Project SO1.A5: Genetic improvement of cowpea to overcome biotic stress and drought constraints to grain productivity

Project Personnel:

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Bao-Lam Huynh

Host Countries (Africa)
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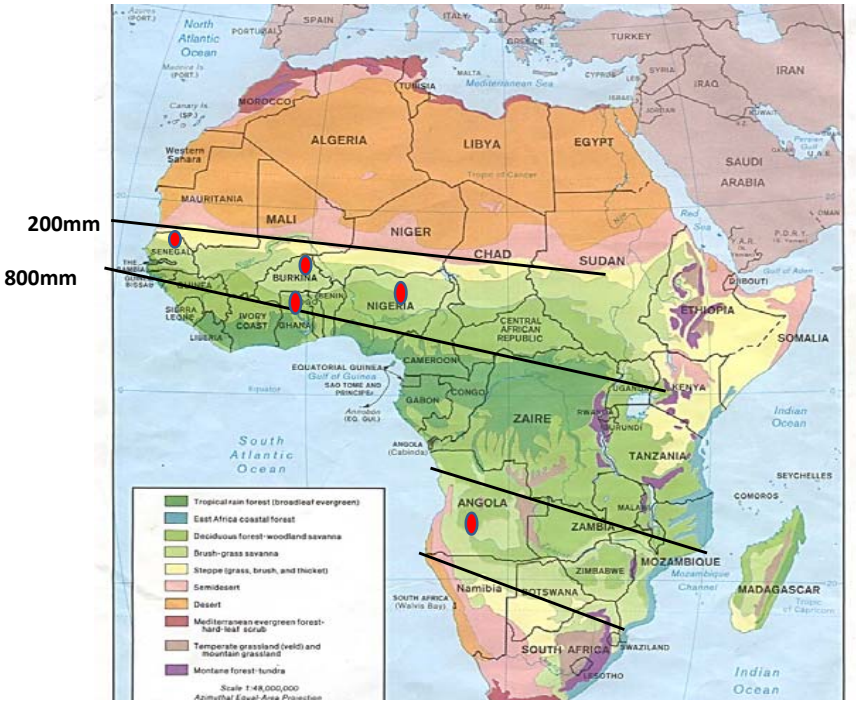
Issa Drabo and Jean-Baptiste Tignegre, Institut de l'Environment et des Recherches Agricole, Burkina Faso (INERA)



Objective 1: Discover QTL for insect resistance and apply in molecular breeding for target regions in West Africa and the US

Collaborators:

Clementine Dabire, INERA, Burkina Faso
Barry Pittendrigh, U Illinois, USA
Manu Tamo, IITA, Benin
Christian Fatokun, IITA, Nigeria
Ousmane Boukar, IITA, Nigeria
Ibrahima Sarr, ISRA, Senegal
Joseph Batieno, INERA, Burkina Faso

Aphid, Flower thrips and Pod sucking bug resistance

Populations phenotyped, SNP genotyped, QTL mapped

Marker selection to introgress R traits into advanced drought tolerant breeding lines.

Flower thrips (*Megalurothrips sjostedti*)

Adult female (L) and 2nd instar (R)
Credit; G Goergen, IITA-Benin

Wilted flower buds (L) and adult thrips (R) on cowpeas in Ghana (from I Atokple)

Flower thrips damage in field screening trial, Senegal.

Sorghum field at back is mature (80-90 days)

Cowpeas in screening trial have no pod-set, remain vegetative.

Normally harvested at 65-70 days

Field screening trial

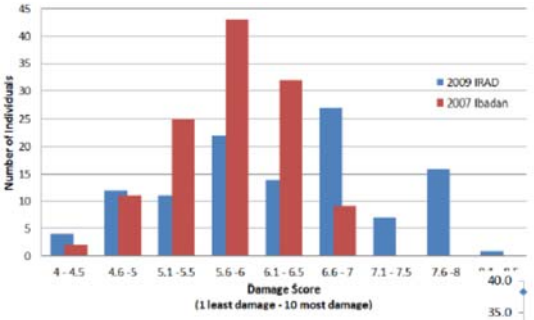
Flower thrips symptoms

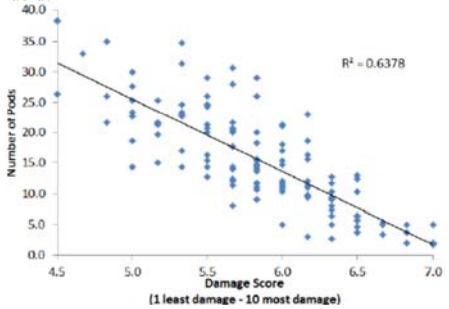
Parents of RIL mapping population under pressure from flower thrips.

