Breeding Updates
PABRA-ECABREN

ECABREN Annual Steering Committee Meeting

(5th-11th February, 2012)

By

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AIM OF PABRA'S BREEDING PROGRAM

- To develop resilient bean germplasm (adapted to fluctuations and extremes of climatic, edaphic factors, pests and diseases) and maintain stable bean production and quality in the presence of diverse stresses; enhancing the capacities of the communities to cope with stresses

Breeding Research Themes addressed

Multiple trait varieties

BIOTIC

Diseases

Pests

ABIOTIC

Tolerance to Drought

Tolerance to water logging

Tolerance to poor soil fertility

Tolerance to Heat/cold

Niche Market products:
International and Regional Markets

Runner beans

Snap beans

Canning beans

Nutrition Breeding:

High iron and Zinc

Low Polyphenol

Efficacy and effectiveness

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REVISED PABRA LOGIC MODEL 2009-2013

Ultimate Outcome

Improved nutrition and health, gender equality, food security, incomes and natural resource base for sustainable livelihoods of resource poor women and men farmers

Intermediate Outcomes

Increased and in gender equitable manner utilization of improved and marketable bean varieties , new crop

Increased trade in a gender equitable manner

Increased response to demands in the bean sector , and utilizing information and knowledge to influence bean policy in a gender equitable manner

Immediate Outcome

1.1: Increased access by especially women farmers to improved dry bean varieties resistant to multiple environmental stresses

1.2: Increased access to cost effective and environmentally friendly integrated stress management options (e.g. for soil fertility and water, pest and diseases) by particularly women farmers

1.3: Increased access to micronutrient rich bean based products in the diets of vulnerable communities

1.4: Increased access to high value bean products targeted to niche markets with a focus on women

1.5: Increased capacity of men and women to participate in technology development, delivery and decision making bodies equitably

2.1: **Increased access to new and existing markets and opportunities for both men and women**

3.1: Increased access particularly for information and knowledge that shapes bean technology development, delivery and influence policy

1.1: Increased access by especially women farmers to improved dry bean varieties resistant to multiple environmental stresses

- **Output 1.1.1:** Current and future risks to bean production and utilization associated with major environmental stresses and end user systems reviewed and analyzed

- **Output 1.1.2:** Genetic, physiological, pathogenic and pest mechanisms conferring resistance to different environmental stresses studied, validated and documented

- **Output1.1.3:** At least 130 new multiple stress resistant bean germplasm identified , widely tested and selected for release

- **Output 1.1.4:** Gender responsive and efficient dry bean varieties delivery systems developed, assessed and used for targeting end user

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Output 1.1.1: Current and future risks to bean production and utilization associated with major environmental stresses and end user systems reviewed and analyzed

Activity Set 1.1.1.1: Review and analyze current and future risks to bean production and utilization associated with major environmental stresses (drought, floods, heat, acid soils, salinity, low soil fertility, risk of soil degradation, pest and diseases)

Questions to answer:

1. What have we done by country?
2. What are the results?
3. What next do we need to do?

Why is PABRA updating the Atlas?

- Existing Atlas now 13 years old
- Atlas can show which countries have similar growing conditions
- Atlas used to target research
- Atlas used to show some research results
- Atlas useful for obtaining funds for new research

What information is included in the Atlas?

- Where are beans being grown?
- What is the cropping system?
- Who are the producers?
- Are beans marketed?
- What varieties are being grown and sold?
- What are the main problems?

Progress: Bean Atlas

- National workshops -: New bean production area boundaries defined
- Surveys to identify and establish the distribution and occurrence of major common bean pests and diseases
- Information is being processed and fed into the bean atlas template
- Compilation and integration of documented information on the status of major bean diseases
- Specialised research on the probabilities of climatic events that can trigger pest and disease outbreaks e.g., Pythium root rot
- Global models used to gauge the major climatic constraints to bean suitability

Output 1.1.2: Genetic, physiological, pathogenic and pest mechanisms conferring resistance to different environmental stresses studied, validated and documented

Activity Set 1.1.2.1: Study, validate and document the genetic, physiological, pathogenic and pest mechanisms conferring resistance to different environmental stresses (linking with capacity building) and generate new stress resistant bean germplasm

