Output 4: **Improved cultivars and management practices developed, evaluated and widely disseminated in partnership with NARS, regional networks, NGOs, and farmers**

Activity 4.1 Supporting breeding programs in NARS, regional networks, farmers' associations, and CIALs with germplasm and technical knowledge

Highlights:

- A large number of breeding line nurseries and germplasm were distributed to bean network partners from CIAT-Headquarters
- Close collaboration between CIAT and breeding programs in the Andean region continued with exchanges of researchers and germplasm. Training programs were developed for researchers from CORPOICA and the Univ. Nacional in Colombia, PROMPEX-INIA in Peru and Univ. San Simon in Bolivia. One training project involved developing and confirming BCMV resistance in Peruvian dry beans, using marker assisted selection for the first time in Peruvian bean improvement. Another project involved selection of BCMV and anthracnose resistance in climbing beans using molecular markers.
- Lines bred for drought tolerance present as much as 50% yield advantage over elite cultivars under drought conditions in Nicaragua, confirming that tolerance mechanisms selected in CIAT-Palmira are effective in Nicaragua.
- Some top yielding cultivars across sites within SABRN (GCI-CAL-28-AR, AFR 708, CIM 9314 and CIM9314-2) combine acceptable market type (red mottled), high yield potential and resistance to ALS or FLS or both.
- The national bean research program in the southern highlands of Tanzania, this year released a CIAT-bred line DRK 124, calling it *Uyole 03* and another line selected from crosses generated by NRI on a collaborative project with Tanzania. Various nurseries and germplasm were distributed to bean network partners.
- Four new small red-seeded lines with tolerance to major diseases and better yield potential (up to 40%) compared to commercial cultivars were selected in three countries in Eastern Africa. Eight new small red lines perform significantly better than commercial checks in regional trials in two countries.
- Two new red mottled bean lines with improved yield potential over the best commercial checks and tolerant to major biotic stresses were identified in regional trials in four countries in East and Central Africa. An elite nursery of new red mottled bean lines was constituted for validation with farmers and other end-users in Eastern Africa.
- Five new red kidney bean lines show outstanding performance in regional trials and are selected in four countries in East and Central Africa. Thirteen new red kidney lines with better performance than the major commercial cultivar (Canadian Wonder) are selected in three countries.
- New releases of sugar bean become popular in south western Uganda as demand for sugar bean rises in east, central and southern Africa markets
- More than six new sugar bean lines with higher yield potential and combined resistance to angular leaf spot, anthracnose and rust identified in regional evaluations in East and Central Africa

- Sixty farmers from the Central and Eastern Highlands of Kenya, in collaboration with researchers, select 20 red mottled, 20 red kidney and 24 bean lines resistant to root rots and angular leaf spot from a genetically diverse germplasm pool. More than 120 farmers start bulking seed of their new red mottled and red kidney bean lines. Farmer's preference criteria for red mottled and red kidney bean cultivars identified.
- Farmers and researchers select 22 new climbing bean lines of major grain types preferred in the Central Highlands of Kenya and other areas in East and Central Africa from segregating populations. New climbing bean lines with farmer preferred traits distributed for wider evaluation and seed bulking in more than 15 districts in Kenya.
- 12 yellow, sugar, white-seeded bean cultivars show good adaptation to humid tropical lowlands (470masl)
- More than 14 agricultural NGOs, farmer associations and community based organization accelerate seed production and dissemination in lowland western Congo. Improved bean cultivars feature prominently in Kinshasa markets.
- Diffusion of improved bean cultivars to other countries in humid tropical lowlands of central and western Africa gains momentum.
- New bean lines of major market classes with high levels of tolerance to aluminium toxicity and acid low fertility soils identified. The Great Lakes region proves to be a potential source of germplasm with tolerance to low soil fertility conditions
- Five bean lines tolerant to drought identified in regional trials in eastern Africa. A regional drought nursery is constituted and distributed to five drought-prone countries in eastern Africa.

4.1.1 Distribution of seed from CIAT Headquarters

Tables 94 to 96 show a summary of Bean Breeding, Andean Breeding and other nurseries distributed from CIAT headquarters to partners and collaborators.

Table 94. Nurseries distributed by the Mesoamerican bean breeding section

Description	No. of nurseries	No. of lines	Purpose	Institution/ Collaborator	Country
Advanced lines	1	3	Participatory Breeding	CIAT-Malawi R. Chirwa	Malawi
	1	3	Participatory Breeding	CIAT-Nicaragua J. A. Beltrán	Nicaragua
	1	11	Research	MAFP - Brian Palmer	Timor-Leste
Common bean lines Durango type	1	35	Participatory Breeding	Crop Breeding Inst. B. Vivek/G. Makunde	Zimbabwe
Common bean lines tolerant to ALS	1	60	Participatory Breeding	ICTA – Julio Cesar Villatoro	Guatemala
	1	60	Participatory Breeding	EAP - Zamorano, Juan Carlos Rosas	Honduras
	1	5	Research	NBPGR- R.V. Singh	India
	1	6	Participatory Breeding	INTA - R. Valdivia	Nicaragua

Table 94. cont'd

Description	No. of nurseries	No. of lines	Purpose	Institution/ Collaborator	Country
Common bean lines tolerant to drought (2003)	1	89	Research	HAAS Feng Guojun	China
	2	85	Participatory Breeding	MAG Juan Carlos Hernández	Costa Rica
		72	Participatory Breeding	Univ. de Costa Rica Rodolfo Araya	Costa Rica
	1	68	Local evaluation	CENTA Carlos Atilio Pérez	El Salvador
Common bean lines tolerant to drought (2001)	1	95	Local evaluation	CENTA Carlos Atilio Pérez	El Salvador
Common bean lines tolerant to drought (2003)	1	89	Local evaluation	ICTA Julio Cesar Villatoro	Guatemala
	2	89	Local evaluation	EAP - Zamorano, Juan Carlos Rosas	Honduras
		6	Seed production	CIAT-Honduras Guillermo Giraldo	
	1	117	Research	Pantnagar Centre for Plant Genet. Resourc. Hari Har Ram	India
	1	89	Research	SPII - A. Keshavarz	Iran
	1	55	Local evaluation	Crop Breeding Institute B. Vivek/G. Makunde	Zimbabwe
Early maturity lines	1	38	Research	Univ. of Idaho S. P. Singh	USA
F_2/F_5 Low fertility populations	1	3	Research	SPII - A. Keshavarz	Iran
F_5 families Rojo de Seda type	1	36	Local evaluation	CENTA Carlos Atilio Pérez	El Salvador
F_5 Families tolerant to drought (2004)	1	118	Participatory Breeding	INTA - R. Valdivia	Nicaragua
F_8 families – Rojo de Seda type with recessive bc-3 gene	1	26	Local evaluation	CENTA Carlos Atilio Pérez	El Salvador
	1	26	Local evaluation	INTA - Aurelio Llano	Nicaragua
F_8 Families tolerant to drought (2004)	1	5	Participatory Breeding	INTA - R. Valdivia	Nicaragua
High iron nursery	1	31	Research	EAP - Zamorano, Juan Carlos Rosas	Honduras
Interspecific F_6 populations	1	23	Local evaluation	EAP - Zamorano, Juan Carlos Rosas	Honduras
RILS - BAT 881 x G 21212	1	3	Research	Univ. of Hannover W. Horst	Germany
RILS - DOR 364 x BAT 477	1	88	Research	Univ. of Leuven Ellen Luyten	Belgium
VIPADOGEN	1	86	Research	Pantnagar Centre for Plant Genet. Resourc. Hari Har Ram	India
Yield nursery DOR 364 x BAT 477	1	36	Yield evaluation	CIF "La Violeta", Hernán Campos	Bolivia

Table 94. cont'd

Description	No. of nurseries	No. of lines	Purpose	Institution/ Collaborator	Country
Yield nursery (BAT 881 X G 21212)	2	36	Yield evaluation	INTA - Aurelio Llano	Nicaragua
		36	Yield evaluation	INTA - R. Valdivia	
Yield nursery (BRIBRI X SEA 5)	2	36	Yield evaluation	INTA - Aurelio Llano	Nicaragua
		36	Yield evaluation	INTA - R. Valdivia	

Table 95. Nurseries distributed by the Andean bean breeding and Germplasm Characterization section.

