



Recent Highlights in Crop Research

Tropical Legumes

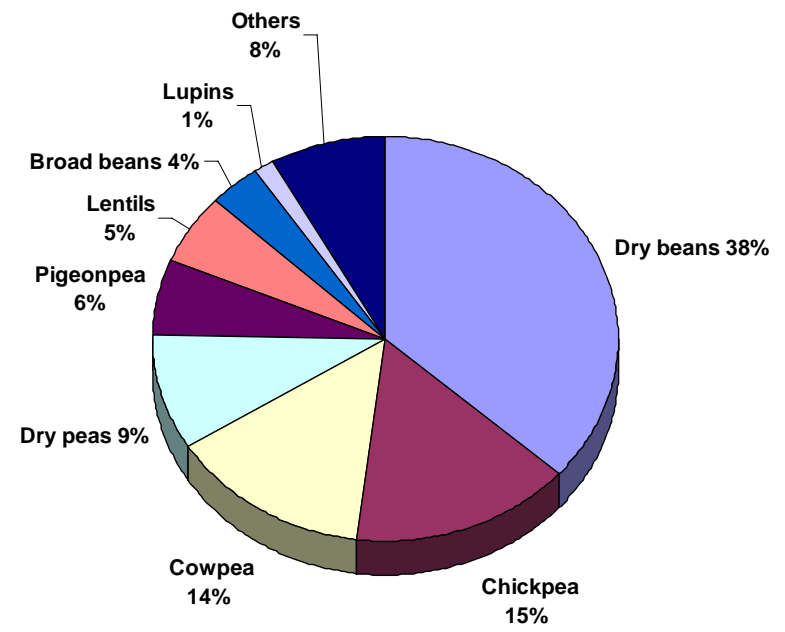
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Tropical legumes



- Common bean (*Phaseolus vulgaris*)
- Chickpea (*Cicer arietinum*)
- Cowpea (*Vigna unguiculata*)
- Groundnut/peanut (*Arachis hypogaea*)
- Pigeonpea (*Cajanus cajan*)
- Soybean (*Glycine max*)





Grain legumes



- Major sources of protein for the poor
- Role in nitrogen fixation
- Recycling of nutrients
- Increased water-use efficiency
- Crop diversification (avoid cereal monocropping)
- Sustainability of production systems



Grain legumes in developing countries



- Global grain legume area = 71.8 M ha
- Major share grown in tropical and sub-tropical countries
- 76% of legumes grown in Asia (50%) and SSA (26%)
- Legumes contribute 1/3 of human dietary protein
- Productivity of legumes low compared to cereals
- Legumes pushed to marginal lands leading to low productivity
- Per capital availability of legumes reduced drastically



Constraints to legume production



- Drought and marginal soils
- Diseases and pests
- Access to improved varieties
- Appropriate crop management
- Availability of quality seed of improved varieties



Regional priorities (from Tropical Legumes II)



Constraint	Regional Importance & Priority Research		
	S. Asia	ESA	WCA
<u>Groundnut</u>			
Abiotic:			
Drought	***	**	***
Salinity	**	-	-
Diseases:			
Aflatoxin	***	***	***
Foliar diseases (Rust, ELS, LLS)	***	***	**
Rosette	-	***	***
Bud necrosis	**	-	-
Pests:			
Spodoptera	**	*	-
Leaf miner	**	**	-
Termites	*	*	**
<u>Chickpea</u>			
Abiotic:			
Drought	***	***	-
Cold tolerance	**	*	-
Salinity	**	*	-
Diseases:			
Fusarium wilt	***	***	-
Ascochyta blight	**	-	-
Botrytis gray mold	**	*	-
Pests:			
Helicoverpa pod borer	***	***	-
Bruchids	**	**	-
<u>Pigeonpea</u>			
Abiotic:			
Drought	***	*	-
Salinity	*	-	-
Diseases:			
Fusarium wilt	***	***	-
Sterility mosaic disease	***	***	-
Pests:			
Helicoverpa pod borer	***	***	-
Pod fly	**	**	-
Maruca	**	**	-
Pod sucking bug	*	***	-
Bruchids	**	**	-