Questions to answer:

1. What have we done by country?
2. What are the results?
3. What next do we need to do?

- **Identifying new pest and disease races:**
  - Characterisation of Anthracnose and ALS disease isolates from Uganda, DRC , Kenya??
  - Surveys in most countries

- **Identifying new sources of pest and disease resistance:**
  - Uganda (ALS), Kenya (ALS, ANT, CBB, BCMV, Drought, BSM), Madagascar, (rust, ALS, Acidity), Sudan (charcoal rot)

- **Mechanism of resistance/tolerance to Biotic and abiotic Stress:**
  - ***Angular leaf spot (ALS):; Malawi, Uganda***
  - ***Anthracnose: Uganda***
  - Common bacterial blight (CBB): Malawi,
  - Halo blight (HB): Malawi
  - Bean bruchid resistance: Tanzania , Malawi,
  - ***Biological Nitrogen Fixation: Kenya.***
  - Heat tolerance**:** Zimbabwe,
  - Drought resistance: Mozambique
  - Tolerance to low soil fertility**:** Mozambique , Zambia,

MAS in Bean improvement

- √ Identification of sources of resistance
- √ Establishment of the nature of resistance and the genes involved
- √ Identification, validation and development of protocols for markers associated with resistant genes
  - √ *Initial focus was on Angular Leaf spot and Pythium root rot*
- √ Introgression of genes and application of markers in selection (E.G., *I* and *bc3* gene for BCMV/BCMNV)
- √ Development of Multiple disease resistance breeding parents (Angular Leaf spot, Pythium root rot, Anthracnose, BCMV and BCMNV)

Marker Assisted Breeding-PABRA

ROCKFELLER FOUNDATION

- Which traits are important and amenable?
- Development of Markers
- Capacity development
- Application in breeding

African Bean Breeding Consortium (ABC) funded by the Kirkhouse Trust

Kenya, Uganda, Tanzania

O**bjectives**

- Introduce the capability of marker-assisted selection (MAS) into African bean breeding program
- infrastructure & training in MAS
- Determine which traits are important and amenable
- **Developing Varieties Tolerant to Two or More Major Biotic Stresses in Africa (ALS, ANT, BCMV & BCMNV, CBB, and Pythium Root Rot)**

ABC Projects currently funded

1. Application of molecular marker assisted selection in developing common bean varieties with improved multiple disease resistance to *Pythium* root rot, bean common mosaic necrotic virus and anthracnose in Uganda (UBP-MUK)

2. Use of marker-assisted selection (MAS) to improve selection efficiency in breeding for resistance to major diseases of common bean (*Phaseolus vulgaris* L.) in Tanzania (SUA). CBB, ALS, BCMV/BCMNV

3. Strengthening Capacity for Marker Assisted Breeding for Common Bean in eastern Africa (Kenya-UON) -Anthracnose, ALS, Root rot and BCMV