Description	No. of nurseries	No. of lines	Purpose	Institution/ Collaborator	Country
Anthracnose differentials	1	12	Biotic stress resistance evaluation	Univ. Nal. - Bogotá Gustavo Ligarreto	Colombia
BAT93	1	1	Nitrogen fixation evaluation	UNAM Gina Hernandez	Mexico
	1	1	Nitrogen fixation evaluation	LBMPS-Univ. Geneva Clive Pankhurst	Switzerland
	1	1	Nitrogen fixation evaluation	Gembloux Univ. Jean Pierre Baudoin	Belgium
BNF/non-nod stocks DOR 364, BAT477	1	4	Nitrogen fixation evaluation	LBMPS-Univ. Geneva William Broughton	Switzerland
CAP, CAN lines x 3 reps	1	86	Yield evaluation	UAGRM Juan Ortube	Bolivia
Climbing bean germplasm nursery x 3 reps	1	41	Yield evaluation	UAGRM, Juan Ortube	Bolivia
Colombian varieties x 3 reps	2	40	Yield evaluation	FIDAR Jose Restrepo	Colombia
F_2 populations	1	18	Line development	PROMPEX Angel Valladolid	Peru
F_3 populations	1	8	Line development	PROMPEX Angel Valladolid	Peru
G 2333	1	1	Biotic stress resistance evaluation	Michigan State Univ Jim Kelly	USA
Germplasm accessions	1	21	Genetic studies	Univ. of Vienna Andrea Pedroza	Austria
	1	34	Transformation capacity	UNAM Jesus Arellano	Mexico
Mid-altitude climbing (MAC) lines x 3 reps	1	37	Yield evaluation	UAGRM, Juan Ortube	Bolivia
POP – bush ñuñas – advanced lines x 6 reps	3	78	Yield evaluation	PROMPEX Angel Valladolid	Peru
Red seeded BIF lines x 2 reps x 2 trials	4	68	PPB/PVS Yield evaluation	FIDAR Jose Restrepo	Colombia

Table 95. cont'd…

Description	No. of nurseries	No. of lines	Purpose	Institution/ Collaborator	Country
RIL parents	1	6	Abiotic stress tolerance evaluation	Michigan State Univ Karen Cichy	USA
RIL parents x 100 g.each	1	18	Nutritional quality evaluation	Cornell University Raymond Glahn	USA
RILs - BAT 93 X JALO	1	4	Genetic studies	Univ. of Vienna Andrea Pedroza	Austria
RILs - DOR 364 x BAT 477	1	4	Abiotic stress tolerance evaluation	INRA Jean Drevon	France
RILs - DOR 364 X G 19833	1	4	Genetic studies	Univ. of Vienna Andrea Pedroza	Austria
RILs - DOR 364 x G 19833	1	89	Biotic stress resistance evaluation	ARC- Grain Crops Inst. Diedre Fourie	South Africa
RILs - G 21078 x G 21242	1	102	Abiotic stress tolerance evaluation	USDA-Baylor Coll. Med. Mike Grusak	USA
RMA, DRK lines x 3 reps	2	23	Yield evaluation	UAGRM, Juan Ortube	Bolivia
RMA, DRK lines x 3 reps	1	23	Yield evaluation	PROMPEX Angel Valladolid	Peru
RMA, DRK lines x 2 reps	1	23	Line development	ARC-Grain Crops Inst. Merion Liebenberg	South Africa
VICARIBE lines x 3 REPS	1	130	Yield evaluation	UAGRM Juan Ortube	Bolivia
VIVA-Crema moteado x 3 reps	1	37	Yield evaluation	Univ. del Tolima Javier Osorio	Colombia
VIVA-Rojos x 3 reps	1	22	Yield evaluation	Univ. del Tolima Javier Osorio	Colombia
VIVA-Rojo moteado x 3 reps	1	29	Yield evaluation	Univ. del Tolima Javier Osorio	Colombia
XAN 159	1	1	Transformation capacity	Univ. of Hannover Hans Jorg Jacobsen	Germany

Table 96. Other nurseries distributed from CIAT headquarters.

Description	No. of nurseries	No. of lines	Purpose	Institution/ Collaborator	Country
ALS differentials (DIFALS)	1	12	Characterization of isolates of *P.griseola*	Univ. Nal. de Heredia Carlos Araya	Costa Rica
ALS differential lines (Mexico 54, Bolón Bayo)	1	2	Characterization of isolates of *P.griseola*	EAP-Zamorano Juan Carlos Rosas	Honduras
ANT differentials (DIFANT)	1	12	Characterization of isolates of *C. indemuthianum*	Univ. Nal. De Heredia Carlos Araya	Costa Rica
	1	12	Characterization of isolates of *C. indemuthianum*	Facultad de Ciencias Agron. de Gembloux, Jean Pierre Busogoro	Belgium
Bean for Empoasca (650 g)		5	Lab research	University Maryland, Dr. William O. Lamp	USA
Bean lines for virus evaluation	1	238	Virus evaluation	La Tupia, Pradera	Colombia
Diacol Calima line (2.7 kg)		1	Lab research	Institu fur Pflanzenwissenschaften, Entomologie, ETZ-Zentrum, Dr. A. Rott	Switzerland
ICA Pijao line (10 g)		1	Lab research	Institu fur Pflanzenwissenschaften, Entomologie, ETZ-Zentrum, Dr. A. Rott	Switzerland
Infested seed with *A. obtectus* (27.1 kg)		1	Lab research	Institu fur Pflanzenwissenschaften, Entomologie, ETZ-Zentrum, Dr. A. Rott	Switzerland

4.1.2 Distribution of germplasm within the ECABREN bean network

Table 97. Germplasm distribution from ECABREN bean network

Description of materials	No. of nurseries	No. of entries	Purpose	Recipient	Country
Red mottled, large whites, small whites, pinto, black and tan/yellow	1	10	Biofortification-trials in Denmark	Shankutala Thilsted	Denmark
Red mottled, red kidneys, small reds, large whites, small whites, carioca, pinto, purples, tan, yellow, brown, black (bush and climbers).	1	89	Mineral and protein analysis of Kisii field trials by students	Mwaura, Department of Food Science and Technology	Kenya
Drought lines, early maturity lines, rootrot resistant lines, low soil pH tolerant lines, and climbing bean selections	6	50	PhD (TSBF)	M. Mucheru, Kenyatta University	Kenya
Small reds, blacks, small whites, browns	1	10	International drought trial	Prof Nancy Karanja, Dept of Soil Science	Kenya
Ayenew, Gofta, Roba-1, Maharagi Soja, K 131, Ituri Matata, HRS 545	1	7	Biofortification Trials	Steve Beebe, CIAT	Cali, Colombia
1 Bush (KK 15) and 9 climbers	1	10	BNF trial (M.Sc. student)	Kamau Gicharu, Kenyatta University	Kenya
HarvestPlus Nursery 1 (Red mottled, red kidneys, small reds, large whites, small whites, carioca, pinto, purples, tan, yellow, brown, black (bush and climbers)	8	29 bush + 9 climbers	Biofortification	ISAR (Rubona), EARO (Melkassa) SARI (Arusha) INERA (Mulungu), ISABU(Bujumbura), CIAT-Malawi, Chitedze Agric. Res. Institute NAARI (Namulonge)	Rwanda, Ethiopia, Tanzania, DR Congo, Burundi, Malawi, (Uganda x 2)
International Drought trial (Small reds, blacks, small whites, browns)	4	36 entries (x 3 reps x 2 trials	Regional evaluation	National program leaders (El Sadig, Musoni, Teshale and Ngulu)	Sudan Rwanda, Ethiopia Tanzania
Large whites, snap (bush)	2	35	Evaluations in Sudan	Gezira University	Sudan
Red mottled, red kidneys, small reds, pinto,	1	4 GLPs	HarvestPlus trials	Shankutala Thilsted,	Denmark
Low Soil Fertility tolerant lines (Cal 143, CIM 9314-36, M'Mafutala, M'Sole, MLB 49-89A, AFR 708)	1	6	Low soil N & P tolerant lines	Annet Namayanja, NAARI, Namulonge	Uganda
BSM tolerant lines (PAD 3, EXL 52,G 22501)	1	3	BSM resistant lines	Annet Namayanja, Namulonge	Uganda
VAX 6	1	1	CBB resistant line	Annet Namayanja, NAARI, Namulonge	Uganda
Drought lines Small reds	2	5	Maize-bean drought trial (with CYMMIT, Zimbabwe)	G. Makunde, Agric. Res. Council, Harare Charles Kapapa, Chitedze Agric. Res. Institute , Lilongwe	Zimbabwe, Malawi