Constraint	Regional Importance & Priority Research		
	S. Asia	ESA	WCA
<u>Beans</u>			
Abiotic:			
Drought	**	***	***
Low soil fertility	*	***	***
Diseases:			
Mosaic (BCMV/BCMNV) ⁴	**	**	**
Angular leaf spot	**	***	***
Bacterial blight	*	**	**
Rust	*	**	***
Pests:			
Bean fly	***	***	*
Bruchids	**	**	**
<u>Cowpea</u>			
Abiotic:			
Drought	**	***	***
Heat stress	*	***	***
Poor soil fertility (low P & low micronutrients)	*	*	**
Diseases:			
Mosaic virus (BIMV, CABMV, CPMV)	*	-	**
Bacterial blight	**	-	***
Pests:			
Flower thrips	-	-	***
Pod sucking bugs	-	-	***
Aphids	***	-	***
Maruca	**	-	***
Bruchids	***	-	***
Parasitic weeds:			
<i>Striga</i> spp	-	-	***
<i>Alectra</i> spp	-	-	***
<u>Soybean</u>			
Abiotic:			
Drought	**	***	***
Heat stress	*	***	***
Poor soil fertility (low P & low micronutrients)		***	***
Diseases:			
Frog-eye leaf spot	*	**	**
Bacterial pustule	*	***	***
Bacterial blight	*	**	**
Mosaic virus	*	**	***
Soybean rust	***	***	***
Pests:			
Pod sucking bug	***	***	**
Aphids	**	**	**
Bean fly	**	**	*
Bruchids	*	*	*



Regional priorities - Abiotic

(from Tropical Legumes II)



Constraint	Regional Importance & Priority Research		
	S. Asia	ESA	WCA
<u>Groundnut</u>			
Drought	***	**	***
Salinity	**	-	-
<u>Chickpea</u>			
Drought	***	***	-
Cold tolerance	**	*	-
Salinity	**	*	-
<u>Pigeonpea</u>			
Drought	***	*	-
Salinity	*	-	-
<u>Beans</u>			
Drought	**	***	***
Low soil fertility	*	***	***
<u>Cowpea</u>			
Drought	**	***	***
Heat stress	*	***	***
Poor soil fertility (low P & low micronutrients)	*	*	**



Regional priorities - Diseases

(from Tropical Legumes II)



Constraint	Regional Importance & Priority Research		
	S. Asia	ESA	WCA
<u>Groundnut</u>			
Aflatoxin	***	***	***
Foliar diseases (Rust, ELS, LLS)	***	***	**
Rosette	-	***	***
Bud necrosis	**	-	-
<u>Chickpea</u>			
Fusarium wilt	***	***	-
Ascochyta blight	**	-	-
Botrytis gray mold	**	*	-
<u>Pigeonpea</u>			
Fusarium wilt	***	***	-
Sterility mosaic disease	***	***	-
<u>Beans</u>			
Mosaic (BCMV/BCMNV)4	**	**	**
Angular leaf spot	**	***	***
Bacterial blight	*	**	**
Rust	*	**	***
<u>Cowpea</u>			
Mosaic virus (BIMV, CABMV, CPMV)	*	-	**
Bacterial blight	**	-	***



Insect pests in legumes



	Bean	Chickpea	Cowpea	Groundnut	Pigeonpea
Legume pod borer (<i>Helicoverpa</i>)	+++	+++	+	++	+++
Spotted pod borer (<i>Maruca</i>)	+++	-	+++	-	+++
Pod fly (<i>Melangomyza</i>)	-	-	-	-	+++
Pod sucking bugs (<i>Clavigralla</i>)	+	-	+	+	++
Whitefly (<i>Bemesia</i>)	++	-	-	-	++
Defoliators (<i>Spodoptera</i>)	++	-	+	++	+
Leaf hoppers (<i>Empoasca</i>)	+	-	+	++	+
Stem flies (<i>Ophiomyia</i>)	+++	-	-	-	-
Thrips (<i>Caliothrips</i>)	++	-	+	++	+
Bruchids (<i>Callasobrudus</i>)	+++	+++	+++	-	+++



Resources availability



- ✓ Germplasm reference sets
 - ✓ Genomic tools
 - ✓ Mapping populations
 - ✓ Linked markers