DISEASE TARGETED FOR MAS

Common Bacterial Blight

Bean Common Mosaic Virus

Angular Leaf Spot

Pythium Root rot

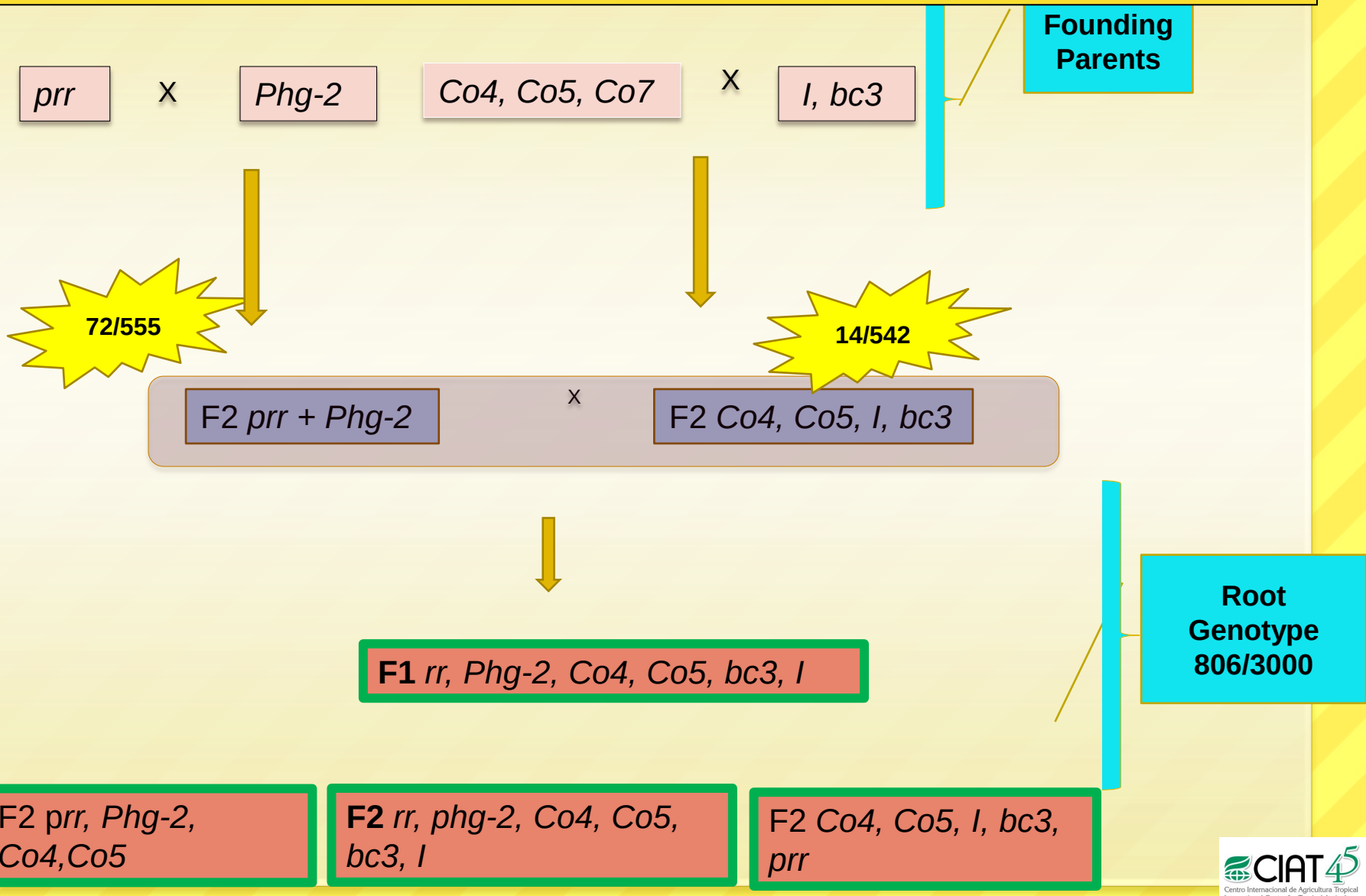
Bean Common Mosaic Necrotic Virus

Anthracnose

MARKERS BEING UTILISED

Trait	Markers	Source
ALS	$OPE4_{709}$	Mex 54 (Mahuku et al,2004)
	$PF9_{260}$	G10474 and G10909
Pythium root rot	PYAA19	RWR 719 (Buruchara et al
	PYBA08	RWR 719
Anthracnose	SAB -3	G2333
	SAB 13	G2333
	SAB 14	G2333, AB 136
BCMV	ROC 11	Various
BCMNV	SW 13	Various
CBB	$SAP6_{820}$	Miklas et 2000; Deidre et al 2007

Current Progress in developing multiple Disease resistance parents to Angular leaf spot, Anthracnose, Pythium root rot and BCMV/BCMNV



Other efforts in MAB

- Generation Challenge Program (GCP)
  - Integrated Breeding platform (IBP; http://www.generationcp.org/ibp)
    - Public web-based one-stop shop for information, analytical tools and related services to design and efficiently conduct molecular-assisted breeding experiments
  - GCP Communities of Practice: Common Bean Communities of Practice (COP)
  - SNP Genotyping of important bean germplasm
  - MAB training program-3 year program

Output:1.1.3: At least 130 new multiple (2 or more) stress resistant bean germplasm identified , widely tested and selected for release

Activity Set 1.1.3.1: Identify, select and test widely new multiple stress resistant bean germplasm for release

Questions to answer:
1. What have we done by country?
2. What are the results?
3. What next do we need to do?