Table 97. cont'd …

Description of materials	No. of nurseries	No. of entries	Purpose	Recipient	Country
Small reds, blacks, small whites, browns	1	36 entries x 1 rep x 2 trials	Drought trials in Rift Valley	Prof. R.S Pathak, Egerton University	Kenya
Parental lines and commercial varieties , BSM , BILFA lines and root rot resistant lines (bush and climbers)	1	100	Development of populations for HarvestPlus CP	Matthew Blair, CIAT (13 May 04)	Cali, Colombia
Angular leaf spot differentials (G 5686, MEX 54, Montcalm, Balon Bayo, Flor de Mayo, G 11796, Don Timoteo, Cornell 49242, G 2858, Amendoim, PAN 72)	1	11	Trials in India	Dr. Sanjay Gupta, ICAR Division of Plant Breeding (13 May 04)	India
Red mottled, red kidneys, small reds, large whites, small whites, carioca, pinto, purples, tan, yellow, brown (bush and climbers)	1	29 bush (short & med. duration) + 10 climbers	Preliminary evaluation for adaptability.	Dr. Sanjay Gupta, ICAR Division of Plant Breeding (13 May 04)	India
Red mottled, red kidneys, small reds, large whites, small whites, carioca, pinto, purples, tan, yellow, brown (bush and climbers)	1	75 bush + 25 climbers	Regional trial	Dr. Jacob M Ngeve, IRAD Centre Agronomique (18 May 04)	Cameroon
Red mottled, red kidneys, small reds, large whites, small whites, carioca, pinto, purples, tan, yellow, brown	5	52 entries x 5 agro-ecologic zones	Advanced breeding lines for preliminary evaluation for adaptability	Tadesse Mebrahtu c/o Asmeron Kidane, Ministry of Agriculture, Asmara (20 May 04)	Eritrea
Red mottled, red kidneys, small reds, large whites, small whites, carioca, pinto, purples, tan, yellow, brown	5	48 entries x 5 agro-ecologic zones	Commercially released cultivars in the region for preliminary evaluation for adaptability	Tadesse Mebrahtu c/o Asmeron Kidane, Ministry of Agriculture, Asmara (20 May 04)	Eritrea
Rwanda Collection (Red mottled, red kidneys, small reds, large whites, small whites, carioca, pinto, purples, tan, yellow, browns)	1	1036	Mineral analysis	Matthew Blair, CIAT (12 July 04)	Cali, Colombia
F_5 Root rot lines	1	50	Line development	R. Otsyula	Kenya
Elite lines and germplasm	1	17	Pest tolerance/yield performance testing and evaluation	Farmers' groups	Kenya
Elite lines and germplasm	1	30	Pest tolerance/yield performance testing and evaluation	Farmers' groups	N. Tanzania

4.1.3 Exchange of germplasm in Southern Africa Bean Research Network (SABRN)

Various countries within SABRN grouping requested specific nurseries. The nurseries were organized either by market class, or constraint or growth habit of the bean plant. These nurseries serve as sources of germplasm with good attributes that might be useful to NARS partners. The ARS partners either use the selected germplasm in their breeding programs, or they can directly release them as varieties. During this reporting period several nurseries were distributed to various countries (Table 98).

Table 98. List of nurseries and trials that were distributed in the SABRN, 2004

Description	No of nurseries	No. of entries	Purpose	Recipient	Country
Sugar lines nursery	1	134	Yield and adaptation	ARI-Uyole	Tanzania
	1			AREX	Zimbabwe
	3			ARC	South Africa
Small reds nursery	1	91	Yield and adaptation	ARI-Uyole	Tanzania
	1			ARD	Swaziland
International ALS nursery	1	70	Resistance to ALS	ARI-Uyole	Tanzania
	1			AREX	Zimbabwe
	1			ARD	Swaziland
Small black lines	1	27	Yield and adaptation	ARI-Uyole	Tanzania
Drought nursery	1	153	Yield and adaptation	ARI-Uyole	Tanzania
Low N nursery	1	79	Screen for tolerance to low N		Tanzania
	1				Mozambique
	1				Zimbabwe
Low P nursery	1	85	Screen for low tolerance to low P		Tanzania
	1				Mozambique
	1				Zimbabwe
MCR lines nursery	1	62	Yield and adaptation		Tanzania,
	2				Zambia
	1				Mozambique
SARBYT	2	19	Yield and adaptation	ARI-Uyole	Tanzania
	2			DR&SS	Zambia
	3			INIA	Mozambique
	2			AREX	Zimbabwe
	2			ARD	Swaziland
	3			ARC	South Africa
	1			ARD	Lesotho
	2			DARS	Malawi
	3			INERA	DRC

Table 98. cont'd…

Description	No of nurseries	No. of entries	Purpose	Recipient	Country
SARBEN	1	99	Yield and adaptation	ARI-Uyole	Tanzania
	2			DR&SS	Zambia
	3			INIA	Mozambique
	2			AREX	Zimbabwe
	1			ARD	Swaziland
	1			ARD	Lesotho
	2			DARS	Malawi
	3			INERA	DRC
Mid- altitude climbers yield trial	2	20	Yield and adaptation	INIA	Mozambique
	1			DARS	Malawi
Red mottled lines	1	742	Yield and adaptation	INIA	Mozambique
	2			DARS	Malawi
Climbing bean nursery	2	27	Yield and adaptation	DR&SS	Zambia
	2			DARS	Malawi
Red kidneys lines	3	70	Yield and adaptation	ARC	South Africa
	1			AREX	Zimbabwe
Root rot nursery	1	78	Root rot screening	ARD	Swaziland
BSM nursery	1	36	Screening for BSM	ARD	Swaziland
Calima lines	3	68	Yield and adaptation	ARC	South Africa
Low pH nursery	1	108	Screen for tolerance to low pH	INIA	Mozambique
	1			AREX	Zimbabwe
Elite lines and germplasm	1	23	Pest tolerance/yield performance testing and evaluation	Farmers' groups	S. Tanzania
SUG 131	`1	1	Pest tolerance/yield performance testing and evaluation	Farmers' groups	Malawi

4.1.4 Testing drought tolerant lines in Nicaragua

Rationale: The Pacific coast of Central America from Nicaragua to El Salvador is subject to repeated and severe droughts that not infrequently have resulted in complete crop losses for many farmers. CIAT and INTA participate in a BMZ-funded project to improve drought tolerance of common bean for this region.

Materials and Methods: F_6-derived families were selected in CIAT by INTA scientists in August, 2003 and shipped to Nicaragua for planting and evaluation under conditions of drought and BGYMV attack. Lines were selected based on seed quality and were increased in January, 2004 for planting in multi-locational yield trials with three repetitions, in Nandarola on the dry Pacific coast, in Matagalpa and in the coastal hills of Carazo in La Compañía Experiment Station, where drought is not normally a problem but which serves as a control treatment without drought.

Results and Discussion: Drought was excessive in Matagalpa and the trial was lost, but the Nandarola site received 120 mm during the growth cycle and experienced drought as the primary yield limitation. The Carazo site experienced no drought as expected. The difference in yield of the elite check variety, INTA Rojo, in the latter two sites was 1216 versus 2265 kg ha-1, or a reduction of 46% due to drought (Table 99). Among the drought-selected lines, yields were superior to that of INTA Rojo by as much as 50% in Nandarola. This confirms that drought genes identified in CIAT-Palmira are effective and offer protection against drought in this Central American environment. Selected lines will be tested in validation trials, while other lines from crosses to fortify resistance to BGYMV are being tested.

Table 99. Yields of drought selected lines in two environments in Nicaragua.

	Yield (kg/ha)	
Identification	**Nandarola (drought)**	**Carazo (non-drought)**
MR 14148-54	1843	1663
MR 14143-28-2	1644	1660
MR 14143-28-4	1498	1714
MR 14258-7	1487	1793
MR 14143-28-1	1467	2014
MR 14143-28-7	1393	1780
MR 14148-80	1393	1926
MR 14292-63-1	1393	1729
MR 14143-28-6	1393	1622
MR 14143-28-5	1361	1960
MR 14292-63-3	1307	1882
MR 14000-2	1226	2550
MR 14143-28-3	1223	1915
INTA Rojo (Elite check)	1216	2265
MR 14202-10	1174	1964
MR 14292-63-2	1142	1864
MR 14152-14	1130	2065
MR 14215-9	964	1480
MR 14148-74	923	1778
MR 14273-4	807	2114
MR 14232-10-3	640	1399
MR 14232-10-2	470	1128
MR 14232-10-1	460	1014

Conclusion: Drought tolerance selected in Palmira can make a useful contribution to protecting the crop against drought in Central America.

Contributors: Aurelio Llano, Mauricio Guzmán, Rodolfo Valdivia, Sergio Blandón (INTA); S. Beebe (IP-1)

4.1.5 BCMV resistance in Peruvian dry beans

Rationale: Most of the local climbing and bush bean varietes grown in Peru have not been improved for BCMV resistance. We began a collaboration with Promenestras en Peru to develop segregating populations that would contain either the *I* or *bc3* resistance genes. The target seed classes have been alubias, bayos, canarios, caballero and ñuñas. Although these seed classes are for local consumption (except for Alubia) they have good potential for the export market, in which Peruvian producers are increasing the range of products they offer and the number of countries exported to.

Materials and Methods: Simple crosses were made to produce F_1 hybrids for multiple and triple or back crosses. Among the bush beans the parents included released white (INIA-Garza) and bayo (Bayo Mochica) varieties as well as a group of yellow-seeded Canario breeding lines (CIFAC series). Among the climbing beans, the parents included white beans (Caballeros, Fabes), yellows (Canario bola) and popping beans (nuñas). The sources of BCMV resistance were a series of BRB lines with matching seed coat color. A few additional crosses were made between red-seeded bush (Catrachita x INIA-B, Montcalm, DRK57, Redkloud y RAA15) or climbing (rojo bolon) beans and BCMV resistance sources. Redkloud is known as Rojo Mollepata in Peru and is a favored highland variety. Catrachita x INIA-B is an advanced line that will be released in the near future.