Sanzi (resistant)

Vita 7 (susceptible)

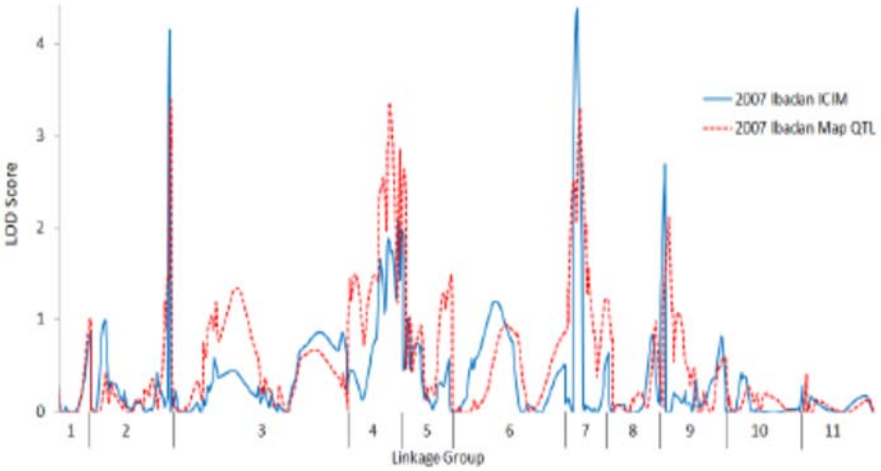
Phenotype scores of flower thrips damage in Sanzi and Vita 7 RIL. (IRAD – blue; Ibadan – red)





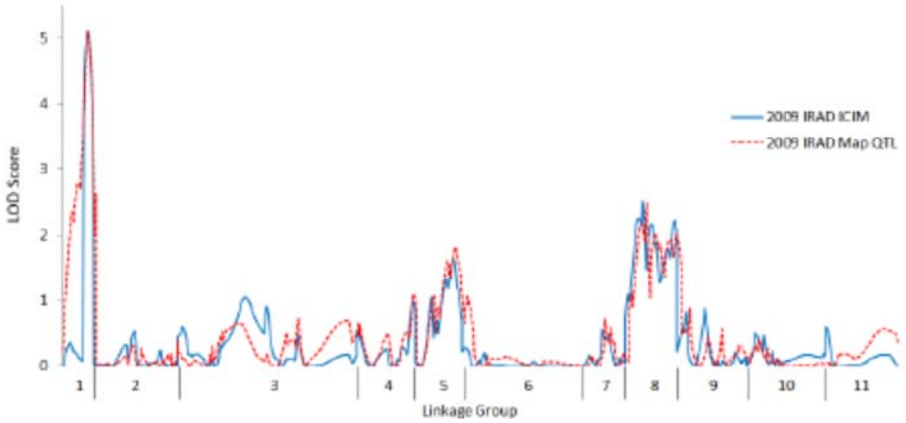
QTL for flower thrips resistance in Sanzi x Vita 7 RIL, phenotyped in Ibadan.

QTL identified on LGs 2,4, and 7 (ICIM and Map QTL)



QTL for flower thrips resistance in Sanzi x Vita 7 RIL, phenotyped at IRAD, Cameroon

QTL identified on LG 1 (5 and 8?). ICIM and Map QTL



Objective 1: Discover QTL for insect resistance and apply in molecular breeding for target regions in West Africa and the US

Resource:

- Aphid resistance – multiple sources

Questions:

- Which resistance is effective in each target area?
- Do the aphid populations vary for response to resistance source (biotypes)?