Multiple stress resilient variety release status across ECABREN member countries (2009- To date)

Country	Pre released	Released
Burundi	-	2
DR C -West	-	11
DRC –East	-	30
Rwanda	-	9
Uganda	15	2
Ethiopia	14*	4
Madagascar	38	3
Kenya	18	1
Total	85	62
% Target (130)		**47.7%**

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Released Bean Varieties with 2 or more attributes (stress and others)

Multiple Bean Variety Releases across ECABREN Countries

Variety	Country						
	Burundi	DRC	Ethiopia	Kenya	Rwanda	Tanzania	Uganda
AFR708		2007		2008			
FLOR DE MAYO	1987				1991	2006	
G2333				2007	1991		1999
G685	1993	2004		2008	1991		1999
GASIRIDA	2010				2010		
KATB1	2008			1998			
KATX56	2008			1999			
KATX69	2008			1998			
RWR719			2003	2008			

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Multiple Bean Variety Releases across SABRN Countries

Variety	Country							
	Angola	s D R Congo	Malawi	Mozambique	South Africa	Swaziland	Zambia	Zimbabwe
CAL143	1998	2011	1996	2007		X (2007)	X (1997)	
*SUG131			2002	X (2007)		X (2007)		
NUA45			2009	X (2011)				X (2010)
PC652-SS3					X (1999)			X (2010)
OPS-KW1					X (2001)		X (2009)	

*Also released in Ethiopia (ECABREN)

1.3. Increased access to micronutrient rich bean based products in the diets of vulnerable communities

Output 1. 3.1: Thirteen bean varieties with enhanced micronutrient concentration and superior agronomic traits accepted/released

Output 1.3.4: Gender responsive delivery systems for micronutrient dense bean varieties and value added products developed, assessed, and applied for targeting end users (vulnerable groups and service providers)

Output 1. 3.1: Thirteen bean varieties with enhanced micronutrient concentration and superior agronomic traits accepted/released

Activity set 3.1.1 Develop bean varieties with improved micronutrient concentration and superior agronomic traits

Questions to answer:

1. What have we done by country?
2. What are the results?
3. What next do we need to do?

High Fe Products

First generation
Target: 70+ ppm Fe and 25-30 ppm Zn
Genetic variation: Local landraces, released or pre-release lines **screening**

Second generation
Target: 90 ppm Fe and >35 ppm Fe
Advanced Lines specifically bred for high micronutrient density; NUA, NUV, ECAB and KAB lines

Third Generation
Target: 90 ppm Fe and >35 ppm Zn
Populations derived from intra-specific and inter-specific crosses to combine micronutrient density with traits relevant for variety; e.g., High iron and drought tolerance, High Fe and Low soil fertility tolerance, High Fe and BCMNV, High iron and commercial varieties

Current Regional nursery : 29 climbing and 32 bush lines including products from the three generations

Entry No.	Trial 1-Climbers	Fe	Zn
1	NGWIN x CAB2/2/3/1/1	97	28
2	NGWIN x CAB2*	95	28
3	MAC 42	94	48
4	RWV 3316	93	31
5	NUV 219-1	88	36
6	CAB 2	85	37
7	RWV 2359	84	38
8	GARUKURARE	82	34
9	KIVUZO	82	34
10	RWV1129	81	34
11	NDIMIRAKAGUJA VOL	81	38
12	ICYANA 2	78	30
13	RWV 2361	79	29
14	MAC 44	78	31
15	RWV 3006	77	36
16	RWV 2887	77	32
17	MAC 74	76	32
18	AGRONOME 2	76	33
19	VRA 4	76	33
20	CAB 19	76	37
21	RUGANDURA	75	31
22	RWV 2070	65	29
23	KIANGARA		
24	VCB 81013	67	34
25	GASIRIDA	65	30
26	Local yield check		
27	MIB 456-High Fe Check	102	34
28	DECELAYA 1-Low Fe Check	55	29