Results and Discussion: The list of F_2 and F_3 populations which were developed and multiplied in Darién for shipment to Peru are shown in Table 100a and 100b. In parallel to these breeding efforts, we inoculated Alubia and Fabes-type breeding lines developed by Promenestras confirming that many contained the *I* gene (Table 101). These genotypes were also evaluated with the SW13 SCAR marker and were found to contain the dominant band associated with *I* gene resistance. Further marker assisted selection will be possible with these genotypes, and Mr. K. Delgado from Promenestras was trained in marker techniques for this purpose. BCMV was confirmed to be the most serious Potyvirus in the samples from INIA-Cusco which were from the Yucay and Mollepata experiment stations (Table 102).

Table 100. Populations generated with Peruvian commercial dry bean genotypes.

a. F_2 populations

No. Entry	Identity	Pedigree	Color Class
Bush Beans			
1	22434-(M) F2	Alubia Cerrillos X BRB197	Alubia
2	22436-(M) F2	Alubia Cerrillos X BRB232	Alubia
3	22439-(M) F2	CIFAC 90013 X BRB197	Canario
4	22440-(M) F2	CIFAC 90013 X BRB196	Canario
5	22441-(M) F2	CIFAC 90013 X BRB232	Canario
6	22442-(M) F2	CIFAC 91125 X BRB212	Canario
7	22443-(M) F2	CIFAC 91135 X BRB212	Canario
8	22444-(M) F2	Bayo Mochica X BRB130	Bayo
9	22445-(M) F2	Bayo Mochica X BRB212	Bayo
10	22446-(M) F2	Bayo Mochica X BRB232	Bayo

Climbing Beans			
11	NV 22371-M (F2)Z	Perry Marrow x Q'osqo Poroto	White
12	NV 22372-M (F2)Z	G2333 x Q'osqo Poroto	Red, Yellow
13	NV 22373-M (F2)Z	Kaboon x Q'osqo Poroto	White, Yellow
14	NV 22374-M (F2)Z	BRC3 x Q'osqo Oroto	Red, Yellow
15	22375-M (F2)Z	BRC3 x Kori Inti	Red, Yellow
16	22376-M (F2)Z	Kori Inti x G2333	Red, Yellow
17	22447-M (F2)Z	Kori Inti x G2829	Yellow
18	22448-M (F2)Z	G2829 x Kori Inti	Yellow
19	22449-M (F2)Z	Kori Inti X BRB197	Yellow
20	22450-M (F2)Z	Kori Inti X Blanco Laran Mejorado	White, Yellow
21	22451-M (F2)Z	Blanco Salkantay X BRB156	White
22	22452-M (F2)Z	Blanco Salkantay X BRB196	White
23	22454-M (F2)Z	Blanco Salkantay X BRB130	White
24	22455-M (F2)Z	Blanco Salkantay X BRB191	White, Red Mt.
25	22456-M (F2)Z	Caballero X BRB 151	White
26	22457-M (F2)Z	Caballero X BRB 232	White, Yellow
27	22458-M (F2)Z	Caballero X Blanco Laran Mejorado	White
28	22459-M (F2)Z	Caballero X BRB 130	White
29	22460-M (F2)Z	Caballero X BRB 196	White
23	22461-M (F2)Z	Caballero X BRB 197	White
24	22462-M (F2)Z	Canario Bola X BRB 191	Yellow, Red Mt.
25	22463-M (F2)Z	Q'osqo Poroto X BRB 232	Yellow
26	22466-M (F2)Z	MAC56 X BRB 197	Yellow
27	22467-M (F2)Z	MAC56 X BRB 204	Yellow
28	22468-M (F2)Z	MAC57 X BRB 232	Yellow

b. F_3 populations

Bush	**Climbers (cont'd)**
ALUBIA CERRILLOS x BRB 130	BRB 212 x ALUBIA FABES
ALUBIA CERRILLOS x BRB 196	BRB 232 x ALUBIA FABES
ALUBIA CERRILLOS x BRB 212	BRB 232 x CAB 19
INIA GARZA x BRB 197	BRB 232 x WATA POROTO
CIFAC 90013 x BRB 130	CAB 19 x BRB 130
CIFAC 90013 x BRB 197	CAB 19 x BRB 196
Climbers	CAB 19 x BRB 197
BRB 130 x WATA POROTO	CAB 19 x BRB 212
BRB 130 x BLANCO SALKANTAY	CAB 19 x BRB 232
BRB 130 x ALUBIA FABES	BRC 12 x BL.SALKANTAY
BRB 196 x CAB 2	BRC 12 x ALUBIA FABES
BRB 196 x CAB 19	BRC 30 x ALUBIA FABES
BRB 196 x ALUBIA FABES	BRC 34 x WATA POROTO
BRB 196 x WATA POROTO	BRC 34 x BL.SALKANTAY
BRB 196 x Q'OSQO POROTO	WATA POROTO x BRB 130
BRB 197 x CAB 19	WATA POROTO x BRB 212
BRB 197 x WATA POROTO	MAC 56 x BRB 197
BRB 197 x BL.SALKANTAY	MAC 57 x BRB 130
BRB 197 x Q'OSQO POROTO	MAC 57 x BRB 196
BRB 212 x CAB 2	MAC 57 x BRB 197
BRB 212 x CAB 19	KORI INTI x BRB 130
BRB 212 x CABALLERO	KORI INTI x BRB 212

Table 101. Alubias and Fabes from PROMPEX-Peru, tested for BCMV resistance.

Entry no.	Advanced Line	N	M	Entry no.	Advanced Line	N	M
1	ALUBIA 3001	8	0	25	ALUBIA 3025	9	0
2	ALUBIA 3002	0	9	26	ALUBIA 3026	9	0
3	ALUBIA 3003	10	0	27	ALUBIA 3027	9	0
4	ALUBIA 3004	10	0	28	ALUBIA 3028	10	0
5	ALUBIA 3005	10	0	29	ALUBIA 3029	10	0
6	ALUBIA 3006	9	0	30	ALUBIA 3030	9	0
7	ALUBIA 3007	2	8	31	ALUBIA 3031	9	0
8	ALUBIA 3008	0	10	32	ALUBIA 3032	8	0
9	ALUBIA 3009	0	9	33	FABES 3001	10	0
10	ALUBIA 3010	10	0	34	FABES 3002	10	0
11	ALUBIA 3011	9	0	35	FABES 3003	10	0
12	ALUBIA 3012	9	0	36	FABES 3004	10	0
13	ALUBIA 3013	9	0	37	FABES 3005	10	0
14	ALUBIA 3014	10	0	38	FABES 3006	10	0
15	ALUBIA 3015	9	0	39	FABES 3007	10	0
16	ALUBIA 3016	9	0	40	FABES 3008	9	0
17	ALUBIA 3017	10	0	41	FABES 3009	9	0
18	ALUBIA 3018	10	0	42	FABES 3010	10	0
19	ALUBIA 3019	8	0	43	FABES 3011	10	0
20	ALUBIA 3020	10	0	44	FABES 3012	9	0
21	ALUBIA 3021	8	0	45	FABES 3013	9	0
22	ALUBIA 3022	8	0	46	FABES 3014	9	0
23	ALUBIA 3023	7	0	47	FABES 3015	8	0
24	ALUBIA 3024	9	0				

N = necrosis (resistance – *I* gene) ; M = mosaic (susceptibility)

Table 102. Potyvirus analysis of INIA-Cusco samples.

Entry No.	Sample	Laboratory results - ELISA			
		BCMV	BSMV	BMMV	Severe
1	Yucay I	+	+	-	-
2	Yucay II	-	+	-	-
3	Yucay III	-	-	-	-
4	Yucay IV	-	-	-	-
5	Yucay V	-	-	-	-
6	Yucay VI	-	-	-	-
7	Yucay VII	-	-	-	-
8	Mollepata I	-	-	-	-
9	Mollepata II	+	-	-	-
10	Mollepata III	+	-	-	-
11	Mollepata IV	+	-	-	-
12	Mollepata V	+	-	-	-
13	Mollepata VI	+	-	-	-
14	Mollepata VII	-	-	-	-
15	Mollepata VIII	+	-	-	-
16	Mollepata IX	+	-	-	-
17	Mollepata X	+	-	-	-
18	Mollepata XI	-	-	-	-
19	Mollepata XII	+	-	-	-

Future Plans: Remnant seed will be planted for pedigree and mass selection to develop locally adapted germplasm for Colombia and other areas of the mid-altitude tropics. Single plant selections will be made in the F_5 generation.