Actions:

- Increase seed of resistance source panel
- Uniform tests of resistance panel in multiple locations
- Genotype aphid populations (B. Pittendrigh)
- QTL mapping and markers for R loci
- MABC for aphid resistance into elite varieties

Cowpea aphids in California

Variation in aphid resistance among the world cowpea core collection grown in California, 2013

Valuable resource of resistance traits

Objective: Develop improved versions of elite cowpea varieties with effective aphid resistance from diverse sources

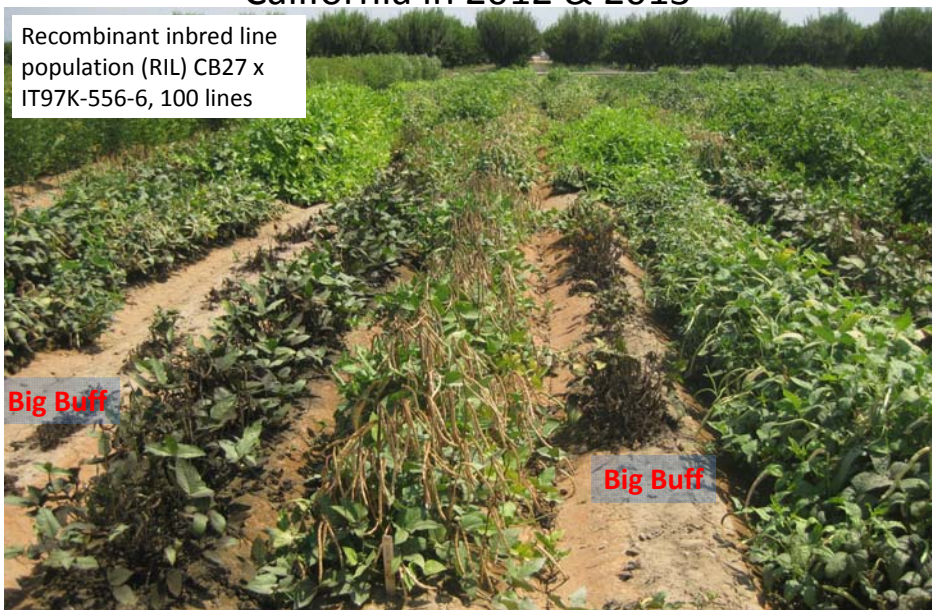
Example: CB27, CB46 and CB50 and new blackeyes in California with aphid resistance from IT97K-556-6

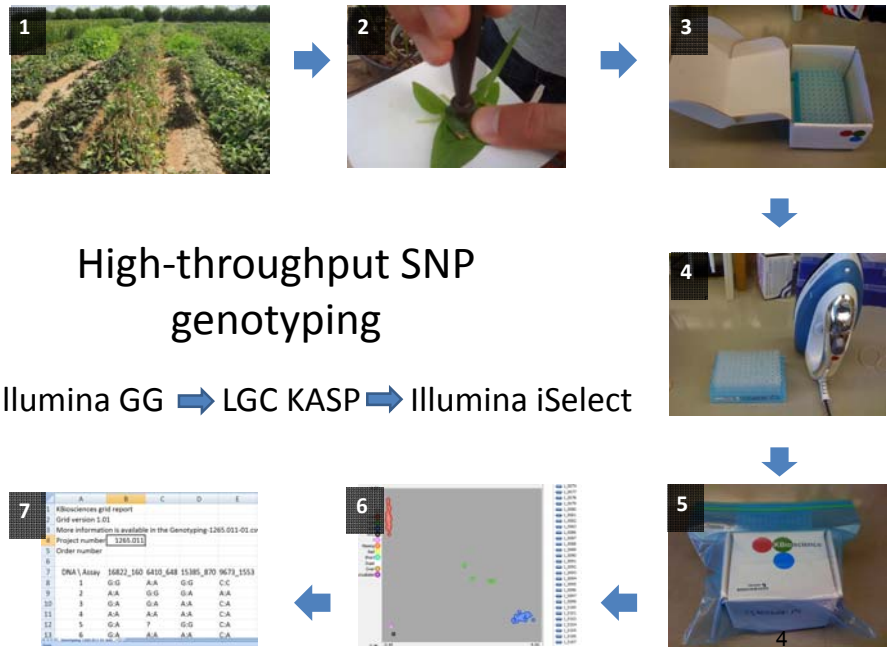
Main steps required for marker-assisted backcrossing (MABC)

1. Develop a mapping population.
2. Phenotype the mapping population.
3. Genotype the mapping population.
4. Associate phenotypes with genotypes to identify QTL for resistance.
5. Use marker-QTL association in MABC.