Entry No.	Trial 2-Bush	Fe	Zn
29	KAB06F2.8-27	85	43
30	NUA 99	82	33
31	RWR 3839	80	35
32	NUA 69	78	40
33	KAB06F2.8-12	75	33
34	RWR 2154	75	37
35	RWR 2245	75	34
36	KAMEMBE 3	75	35
37	RWR 3803	75	34
38	AKANYAMANZA B	77	31
39	KAB06F2.8-36	74	35
40	KAB06F8.8-35	74	36
41	CODMLB 001	81	37
42	HM 21-7	79	34
43	Ngwaku-Ngwaku √		
44	NUA 45	102	35
45	NUA 59		
46	NUA 56	95	37
47	NUA 35		
48	Local Yield check		
49	Zebra		
50	ACC 714	81	35
51	CODMLB 033	75	32
52	ROBA 1		
53	SMC 21		
54	SEMC 16		
55	SMC 18		
56	SEMC 17		
57	GLP 2		
58	CAL 96-Low Fe check	54	25
59	DOR 500-Low Fe check	58	27
60	MAHARAGI SOYA		

Released bio-fortified varieties with high Fe and Zn content in ECABREN (2009- To date)

Country	Pre released	Released
Burundi	Nakaja-	Kiangara- VCB81013- (Fe 67, Zn 34) Gasirida – (Fe 65, Zn 30) GLP2- NGWAKUNGWAKU- VCB81012- (Fe 66.8,
DR C - West		Ngwaku-ngwaku - CODMLB001 -(Fe 81, Zn 37) HM 21-7-(Fe 79, Zn 34)
DRC –East	CODMLB 001- (Fe 81, Zn 37) HM 217- (Fe 79, Zn 34)	
Rwanda	RWV3006- (Fe 77, Zn 36 RWV2872- (Fe 70.4, Zn 25.2) RWV2361- (Fe 79, Zn 29) RWV3316; (Fe 93, Zn, 31) *RWV2269- *RWV1348- (Fe 69.6, Zn 30.4) MAC 42 (Fe 94, Zn 48) RWV2887 (Fe 76.6	*MAC 44 - (Fe 78, Zn 34) RWV 1129- (81 Fe. 34 ZN) RWR 2154 (Fe 75, Zn 37) RWR 2245 (Fe 75, Zn 34) CAB 2- (85 Fe, 37 Zn) *RWR 2070 (Fe 65, Zn 29)
Total	11	15

1.4 Increased access to high value bean products targeted to niche markets with a focus on women

Output 1.4.1: Competitive and market demanded bean products, including 23 niche market varieties (new snap runner , canning and organically produced) and value added products, developed in collaboration with smallholder farmers

Output 1.4.2: Gender responsive delivery systems for niche market bean varieties (new snap, runner , canning and organically produced) and value added bean products developed, assessed and used for targeting end users

Output 1.4.1 Competitive and market demanded bean products, including 23 niche market varieties (new snap runner , canning and organically produced) and value added products, developed in collaboration with smallholder farmers

Activity Set 1.4.1.1 Identify and promote, in collaboration with smallholder farmers, competitive and market-demanded products[these include niche market bean varieties (snap runner canning and organically produced] and value added products

Questions to answer:

1. What have we done by country?
2. What are the results?
3. What next do we need to do?

Niche Market Bean varieties in PABRA (2009- To date)