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4.1.6 New small red lines with high yield potential identified in regional evaluation in Eastern Africa

Rationale: Small red grain type is an important market class in bean producing countries of East and Central Africa. Small and medium size reds accounts for more than 20% of the area under bean production in Africa (Wortmann et al, 1998). Small reds are particularly important in Ethiopia, where they account for more than 50% of the production. They are also widely grown in Kenya, Rwanda, DR Congo, and Tanzania. Small and medium reds are becoming popular in Madagascar and some parts of western Africa. Productivity of small reds is constrained by diseases especially rust, root rots, common bacterial blight, angular leaf spot, drought and low soil fertility. Most of the regionally important commercial varieties such as Red Wolaita in Ethiopia, GLP 585 ('Wairimu') in Kenya, Maasai Red in Tanzania and Umubano in Rwanda, DR Congo and Uganda are susceptible and have low yield potential. Umubano is also susceptible to Fusarium wilt strains occurring in Rwanda. A regional program to develop and disseminate high yielding, marketable small red bean lines with resistance to biotic and abiotic stress factors and acceptable grain characteristics was started in 2001. This program involved the development of segregating populations from simple and complex crosses, screening existing advanced breeding lines from regional bean programs and the CIAT bean program in Colombia, followed by constraint evaluation and yield testing across agro ecological zones in Eastern Africa. We previously reported on the progress made in population development and constraint evaluation. This report highlights progress made in regional evaluation and identification of candidate lines.

Materials and Methods: Twenty five small red lines were evaluated in Ethiopia, Madagascar, Tanzania and Kenya in 2003/2004. The lines were identified from previous constraint evaluation in the regional program. The trials were laid out in a 5 x 5 lattice design with three or four replicates. Plots had four 5m rows. Spacing was 45-50 cm between rows and 10-15 cm within rows. Data was collected from the two inner rows. Normal cultural practices were followed. Regionally important commercial cultivars were included as checks. A variety selection meeting was conducted September 2004 to identify the most promising lines in each country and regionally.

Results and Discussion: In Ethiopia, yield of the 25 lines varied from 851 kg ha^{-1} (ECAB 0420) to 2929 kg ha^{-1} (ECAB 0426) with a trial mean of 1691 kg ha^{-1}. Sixteen lines had better grain yield compared to Red Wolaita, the most popular small red bean variety in Ethiopia (Table 103). Grain size of the new lines was comparable or slightly larger than that of Red Wolaita (22 g per 100 seeds). However, only six lines had better yield than Maasai Red. Sixteen lines had better grain yield compared to GLP 585 (Wairimu).

Table 103. Plant height, 100-seed mass and grain yield of 25 small red bean lines at Awassa in southern Ethiopia, 2003/04.

Line	Plant height (cm)	100-seed mass (g)	Grain yield (kg ha-^{1})
ECAB 0426	36	23.7	2929
ECAB 0427	45	24.0	2455
ECAB 0416	41	23.7	1934
ECAB 0429	43	20.7	1923
ECAB 0418	41	23.1	1966
ECAB 0419	40	24.3	1598
ECAB 0411	34	20.9	2564
ECAB 0402	40	24.5	2263
ECAB 0424	40	24.3	1935
ECAB O421	37	25.8	1716
ECAB 0417	36	22.3	1553
ECAB 0415	33	24.3	2301
ECAB 0422	38	22.3	2229
ECAB 0410	44	21.5	1558
MCM 2001	39	22.8	1556
GLP 585	40	21.3	1346
Maasai Red	37	25.1	2032
Red Wolaita	35	22.0	1449
Trial mean	38	23.4	1691

In Madagascar, seven small red lines were selected. Grain yield of the selected lines varied from 771 to 1278 kg ha-^{1}. The selected lines were ECAB 0427 (771 kg ha-^{1}), ECAB 0418 (707 kg ha-^{1}), ECAB 0411 (1155 kg ha-^{1}), ECAB 0417 (1278 kg ha-^{1}), ECAB 0415 (1072 kg ha-^{1}), ECAB 0422 (824 kg ha-^{1}) and ECAB 0410 (780 kg ha-^{1}). This compared with 870 kg ha-^{1} for GLP 585. The selected Flines flowered in 42 to 48 days in Madagascar. GLP 585, ECAB 0415 and ECAB 0410 flowered in 48 days. All other lines flowered in 42 to 43 days.

In Kenya, the best performing varieties included ECAB 0429 (1925 kg ha-^{1}), ECAB 0426 (1895 kg ha-^{1}), ECAB 0420 (1813 kg ha-^{1}), ECAB 0428 (1757 kg ha-^{1}), ECAB 0408 (1757 kg ha-^{1}), ECAB 0410 (1644 kg ha-^{1}) and ECAB 0402 (1617 kg ha-^{1}). Results also showed that, as in Ethiopia, Maasai Red was the best yielding check variety in Kenya.

Regionally, four new lines were selected in the three countries. These were ECAB 0418, ECAB 0411, ECAB 0417 and ECAB 0410. Eight lines were selected in two of the three countries. Three lines were selected in one country. Results from Tanzania are pending. These results indicate that the new small red lines may have both broad and country specific adaptation. No significant susceptibility to diseases was reported. However, further evaluation on-farm and on-station across agro ecological zones will confirm the best candidates for release and seed production.

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4.1.7 New red mottled bean lines identified in regional evaluation in Eastern Africa

Rationale. The large seeded red mottled bean is probably the most important market class in East and Central Africa and in major bean producing countries in southern Africa such as Malawi. Regionally, it has an estimated 20% market share, and probably higher in Kenya, Uganda and Malawi, the leading producers and consumers of red mottled bean. Red mottled bean is gaining popularity in the region. For example, red mottled is now a popular grain type in southern Ethiopia, five years since it was introduced in the area. In Awassa, the red mottled bean is selling at a higher price in local markets (20 to 30 Birr per kg, equivalent to US$ 2 to 3) compared to the traditionally popular small red. However, most of the regionally important commercial cultivars such as GLP2, K20, K132 and Lymungu 85, are susceptible to diseases, pests and low soil fertility. This has contributed to decline in national production and low yields in farmers' fields, adversely affecting food security, nutrition and incomes of bean growers in the region. A regional program was started in 2001 to develop improved red mottled bean lines with resistance to diseases (especially angular leaf spot, anthracnose, common bacterial blight and root rots) and tolerance to abiotic stress factors especially low soil fertility and drought. Last year, we reported on development of breeding populations and identification of lines combining resistance to two or more biotic and abiotic stresses. In this report, we highlight the performance of the lines in regional trials and selection of candidate lines for release.

Materials and Methods: One hundred advanced red mottled lines were distributed to sites in Uganda, Ethiopia, DR Congo, Kenya, Burundi and Tanzania in 2003 for evaluation and identification of best performing lines in major agroecological zones. The study also sought to identify lines with broad and country specific adaptation both on-station and in farmers' fields. Regionally important red mottled commercial cultivars were included as checks. The trials were laid out in lattice design with three or four replicates. Each plot had four, 5 m rows. Agronomic data was collected from the inner two rows. Intra-row spacing was 10 cm and 45 between rows. Rating for biotic and abiotic stresses followed CIAT (1987) standard system. Collaborators added other promising red mottled lines to the standard set (25 entries) for comparison.

Results and Discussion: In Uganda, seven lines were selected. These were ECAB 0060, ECAB 0070, ECAB 0090, AFR 623, POA8, F7MG/1 and POA 4. Fifteen lines were selected in DR Congo from a regional multiple constraint nursery. These included CAL 143, AND 907, AND 897, AND 1060, AFR735, AFR 699, UBR93/4, AND 1005, POA 2, CAL 175, CAL 172, VAC 49, POA 8, AFR 623 and CAL 176. POA 2 is released in Uganda (as NABE 4). Selection was based on evaluation on-farm and on-station for two seasons. The nurseries were also distributed for further evaluation and selection in M'vuazi and Equator regions. Characteristics of the selected lines are shown in Table 104. In Ethiopia, 25 lines including a local check were evaluated at Awassa. Grain yield varied from 2018 kg ha^{-1} for the local check to 3321 kg ha^{-1} for ECAB 0027 with a trial mean of 2692 kg ha^{-1} (Table 105). Growing conditions were favourable and no major disease incidence was recorded. The best yielding lines were ECAB 0027, ECAB 0008, ECAB 0081, ECAB 0063, ECAB 0042, ECAB 0043, ECAB 0098, ECAB 0019 and ECAB 0081. Test lines produced higher yields compared to K132, CAL 143, GLP 2 and Lyamungu 85.

Table 104. Days to flowering and maturity, reaction to angular leaf spot, anthracnose, ascochyta, rust and grain yield of bean lines selected from the regional multiple constraint nursery (MCN) in eastern DR Congo, 2003/2004.