Resistance phenotyping a mapping population in California in 2012 & 2013

Recombinant inbred line population (RIL) CB27 x IT97K-556-6, 100 lines

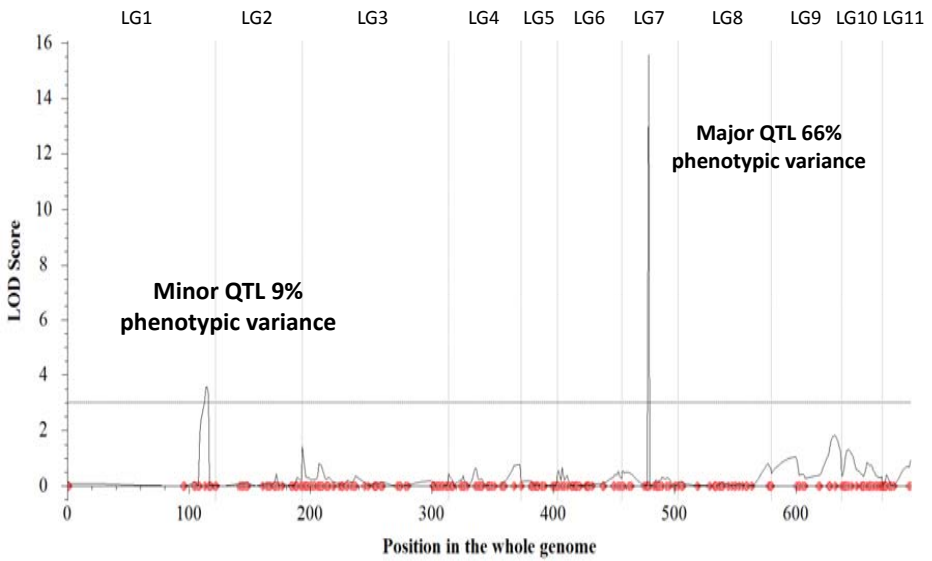




High-throughput SNP genotyping

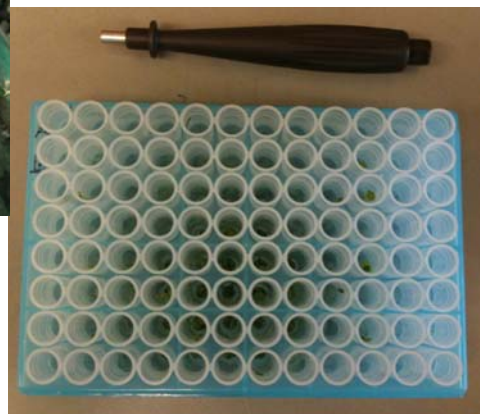
Illumina GG ➡ LGC KASP ➡ Illumina iSelect

QTLs for aphid resistance in CB27 x IT97K-556-6

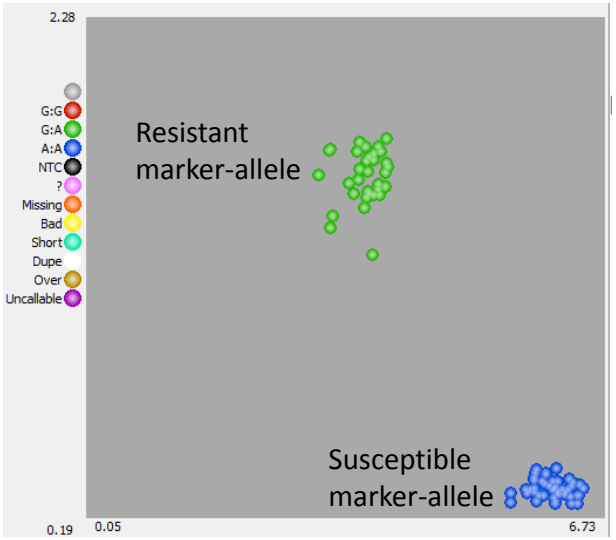


Backcross plants grown in greenhouse

Leaf tissues collected for marker analysis



Marker profile of backcross plants



Plants without resistant marker-alleles are removed

Plants with resistant marker-alleles and highest CB46 background are backcrossed to CB46

Assessment of cowpea yield loss due to Aphids in Ghana (Kusi *et al*, 2014)