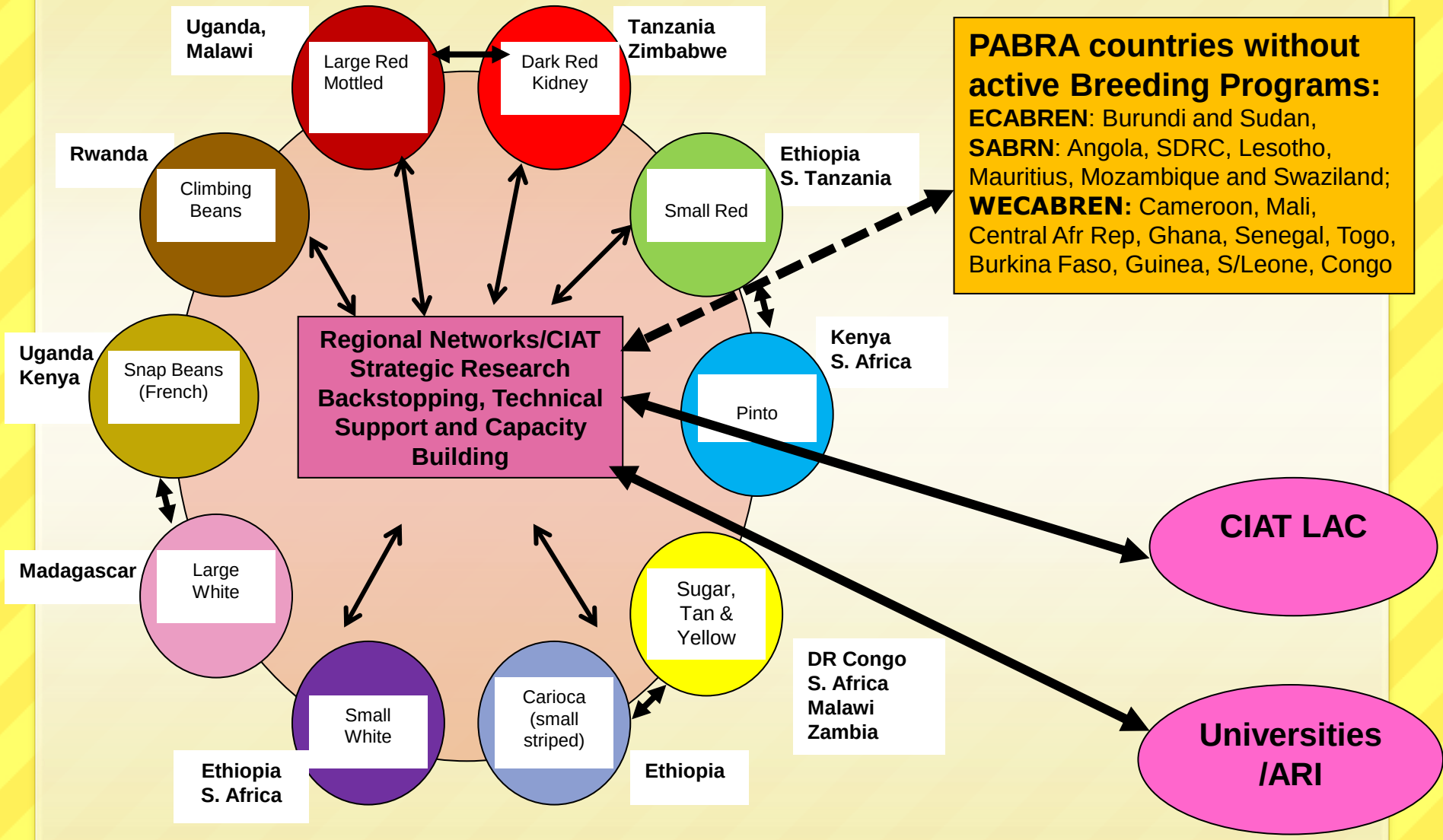
Country	Pre released	Released
Malawi		VTTT924/4-4
Mozambique		A222, VTTT923/10-3, VTTT924/4-4
Rwanda		**Pyramide**
S. Tanzania		Wanja Cross, NRI 06 E13, NRI 05 P200
Zambia		VTTT 923/10-3, Lwangeni (OPS-KW1)
Zimbabwe		SUG131, Gloria (PC652-SS3)
Swaziland		RS5, PAN9249
S. DRC	ECAB 0621, ECAB 0607, HSR 545	
S. A		PAN 9281, PAN 9280, PAN 9298, PAN 9292, PAN9213
Uganda	**Mara, Tana, Serengeti, Eza-1-4**	
Total	**7**	**19**

PABRA Breeding Strategy (Malawi, November, 2011)

- **The main priorities for the breeding program:**
  - yield improvement,
  - improvement of resistance to major biotic and abiotic constraints,
  - identification, characterization and utilization of new and better sources of resistance to major biotic and abiotic constraints
  - cooking and nutritional quality including improvement of Fe and Zn content,
  - Improving canning quality for the canning industry as well as developing new niche market varieties (snap/green beans).