Line	Days to 50% flowering	Days to maturity	Angular leaf spot	Anthracnose	Ascochyta	Rust	100-Seed mass	Grain yield (kg ha^{-1})
SCAM 80CM/2	41	92	4	1	1.6	1.6	35.8	2047
SEQ 1006	49	94	3.3	1	1	1.3	41	1874
CAL 143	47	94	4	1	1.6	1.6	37	1807
AND 907	47	94	3.3	1.3	1.3	1.3	38.5	1785
AND 897	47	94	3	1.3	1.3	1.3	39.2	1761
AFR 735	39	89	3.3	1	1.6	1	37	1675
AND 1060	47	92	3.3	1	1.6	1	43	1393
AFR 699	51	99	3	1	1.3	1.3	42	1196
UBR93-4	47	92	3.6	1	1	1	42	1436
AND 1005	51	99	3.3	1	2.0	1	45.2	1072
POA 2	47	92	3.3	1	1	1.3	36	1029
CAL 175	45	92	3.3	1.3	1.6	1	42	1160
CAL 172	45	89	3.3	1.3	1.6	1.3	37.2	1009
VAC 49	51	92	3.3	1	1.3	1	29	883
POA 8	45	92	4	1	1	1	53	950
AFR 623	47	92	3.3	1.3	1	1	43.5	1172
CAL 176	47	92	4.3	1.3	1.6	1.3	48.2	1280

Table 105. Plant height, 100-seed mass and grain yield of red mottled bean lines selected at Awassa, southern Ethiopia, 2003/4.

Line	Plant height (cm)	100-seed mass	Grain yield (kg ha^{-1})
ECAB 0056	39	41.5	2555
ECAB 0034	39	42.6	2581
ECAB 0042	34	45.5	2991
ECAB 0008	36	51.6	3261
ECAB 0063	43	46.7	3163
ECAB 0060	33	42.7	2389
ECAB 0068	40	43.0	2576
ECAB 0041	38	41.8	2789
ECAB 0043	34	50.8	3121
ECAB 0047	39	44.7	2706
ECAB 0020	39	43.2	2574
ECAB 0098	34	41.6	2990
ECAB 0019	35	41.5	2981
ECAB 0023	38	45.8	2956
ECAB 0081	35	47.9	3173
ECAB 0013	37	43.7	2329
ECAB 0050	36	45.1	2783
ECAB 0027	42	49.1	3331
ECAB 0097	48	47.0	2780
ECAB 0082	40	42.5	2039
K132	36	43.8	2156
CAL 143	35	38.2	2398
GLP 2	45	40.6	2455
Lyamungu 85	37	49.7	2217
Local check	38	50.2	2018
Mean	37.6	44.8	2692

In Tanzania, 23 lines were evaluated under irrigation at Madiira (Arusha) due to failure of rains during the season. Yields were generally high (over 2 t ha^{-1}). The best performing lines were: ECAB 0060, ECAB 0063, ECAB 0019, ECAB 0036, ECAB 0020, GLP 2, ECAB 0023, ECAB 0082, ECAB 0081, ECAB 0042, ECAB 0027, ECAB 0043, ECAB 0050 and ECAB 0013. In Madagascar, five lines were selected. Yields were lower in Madagascar compared to other sites. The best performing lines were ECAB 0034 (890 kg ha^{-1}), ECAB 0063 (866 kg ha^{-1}), CAL 143 (1022 kg ha^{-1}), K132 (727 kg ha^{-1}) and Lyamungu 90 (658 kg ha^{-1}). Based on performance at three locations over two seasons, the best performing lines in Kenya were: ECAB 0019, ECAB 0027, E8, ECAB 0063, ECAB 0041, ECAB 0060, ECAB 0023, ECAB 0081, ECAB 0098, ECAB 0013, ECAB 0097, ECAB 0056, ECAB 0043, ECAB 0008, ECAB OO20, ECAB 0047 and ECAB 0068.

These results indicate that most of the lines performed well in more than one country, indicating broad adaptation. Two outstanding lines that were selected at sites in four countries were: ECAB 0060 and ECAB 0063. Six lines showed good performance in three countries. These were ECAB 0020, ECAB 0019, ECAB 0023, ECAB 0081, ECAB 0013, and CAL 143. From the MCN nursery, POA 2, POA 8 and AFR 623 were selected in both DR Congo and Uganda. Twelve lines showed good adaptation in two countries. It appears that some regionally adapted lines, with better grain yield and resistance to the major diseases may be identified from these trials. Lines with broader adaptation are preferred by seed producers because they justify seed production for a larger market.

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4.1.8 New dark red kidney bean lines identified from regional evaluation in Eastern Africa

Rationale: Dark red kidney is one of the most important market classes of the common bean in East and Central Africa. It commands an estimated 10% market share in domestic and regional markets, and a much higher share in Kenyan and Tanzanian markets. Production is dominated by a single variety, Canadian Wonder which was introduced in the region more than 50 years ago. However the productivity of this variety has been on the decline because of susceptibility to diseases, especially angular leaf spot, anthracnose, common bacterial blight, root rots, drought and declining soil fertility. More recent releases such as Selian 97 have yet to meet consumer acceptability comparable to Canadian Wonder. Red kidney bean is predominantly produced by smallholder farmers, with limited options for inputs to reduce effects of biotic and abiotic stresses. Development of new varieties with natural host resistance to these stresses is probably the most effective strategy of improving productivity of red kidney bean. In 2001, the East and Central Africa Bean Research Network started a market led breeding strategy to develop high yielding, red mottled beans with tolerance or resistance to two or more biotic and abiotic stresses. This program started with development of segregating populations from simple and multiple crosses, and introduction of red kidney grain type from CIAT, Colombia. During the first phase of this work, the segregating populations were selected for six to eight generations under natural and artificial disease epiphytotics, low soil fertility and drought stress. In second phase, red kidney lines with acceptable grain and resistance to major stresses were entered into regional evaluations to expose them to a wider range of pathogen diversity and production environments in East and Central Africa and to identify candidates for national and regional releases. This report highlights progress made in identification of promising red kidney lines from regional evaluation.

Materials and Methods: One hundred-twelve red kidney lines were evaluated in trials sites in Ethiopia, Madagascar, Tanzania, Rwanda and Kenya. The experiments were laid out in lattice design with three to four replicates. Spacing was 45-50 cm between rows and 10-20 cm within rows. A plot had four rows. Yield and other agronomic data were collected from the inner two rows. Rating for biotic and abiotic stresses followed CIAT (1987) standard system. Collaborators added other promising red kidneys lines to the standard set (112) for comparison. Normal cultural practices were followed. Breeders, pathologists, soil scientists and agronomists from participating countries made selections during 'candidate variety' selection meeting in Nairobi, September 2004. Canadian Wonder was included as the check variety.

Results and Discussion: In Tanzania, high yields were recorded because the trial was irrigated after rains failed. Grain yield varied from 3148 to 4897 kg ha^{-1}. There was a low incidence of rust on one line and anthracnose on two lines. Plant vigour varied from 1 to 3. Four lines which flowered in less than 41 days were grouped as early maturing. These were EACB 0243, ECAB 0294, ECAB 0287 and ECAB 0217. All other lines flowered within 44 days. Canadian Wonder had the lowest yield (3148 kg ha^{-1}). ECAB 0204 had the highest grain yield (4897 kg ha^{-1}) and was the only line that yielded better than Selian 97. In contrast, low yields were recorded in Madagascar. Yields of the best 12 lines varied from 710 to 1693 kg ha^{-1}. However, only five lines had better yields than Canadian Wonder (GLP 24) with a mean yield of 825 kg ha^{-1}. These were ECAB 0240 (889 kg ha^{-1}), ECAB 0247 (875 kg ha^{-1}), AND 931-B1 (982 kg ha^{-1}), TZ 201-439-3 (777 kg ha^{-1}), EMP 250-51 (1142 kg ha^{-1}), VTT 926/2-4 (1693 kg ha^{-1}) and UBR (91)45-1 (1266 kg ha^{-1}). ECAB 0240 and UBR (91)45-1 flowered in 40 days. TZ 201-439-3 was the last to reach 50% flowering (48 days).

Relatively high yields were recorded in Ethiopia. Grain yield varied from 2300 kg ha^{-1} (ECAB 0281) to 3452 kg ha^{-1} (ECAB 0270). Some characteristics of the 11 lines that produced more grain than the check Canadian Wonder are shown in Table 106. However, 21 lines (including Canadian Wonder) yielded better than Selian 97.

Table 106. Plant height, 100-seed mass and yield of the best yielding lines at Awassa, southern Ethiopia.