Reference sets



	Bean	Chickpea	Cowpea	Groundnut	Pigeonpea
Genotyping					
GCP SP1	1600x36	3000x50	2000x16	1000x20	1000x20
Other		500x50		250x20	-
Phenotyping					
Abiotic stresses	~100 (roots)	~200 (roots)	-	-	-
Biotic stresses	-	-	-	~200 (GRD,LLS)	-
Reference set	300	300	374	300	300



Bean (legume) genetic markers



Isozymes|

RFLPs —————|.....|

RAPDs —————>

SCARs —————>

AFLPs —————|.....|

Microsatellites (SSRs) —————>

New Markers —————>

(SNPs, DARTs)

under development —————>

Timeline

1991

1992

1993

1994

1995

1996

1997

1998

1999

2000

2001

2002

2003

2004

2005

2006



Genomics resources



	Bean	Chickpea	Cowpea	Groundnut	Pigeonpea
SSRs	800+	1000+	1000+	1000+	100+
BACs (BES)	12,10X	10,4X	10X	6,6,6X	-
ESTs	27000+	50000+	45000+	13000+	900+
SNPs	150+	-	3500+	-	-
DArTs	-	++	-	-	+
Gene arrays	(+)	(+)	(+)	(+)	-



Mapping populations under study (TLI, TLII)



	Bean	Chickpea	Cowpea	Groundnut	Pigeonpea
Drought	4	4	7	3	2
Diseases	2	4	4	10	2
Other (reference)	2(ref)	1 (interspecific)	-	2+ (AA, BB)	1 (interspecific)
RILs	++	++	++	++	+
ILs, AB lines	+	+	-	+	+



Linked markers



Crop	Constraint Name	Gene / Source (marker name)	Marker		Trait Inheritance	Status	
			Type	Inheritance			
Bean	BCMV	bc-3 (ROC11)	SCAR	Dom/Tra ns	major rec. gene / qualitative	wide-scale use	
		I (SW13)	SCAR	Dom/Cis	major dom. gene / qualitative	moderate use	
	CBB	CBB-QTL (SU91)	SCAR	Dom/Cis	quantitative	low use	
		ALS	Mex540- QTL (OPE4)	RAPD	Dom	quantitative?	low use
	Bruchid Drought	<i>Phg-2</i> (NO2) Arc/APAlocus BAT477-QTL	SCAR SSR SSR	Dom/Cis Co-dom Co-dom	major dom. gene / qualitative quantitative? quantitative	low use implementation confirmation	
Chickpea	Ascochyta blight		SSR	Co-dom	quantitative	implementation	
	Fusarium		SSR	Co-dom	quantitative	confirmation	
	Root volume		SSR	Co-dom	quantitative	implementation	
	Chilling sensitivity		SCAR	Dom	quantitative		
	Double-podding		SSR	Co-dom	quantitative		
	Flowering	<i>eFl-1</i> , <i>ppd</i>			quantitative		
Cowpea	Rust <i>Uromyces vignae</i>	<i>Rr1</i>	AFLPSCAR	Dom	qualitative	implementation	
	Cowpea aphid	<i>Rac1</i>	RFLP	Dom	qualitative	confirmation	
	Root-knot nematodes	<i>Rk</i>	AFLP	Dom	qualitative	confirmation	
	<i>Striga gesneroides</i> Races 1, 3, 5	<i>Rsg2-1</i>	AFLPSCAR	Dom	qualitative	implementation	
	<i>Striga gesneroides</i> Race 1	<i>994-Rsg</i>	AFLPSCAR	Dom	qualitative	implementation	
	Aphid Borne Mosaic Virus		AFLP	Dom	qualitative	confirmation	
	Southern Bean Mosaic Virus		AFLP	Dom	qualitative	confirmation	
	Blackeye Cowpea Mosaic Virus		AFLP	Dom	qualitative	confirmation	
	Cowpea Severe Mosaic Virus		AFLP	Dom	qualitative	confirmation	
	Fusarium wilt		AFLP		qualitative	confirmation	
	Chilling tolerance		Gene		qualitative	confirmation	
	Drought tolerance	IT93K-503-1			quantitative	confirmation	
	Grain weight		RAPD		qualitative	confirmation	
	Ground-nut	Rosette virus		AFLP	Dom	major gene (75% phen. variation)	confirmation
		Nematode		RAPDSCAR	Dom	2 dominant genes	
Pigeonpea	Fusarium		RAPD	Dom	quantitative		