- **New priorities include;**
  - tolerance to Heat or cold
  - tolerance to water logging/excessive water
  - Assessment of advanced and fixed lines for productivity in different cropping systems particularly intercrop and sole cropping systems

Market-Class led breeding strategy and sharing breeding responsibilities



Bean market classes, production area, major constraints and revised market led breeding strategy for ECABREN and WECABREN countries

Market class	Production (ha)	Major production constraints*, **	Program-Priority	Countries*** where the bean types are of high or moderate importance
A1. Red Mottled	740,000	ALS, Anth/RR, low P, BSM, drought, whiteflies, low N, WB,	Program –1	**UGANDA**, **Kenya,** DR Congo, **Tanzania**, Sudan, Cameroon, Madagascar, Burundi, Ethiopia, and Rwanda
AII. Reds				
AIIa. Large Red Kidneys	350,000	ALS, Anth, low P, BSM, RR, CBB, HB, HEAT, drought, rust,	Program-2.1	**TANZANIA**, Kenya, Rwanda, Madagascar, Ethiopia, Cameroon, Burundi, Ethiopia, Uganda and DR Congo
AIIb. Small and Medium Reds	670,000	ALS, Anth, /CBB, low P, BSM,RR, Rust, drought, BCMV/BCMNV, whiteflies	Program 2.2	**ETHIOPIA**, Kenya, Tanzania, Rwanda, DR Congo, Lesotho, Zimbabwe

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Market class	Production (ha)	Major production constraints*, **	Program-Priority	Countries*** where the bean types are of high or moderate importance
III. Browns	380,000			
IIIa. Yellow		ALS, Anth/CBB, RR ,low P, drought, LSF, rust and others above	Program-3.1	**BURUNDI,** DR Congo, Rwanda, Tanzania, Kenya and Madagascar
IIIb. Brown		ALS, Anth/CBB, RR ,low P, drought, LSF, rust and others above	Program 3.2	**BURUNDI,** DR Congo, Rwanda, Tanzania, Kenya and Madagascar
IIIc. Tan/Khaki		ALS, Anth/CBB, RR ,low P, drought, LSF, rust and others above	Program 3.3	**TANZANIA**, DR Congo, Rwanda, Uganda and Burundi

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Market class	Production (ha)	Major production constraints*, **	Program-Priority	Countries*** where the bean types are of high or moderate importance
IV. Cream	360,000			
IV a. Pinto		ALS,CBB/rust, low P, Anth, Foliage beetles, RR	Program 4.1	**KENYA**, Uganda, Madagascar
IV b. Sugars		ALS,CBB/rust, low P, Anth, Foliage beetles, RR,	Program 4.2	**UGANDA**, DR Congo, Ethiopia, Kenya, Rwanda and Burundi
IV c. Carioaca		ALS,CBB/rust, low P, Anth, Foliage beetles, RR,	Program 4.3	**KENYA**, Tanzania, DR Congo, and Madagascar

Bean market classes, production area, major constraints and revised market led breeding strategy for ECABREN and WECABREN countries

Market class	Production (ha)	Major production constraints*, **	Program-Priority	Countries*** where the bean types are of high or moderate importance
V. White seeded				
Va. Navy (Cam, DRC,	310,000	Rust, ALS, CBB,BSM, bruchids,	Program 5.1	**ETHIOPIA,** Rwanda, Kenya, Cameroon, DR Congo, and Madagascar
Vb. Large white kidney	220,000	ALS, Anth, low P	Program 5.2	**MADAGASCAR**, DR Congo, Ethiopia, Rwanda, Cameroon and Tanzania

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Bean market classes, production area, major constraints and revised market led breeding strategy for ECABREN and WECABREN countries

Market class	Production (ha)	Major production constraints*, **	Program-Priority	Countries*** where the bean types are of high or moderate importance
VI. Mixed Colours/others				
VIa. Purples/ Mwezimoja types	270,000	ALS, Anth, low P, RR	Program 6.1	**TANZANIA**, **Kenya** and Madagascar
VIb. Blacks	130,000	ALS, Anth, low P, BSM, rust	Program 6.2	**DR Congo,** Uganda, Kenya, Tanzania, Sudan and Madagascar
VII. Climbers				
VIIa. All market classes)		Anth, ALS, RR, low P	Program 7.1	**Rwanda,** Burundi, DR Congo, Uganda, Kenya, Ethiopia and Tanzania.