Line	**Plant height (cm)**	**100-seed mass (g)**	**Grain yield (kg ha^{-1})**
ECAB 0241	39	39.2	3089
ECAB 0253	43	45.8	2964
ECAB 0233	42	44.2	2928
ECAB 0201	39	45.3	2975
ECAB 0243	39	45.8	2908
ECAB 0203	40	41.2	2973
ECAB 0267	36	42.1	2852
ECAB 0287	37	49.8	3089
ECAB 0217	35	43.8	3283
ECAB 0256	38	43.1	3150
ECAB 0270	37	38.5	3452
ECAB 0295	40	56.2	3333
Checks			
Canadian Wonder	37	44.1	2833
Selian 97	36	53.3	2562
Trial mean	38	44.9	2868

The best yielding lines at two locations in Kenya were (in decreasing order) ECAB 0296 , ECAB 0224 , ECAB 0240, ECAB 0234, ECAB 0219, ECAB 0246, ECAB 0228, ECAB 0290, ECAB 0262, ECAB 0288, ECAB 0251, ECAB 0231, ECAB 0232, ECAB 0248, ECAB 0282, and ECAB 0292. Mean yields at Kabete and Thika varied from 1908 kg ha^{-1} for ECAB 0292, to 2218 kg ha^{-1} for ECAB 0296. Mean yields were 1322 kg ha^{-1} for Canadian Wonder and 1326 kg ha^{-1} for Selian 97. Twenty-one lines selected at Awassa (Table 106) were also selected in previous trials in Kenya.

These results indicate most lines were adapted and therefore performed well in more than one country. Among the lines selected in four countries were: ECAB 0201, ECAB 0252, ECAB 0240, ECAB 0267 and ECAB 0247. Thirteen lines performed well and were selected in three countries. Only four lines were selected in two countries (ECAB 0295 and ECAB 0224).

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4.1.9 New lines identified in sugar beans, a market class gaining prominence in East and Central Africa

Rationale: Although sugar bean grain type has been a relatively small market class in eastern Africa, recently it has become more important because of growing demand in export destinations and among domestic consumers. In the Great lakes region, sugar bean is grown in eastern DR Congo for export to urban centers in the western part of the country. Sugars are important in southern Africa especially in South Africa, Zimbabwe, Zambia and Angola (Wortmann et al, 1998). South Africa imports sugar bean from China and Brazil to meet its domestic requirements. East and Central Africa bean growing countries are increasing production to meet the growing demand. For example, in 2003 Uganda secured orders to supply South African supermarkets. Recently, dealers from other countries in southern Africa have placed orders to supply 5,000 t of sugar bean. In Ethiopia, sugar bean are retailing at over $350 per ton compared to $200-250 per ton for other grain types (Asrat Asfaw, personal communication). Production of sugar bean is constrained by diseases, pests and lack of marketable varieties. Sugars are susceptible to rust, common bacterial blight, angular leaf spot, anthracnose, halo blight, drought, bruchids and excessive rain. Starting in 2001, DR Congo has been leading a regional effort to identify marketable sugar bean varieties with resistance to major diseases and pests. This report highlights progress made in this effort.

Materials and Methods: A regional germplasm collection was assembled and screened for sugar grain type. The collection comprised of segregating populations derived from 52 parents of diverse genetic backgrounds and known resistance to specific stress factors, especially angular leaf spot, common bacterial blight and halo blight. Included in this collection were six multiple constraint nurseries (MCN) constituted from advanced lines developed at CIAT, Colombia and from regional breeding programs in East and Central Africa. The materials were initially screened for adaptation and tolerance to biotic stress factors at Kabete Field Station, University of Nairobi and at INERA- Mulungu Research Station in DR Congo. Subsequently, 27 selected lines were evaluated in Uganda, DR Congo and Kenya in 2003 and 2004. Disease scoring followed the standard CIAT scale (CIAT, 1987).

Results and Discussion: Thirteen new sugar lines were identified at Mulungu Research Station in eastern DR Congo (Table 107). Lines with bush growth habit (Types I and II) flowered in 39 to 48 days, and matured in 82 to 94 days. As expected, climbing bean lines flowered and matured later. There was high disease pressure from angular leaf spot. All selected lines had intermediate reactions to angular leaf spot. Most of the lines had resistant scores to anthracnose, aschochcyta and rust. There was considerable variability is seed size. The 100-seed mass varied from 26.7 g in RWV 1134 to 47 g for MAC 70-2. Grain yield varied from 1009 kg ha^{-1} for RWV 1128-2 to 2004 kg ha^{-1}for KS 151-3F11-1 and 2024 kg ha^{-1} for P94056. The climbing sugar bean lines did not show the expected superiority for grain yield compared to the bush lines.

Table 107. Days to flowering and maturity, reaction to angular leaf spot, anthracnose, aschochyta and rust, 100-seed mass and grain yield of 15 sugar bean lines selected at Mulungu, DR Congo from regional multiple constraint nurseries between 2001 and 2004

Lines	Days to 50% flower	Days to maturity	Angular leaf spot	Anthracnose	Ascochyta	Rust	100-seed mass (g)	Grain yield (kg ha^{-1})
a. Bush								
P 94056	48	92	4.6	1	2	2	27.5	2024
KS 65-2	48	92	3.6	1	1.3	1	34.8	1858
NM 12652/9A-1	41	85	3.6	1.3	1.3	1.6	-	1418
NM 12650/4A-1	39	85	4.3	1.3	1	1.3	36.0	1412
NM 12633/9A	39	82	4	1	1	1.6	44.2	1411
Montcalm 1	48	92	4.3	1.6	1.3	1.6	34.0	1403
VTTT 926/3-5	41	88	4.0	1.6	1.0	1.3	40.2	1327
NM 12656/14-1	39	82	3.3	1.3	1.6	1.6	42.5	1299
MX 875-3T	41	85	5.0	1.3	1.6	3.3	28.1	1107
NM 12647/A-1	39	85	4.6	1.0	1.3	2.0	35.2	1013
DOR 481	42	94	4.0	1.0	1.0	1.3	24.0	1288
KS 151-3F11-1	47	90	-	-	-	-	-	2004
b. Climbing beans								
MAC 70-2	49	98	3.3	2.0	1.0	1.3	47.0	1667
RWV 1134	47	105	4.6	1.3	1.3	2.6	26.7	1340
RWV 1128-2	45	110	4.0	1.3	1.0	1.6	41.0	1009

In Western Congo, two lines KS 65-2 and KS 47-1 that performed well in lowland conditions entered pre-release stages. In Uganda, MAC 31 was selected and released in 2003. This line is becoming very popular in local markets because of its large seeds and pods. It is being grown in eastern Uganda (Mbale district) for trial in export markets. Sugar 73 (MAC 73?) was released as NABE 5. Based on grain yield at two locations in Kenya, the best performing sugar bean lines were ECAB 0806 (1676 kg ha^{-1}), ECAB 0822 (1645 kg ha^{-1}), ECAB 0810 (1645 kg ha^{-1}), ECAB 0807 (1629 kg ha^{-1}), ECAB 0805 (1629 kg ha^{-1}), and ECAB 0823 (1565 kg ha^{-1}). These lines showed higher yields compared with Sugar 73 (1455 kg ha^{-1}).

These results indicate that improved sugar bean varieties were identified from the working collection. However, there is need to broaden the genetic base of existing populations to meet the growing demands. Colour retention in sugars remains a challenge. Most sugar varieties change from preferred wine red speckles on cream or white background to brown after storage, thus losing their consumer appeal. Only modest progress has been made for resistance to angular leaf spot and common bacterial blight. Recently identified sources of the diseases should be exploited to improve productivity in farmers' fields.

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Collaborators: Bean program teams at Kabete, Mulungu and Namulonge

4.1.10 Participatory selection of red mottled and red kidney bean lines tolerant to angular leaf spot and root rots in the Central and Eastern highlands of Kenya

Rationale: Involvement of farmers in variety development programs is advocated because it enhances farmer acceptance and adoption of new varieties. In addition it facilitates the inclusion of farmers criteria and development of varieties adapted to specific ecological niches (Ceccareli, 1994). Considerable experimentation with participatory approaches in bean improvement has been conducted in East and Central Africa (Sperling, 1993; CIAT, 2002; Kimani et al, 2004; Buruchara et al, 2004). Results indicate that not only does farmer involvement increase chances of adoption of a new variety but also may shorten time to new releases. Bean improvement programs have therefore incorporated elements of participatory breeding in the formal-led breeding schemes. Red mottled and dark red kidney beans are probably the most popular and widely marketed grain type in Kenya, Uganda, Tanzania and other countries in the region. However, limited participatory work has been conducted to improve these market classes. Most of the commercial varieties are susceptible to diseases and low soil fertility. These stresses cause significant yield reduction and are associated with declining yield in farmer's fields. Purpose of this study was to identify selection farmer's selection criteria for red mottled bean and select high yield lines adapted to this region. This report highlights progress in participatory selection of red mottled and red kidney bean varieties in Central and Eastern Highlands of Kenya.