<u>Resistant:</u>

Improved Zaayura	3.8 %
SARC 1-57	4.9 %
SARC 1-91-1	9.8 %

<u>Partially resistant:</u>

IT97K-499-35	17.1 %
Padituya	16.1 %

<u>Susceptible:</u>

Susc BC progeny	32.8 %
IT99K-573-1-1	32.1 %
Apagbaala	30.3 %

Aphid resistance breeding in Ghana using foreground and background MAS

Francis Kusi and Ibrahim Atokple

Damage on susceptible seedlings

SARC1-57=2 surviving aphid attack

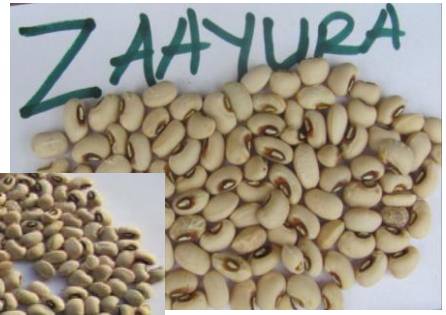
Aphid infested Zaayura seedlings

Aphid resistance breeding in Ghana using foreground and background MAS

Francis Kusi and Ibrahim Atokple

Aphid resistance donor

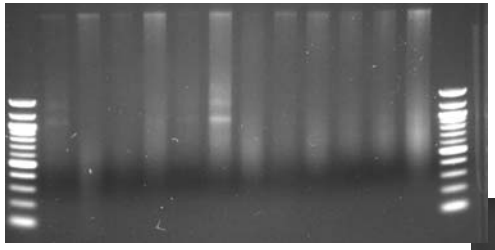
BC4F3 derived by MAS for aphid resistance



SARI released variety (recurrent susceptible)

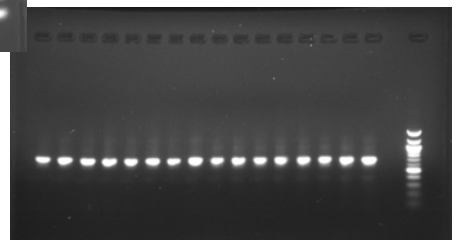
Molecular characterization of aphid samples from African and USA cowpea production areas

Collaborative research with Barry Pittendrigh, U. Illinois
LIL Cowpea IPM project: *SO1.B1*

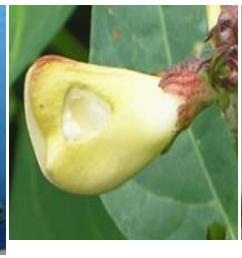


DNA profiles from dried aphid samples

Cytochrome oxidase I (COXI) aphid specific profiles from dried samples



Maruca vitrata damage symptoms on Cowpea – from Ibrahim Atokple and Francis Kusi, Ghana



Target of Bt cowpea development- LIL collaborating on foreground and background MAS breeding

Collaborative efforts to aid in foreground and background selection for Bt cowpea advancement into elite cowpea varieties

Jeremy Ouedraogo & Jean-Baptiste Tignegre, INERA - Burkina Faso

Bt transgenic plants in screenhouse INERA - Burkina Faso

Collaborative efforts in foreground and background selection for Bt cowpea into elite cowpea varieties

Jean-Baptiste Tignegre making backcrosses to introgress Bt into breeding lines, INERA - Burkina Faso

Backcrossed Bt plants in screenhouse INERA - Burkina Faso

Objective 2: Complete release and validation of advanced cowpea lines developed under the Pulse CRSP in Burkina Faso, Senegal, and US.

Collaborators:

Dr. G. McClaren, CGIAR GCP IBP
Dr. Ousmane Boukar, IITA, Nigeria
Dr. TJ Higgins, CSIRO, Canberra, Australia
Dr. Samba Thiaw, ISRA, Senegal
Dr. Mywish Maredia, Michigan State U., USA

Burkina Faso: 9 pre-release CRSP lines
Senegal: 3 large white pre-release CRSP lines
USA: Lygus, Fusarium and nematode resistant blackeyes

Large-seeded white grain types for Senegal release: Montiero source crossed into Senegal elite Melakh (N. Cisse)

All lines *Bacterial Blight* and *CpMv* resistant; line 3217 *Amsacta* tolerant

Lines	Yield10 Station	Yield12 On-farm	Yield13, On-farm	Days to Maturity	100 Seed-wt
3178	1767	859	606	59.8	26.8
3217	1871	824	687	59.5	25.8
3211	1360	739	512	60.5	25.8
3205	1551	709		62.8	26.5
MELAKH	1455	698	627	60.0	20.3
3201	1441	670		59.8	26.3