Bean market classes, production area, major constraints and revised market led breeding strategy for ECABREN and WECABREN countries

Market class	Production (ha)	Major production constraints*, **	Program-Priority	Countries*** where the bean types are of high or moderate importance
VIII. Snap and runner beans	--------			
VIIIa. Bush snaps		Rust, RR, ALS, anthracnose	Program 8.1	**Kenya**, Rwanda, Uganda, Tanzania, Ethiopia, DR Congo, Burundi and Madagascar
VIIIb. Climbing snaps		Rust, RR, ALS, anthracnose	Program 8.2	**RWANDA**, Kenya, DR Congo, Uganda, Tanzania and Burundi
VIIIc. Runner Beans (Dry grain and vegetable snap types)		Photoperiodism (long day), pod characteristics, flourly leafspot and rust	Program 8.3	**KENYA**, Madagascar, Tanzania, DR Congo and Ethiopia

ECABREN Constraint Nurseries

Nurseries	Who has materials to contribute?	Coordination	When can we have seed?
Drought	KE, RW, ET, TZ,	NARL, Kawanda (Mathew and Clare)	Now- Feb
Root rot	UG, KE, RW, , DRC		
Anthracnose	UG, KE,		
Climbing beans	RW, DRC, BU,		
Red mottled	UG, CAM, , RW, BU		
Small red	ET, MD, RW,		
Red Kidney	TZ, BU, MD, RW		
Snap	KE, RW, UG,		
Navy/canning (small and large)	ET, KE, BU, RW, CAM, MD		
Nutrition	RW, KE, BU, , DRC		
Low Soil Fertility	KE, DRC, CAM, BU, UG, Uyole		

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Areas identified for special projects focusing on cross cutting research themes.

Constraint	Countries	Leading
Drought	All	KE, TZ, ET, UG
Insect pests (bean stem maggot, bruchids and whiteflies)	All	UG, KE, BU
LSF	All	DRC, RW, ET- Haramaya
Nutrition	All	RW, DRC, KE

Bean Germplasm at Kawanda

- Low soil fertility (BFS; Low Fertility and drought tolerant lines; 23)-
- Fe and drought (MIB; 17, SMB; 19, SMC; 22, SMN; 21, SMR; 26, SMC; 53; SAB; 18)
- SSIN lines-Fe and Drought (322 lines)
- MNC: (79 climbers)
- MCA - 13 lines, NUC; 17, MAC; 10, MBC; 16, NUV219-1, VRA (Climbers)
- DAB lines (144 Bush lines)
- NUAs (94 bush lines)
- Disease differential sets, BCMV, Anthracnose , ALS and Rust
- *P. lunatus* (55 lines)
- *P. accutifolius* (50 lines)
- SABRN Nursery (138 lines)
- Nutrition Nursery (Fast track, 38 and Second; 60 lines)
- Root rot; 62, MAS (ALS) 42, Kenya- Kakamega-44 families)
- Burundi released and pre-release varieties
- Fusarium root rot
- I and bc3 lines -16
- Ethiopia Drought canning beans-34 lines
- Anthracnose and ALS international Trials
- harcoal rot lines from Sudan

FLOW OF MATERIALS IN A BEAN BREEDING PROGRAM

Make Crosses

FEMALE PARENT (Good adapted variety or landrace)

X

MALE PARENT (Good sources of important genes)

F1 - Selfed

Segregating F_2 population

Evaluate Segregating F_3 populations under stress environment– select best single plants

Increase seed at F_4 generation

Evaluate under stress again at F_5 – select best single rows

Evaluate F_6 generation, introduced lines or varieties and landraces too) lines for yield performance and resistance to stress and select the best lines

Conduct Preliminary Yield Trials (**PYT**)– 30-40 lines, 2 Reps, 2-3 sites on-station and on-farm. Repeat 2 times possibly and select best lines

Conduct Advanced Yield Trials (**AYT**) on-station and on-farm– 15-20 lines, 3 Reps, 3-4 sites. Repeat 2 times possibly and select best lines

Conduct National Performance Trials (NPT) - 10-15 varieties, 4 -5 sites. Do Distinctiveness, Uniformity and Stability (**DUS**) test if required.

Release varieties that pass the NPT and DUS test or client selected varieties where there are no release procedures