds & Pulses

2004 : Integrated Scheme on Oilseeds, Pulses, Oil palm & Maize (ISOPOM)

2007 : National Food Security Mission

2010 : Accelerated Pulses Production Programme

Varieties of Pulses for specific attribute: Short duration

CHICKPEA (DESI): DCP 92-3, JG 11, JG 14

CHICKPEA (KABULI): IPCK 2002-29, IPCK 2004-29, KAK-2

LENTIL: IPL 81, JL 3, KLS 218, WBL 77

FIEDPEA: IPF 99-25, AMBIKA

PIGEONPEA: UPAS 120, PUSA 992

MUNGBEAN: SAMRAT, MEHA, IPM 02-3, PUSA VISHAL, PM 5, HUM 16

URDBEAN : PDU -1, WBU -109, PANT U 31, KU 92-1






Challenges for pulses in India

- Decline in area of Pulses in Indo-Gangetic Plains (IGP)
- Low genetic yield potential
- Low realized yield
- Instability in production
- Climate change
- Biotic and abiotic stresses
- Poor seed replacement rate
- Post harvest losses
- Wide fluctuation in price
- No regular MSP/procurement policy
- Poor availability of critical inputs in productivity zone
- Poor transfer of technology

General plant ideotype in pulses

- **Erect and upright habit**
- **Determinacy**
- **Early growth vigour, early flowering and synchronous maturity**
- **Average plant height**
- **Pod bearing from well above the soil surface for mechanical harvesting**
- **More pods/plant and increased number of seeds/pod**
- **High harvest index**
- **Yield stability**




Genetic enhancement for yield and quality

- Vast genetic resources would require to be used for development of new plant types for different agro climatic zones.
- Wider adaptation is rare in pulses;
- Conventional breeding needs to be focussed on development of high yielding varieties with wider adaptation, minimizing anti-nutritional factor and enhancing nutritive values of the pulses
- Breeding for low neurotoxic compounds in lathyrus essential for enhancing areas under pulses.
- Biofortification and bioavailability of iron (Fe) and zinc (Zn) from specific pulses and enriching sulphur-rich amino acids methionine and cystine in the grains



Development of Integrated crop management module

Biotechnological approaches for improving host plant resistance to insects:

Host plant resistance is one of the most economic means of controlling insect pests. However, only low to moderate levels of resistance have been observed in the cultivated germplasm for Helicoverpa in chickpea and pigeonpea, Therefore, it is important to increase the levels of resistance to these insects introgression of resistance genes from the wild relatives of crops, marker assisted selection, genetic engineering, and pyramiding of resistance genes using molecular approaches.

Integrated Pest Management:-

Diseases and pests are wide spread in pulses which include fungal, viral, nematodes and insects. Chemical control for management is hazardous for human health. Therefore, an integrated approach is required to control the problems. Integrated pest management involves the use of alternative techniques and options that are available and help keep the pest population below economic threshold level (ETL); this approach recommends use of chemicals as a last option for pest control.

Yellow mosaic disease

Wilt disease

Root-knot gall

Natural predators

Pheromone trap

Climate Risk management

Terminal drought and heat stress have become serious problems in winter pulses particularly coinciding with reproductive phase. Both stresses combined together are responsible for about 40% yield reduction or more depending upon the severity of the stress level. Large scale screening of germplasm for heat tolerance and drought is underway to address the anticipated rise in temperature and water scarcity. Besides genetic option, appropriate management practices are being evolved to mitigate the adverse effect of drought and heat.

Heat sensitive

Heat tolerant

Reducing post harvest loss

Enhancing milling efficiency is one of the major issues to reduce the post harvest yield loss. Besides this, efforts would be made towards exploitation of genetic variability for milling characteristics and resistant to stored grain pests, development of efficient harvest and threshing machine, design and development of efficient dhal mills and development of improved technologies for storage.

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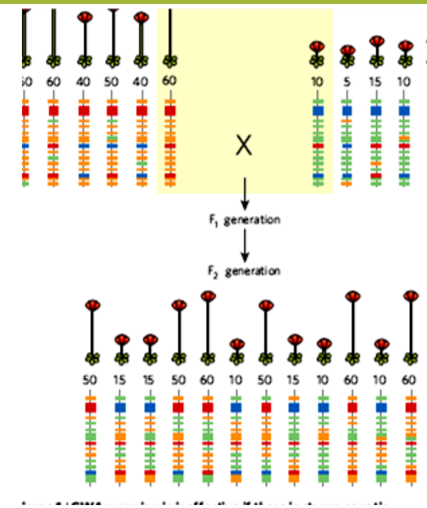

Next-generation genetics in plants

Magnus Nordborg[1] & Detlef Weigel[2]

Natural variation presents one of the fundamental challenges of modern biology. Soon, the genome sequences of thousands of individuals will be known for each of several species. But how does the genotypic variation that will be observed among these individuals translate into phenotypic variation? Plants are in many ways ideal for addressing this question, and resources that are unmatched, except in humans, have now been developed.

XII Plan Priorities

- **Development of photo thermo insensitive varieties**
- **Development of transgenics against gram pod borer in chickpea and pigeonpea**
- **Exploitation of heterosis in pigeonpea**
- **Integrated approach for genetic enhancement through pre-breeding**
- **Genomics-enabled pulse crops improvement**
- **Breeding for tolerance to drought & temperature extremities**
- **Efficient plant architecture in major pulse crops**
- **Development of Integrated crop management module**
- **Crop modeling for mitigating climate change**
- **Bio-fortification of grain legumes**


Thank you