Large-seeded white grain types developed under CRSP for Senegal release: Montiero source crossed into Senegal elite Melakh (N. Cisse)

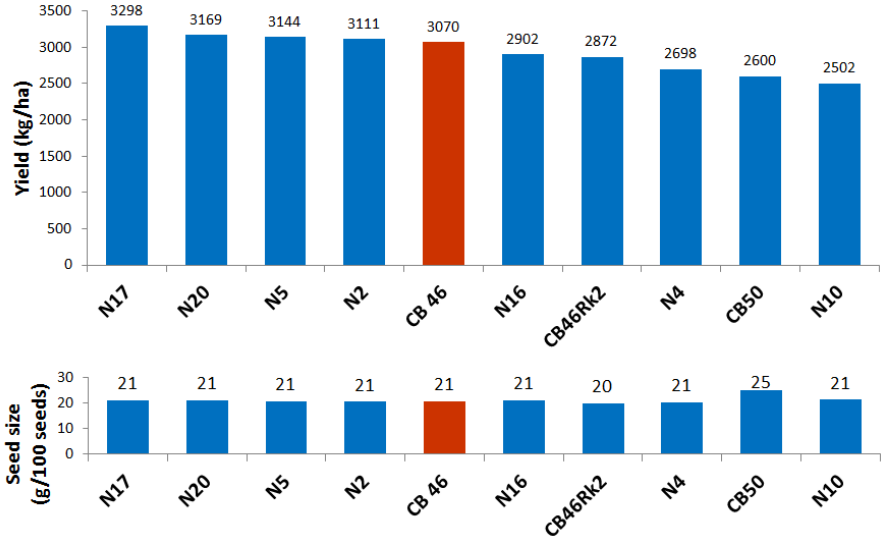
Montiero ST
Source of large seed size

Large seeded pre-release line with Melakh background

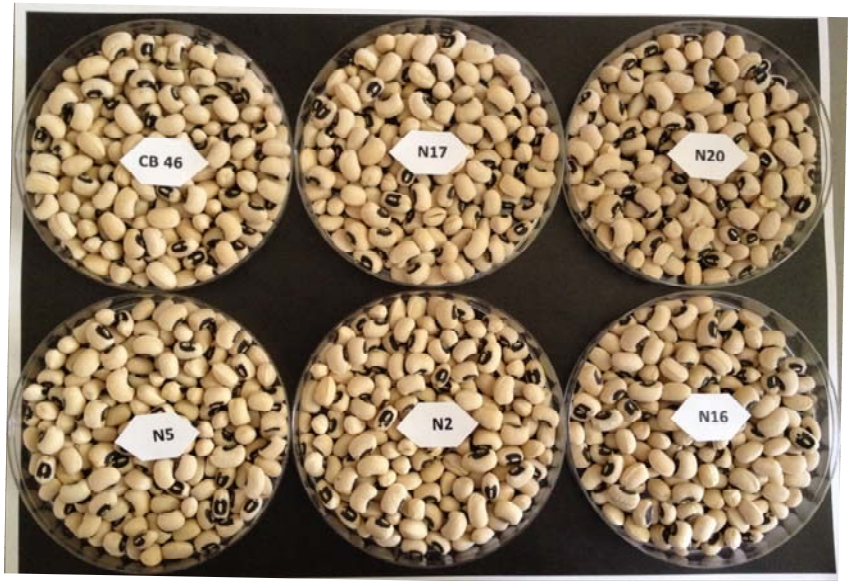
Pre-release white grain types for Burkina Faso (I. Drabo)

All lines *Striga* resistant; range of disease resistances; high biomass yield

Grain yield and seed size of blacke lines with stacked nematode and Fusarium wilt resistance genes, CA 2013



Seed quality of advanced resistant blackeye lines and standard CB46 from 2013 field trial



Objective 3: Increase capacity of NARS in Burkina Faso, Ghana and Senegal to serve the cowpea sector.

Collaborators: Dr. G. McClaren, CGIAR GCP IBP

Dr. Ousmane Boukar, IITA, Nigeria

Short-term training: Workshops, short visits

Example: Cowpea modern breeding workshop at UCR - March 24-28, 2014.

12 African breeders/geneticists plus 3 LIL/ILCRC/TLI students

Degree training: MS and PhD

Arsenio Ndeve, Mozambique

Sassoum Lo, Senegal

Mitchell Lucas, USA