Materials and Methods: One hundred red mottled, 115 red kidney and 53 root rot tolerant bean lines were evaluated by 60 farmers at Embu Research Station in Kenya between 2001 and 2004. The entries were initially selected from a diverse germplasm pool constituted from six multiple constraint nurseries (MCN 1-6). The MCN nurseries originated from regional breeding programs at Kawanda, Kabete, and CIAT bean program, Colombia. Preliminary selection for adaptation and tolerance to diseases especially angular leaf spot, anthracnose, root rot and drought were conducted at Kabete Field Station, University of Nairobi. Subsequently, 100 red mottled and 115 red kidney lines with tolerance to these stresses and local checks were sown at KARI-Embu research station to increase the seed and make preliminary observations during the short rain season, 2001. In the following long rain season (2002), three farmer groups from Meru, Embu and Kirinyaga were invited to evaluate and select the trial sown in larger plots at the station. The farmer groups came from semi-arid, bean growing areas with moderate to low rainfall.

Results and Discussion: Farmers used more than 20 criteria to identify preferred varieties. The criteria could be grouped into nine categories: yield related (high yield, pod load, germination percentage), seed characteristics (appealing colour, grain size), resistance to biotic and abiotic stresses (resistance to insect pests, diseases), maturity (early maturing lines were preferred for dry areas and late maturing for the wetter highlands), marketability (farmers selected grain types which they indicated were easy to sell and fetched high prices), harvesting and post harvest traits (resistance to shattering, good storability, colour and weight retention and resistance to storage pests), and cooking and organoleptic traits (short cooking time, good taste and low flatulence) and grain size. Small seeded types were preferred for making stews, medium size for traditional dish 'githeri' –a mixture of boiled maize and beans, and large seeds were preferred for mashed dishes. Appearance of cooked food, and ability to retain freshness when food is preserved for a few days were considered important.

Farmer evaluation and selection reduced the number of red mottled lines from 100 lines to 31, dark red kidney from 115 to 30, angular leaf spot and root rots resistant varieties to 23 (Table 108). The involvement of farmers in the evaluation and selection process ensured that only varieties acceptable to farmers were advanced to the next stage of experimentation and therefore more efficient use of resources (funds, land, inputs, time etc.) in the variety development program. In 2003, farmers evaluated the selected lines and started seed bulking in different agro-ecological zones in Embu, Meru Central and Kirinyaga districts. Number of criteria used to select these lines is probably much higher than could be accommodated in a conventional breeding program.

Table 108. Number of red mottled, red kidney and angular leaf spot and root rot tolerant lines selected by farmers in Meru, Embu and Kirinyaga districts in the Central Highlands of Kenya, 2003.

	Nursery		
	Red mottled	**Red kidney**	**Root rot and angular leaf spot tolerant lines**
Total lines in trial	100	115	53
Number selected	31	30	24
Number of lines in seed bulking	20	20	24
Number of selector farmers	60	60	20

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4.1.11 Participatory selection of climbing beans in the central highlands of Kenya

Rationale and Background: Climbing beans offer new opportunities for increasing bean yields in farmer's fields. Typically, they have 3:1 yield advantage compared with bush beans. They are particularly suited to intensive bean production systems where land availability is declining because of rapid population growth. Climbing bean are well adapted to intensive production systems because of their upright growth habit when staked and therefore vertical exploitation of space, longer growing period, which result in high yields per unit area. Although climbing have been traditionally grown in some regions in East and Central Africa (Wortmann et al, 1998), production received new impetus with introduction of high yielding climbing beans in the Great Lakes Region in the late 1980's and early 1990's. Farmers quickly recognized their potential, experimented with them and started production. This contributed to increased bean production especially in Rwanda and DR Congo where adoption rates of more than 40% have been reported. Climbing bean technology is rapidly spreading to other countries in the highlands of eastern Africa where conditions (high population density, declining land sizes, and high per capita bean consumption) are similar to those in Great Lakes region. In Kenya, the leading bean producer in Africa, climbing beans were first introduced in Western Kenya from Rwanda. Fifteen seeds each of six lines (Umubano, Vunikingi, Flora, Gisenyi, Puebla and Ngwinurare) were introduced in 1995 to the Central and Eastern Highlands from KARI-Kakamega. Seeds were increased, and the varieties evaluated with farmers. Farmers accepted the new varieties because of their yields and resistance to major bean diseases in the region (angular leaf spot, anthracnose and root rots). Between 1999 and 2002, the varieties were directly distributed to more that 6500 farmers (excluding farmer-to-farmer exchanges). Seeds of climbing beans were selling at between $1.25 to 2.5 per kg. However, although farmers accepted the new climbing beans, they indicated that they were more difficult to sell because they lacked the preferred grain type. In this region, the preferred grain types are red mottled and red kidneys, and to a lesser extent pintos and small reds. None of the new varieties was red mottled or kidney. In 2001, ECABREN and KARI-Embu started a program to introduced climbing beans that were segregating for the preferred grain types. This report highlights progress in this program.

Materials and Methods: One hundred climbing bean genotypes were introduced to Embu Regional Research Centre during the 2001 short rain season (Oct-December). The genotypes comprised of F_4 segregating populations of medium altitude climbers (MAC) from CIAT, Colombia and advanced lines from the regional climbing bean nursery at Kabete. Preliminary evaluation for morphological traits (growth habit, pod clearance and plant height) and yield components was conducted at the station. During the short rain season of 2002, representative farmer groups from Meru, Embu and Kirinyaga districts were invited to evaluate and select single plants with preferred traits. Farmers agreed on the most important selection criteria. Progeny rows of selected lines were established at the station during the long rain season of 2003 to produce adequate seed for on-farm testing in 2004.

Results and Discussion: A total of 22 climbing bean lines were selected. Some characteristics of these lines are shown in Table 109. The F_4 populations were segregating for a wide range of grain types, which included red mottled, red kidney, small reds, pinto, sugars and yellows. The lines also showed considerable variation in duration to maturity, plant height, vigour, pod load and grain yield (Table 109).

Twelve of the selected climbers were planted at Kaguru Farmer’s Training Centre (near Meru town) to increase seed for further evaluation and demonstration during a farmer’s field day. Twenty farmers who either had experience or were interested in growing climbing beans were invited to evaluate the lines. Farmers used ribbons of different colours to indicate their selection. Selections with the highest number of ribbons were MAC 28-1 (20), MLV 216-97A (13), MAC 524B (11), MAC 64 (10), MAC 36-2 (9), MAC 59-97B2 (8) and MAC 36-1 (1). Plot yields of these lines at the farmer’s centre varied from 7t ha^{-1} for MLV 216-97A to 3 t ha^{-1} for MAC 26. MAC 28-1, the most popular line with farmers, had a yield of 4.4 t ha^{-1} at Kaguru, Meru. Seed of the 20 climbing bean lines selected at Embu were distributed to Murang’a, Nyeri, Kirinyaga, Embu, Meru South, Meru Central, Kitui, Makueni and Machakos districts during the 2003 short rain season for evaluation by farmers and seed bulking.

Table 109. Days to flowering, maturity and grain yield of 22 climbing bean lines selected by farmers and researchers at KARI-Embu, Kenya, 2003.

Population/Line	Days to 50% flower	Days to maturity	Grain yield (kg ha^{-1})	Other attributes
MAC 64	40	88	3000	Red mottled
MAC 46	40	80	3000	Mwezi Moja type
MAC 36-2	40	80	1067	Mwezi Moja
MAC 17	43	88	1067	Large red kidney
MAC 50	44	81	1133	Medium pink (Mwezi Moja type)
MAC 13	48	99	800	Medium, red and round seeds
RD2-1	49	81	871	Small yellow
MAC 28-2	49	99	1200	Medium, dark red mottled
MAC 56	48	90	1600	Pinto, small seeded
MLV 216-97A	48	102	2467	Medium size, red kidney
MAC 20	48	90	2267	Purple kidney
MAC 36-1	49	96	3733	Red mottled, medium size
MLV 59-97A	49	104	3333	Cream
MAC 35	49	108	3800	True Mwezi Moja grain type; heavy podding and foliage yield
MAC 28-1	49	94	2948	Mwezi Moja type
UMUBANO	48	95	2933	Small, glossy red
RWV 524B	49	102	3000	Red kidney, large seeded, heavy podding
MAC 12-2	49	94	2933	Sugar /cranberry
RWV 1105	49	95	2000	Medium red mottled; attractive grain type
MAC 34	48	91	2267	Medium, red mottled
MAC 2 (26?)	48	91	2667	Pinto-segregating for pinto, Mwezi Moja, yellow pinto and red mottled (unstable grain type)
MLV 6-90B6	48	99	2333	

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4.1.12 Improved bean varieties for humid tropical lowlands identified

Rationale: Beans are traditionally cultivated in the medium and highland agroecological zones (>1000 masl) of East and Central Africa. Most of the varieties developed in the last 20 years are therefore adapted to the cooler altitudes. However, beans are widely consumed in the lowland areas in the region. But lowland production is limited because of lack of research effort for this zone. Most of the beans consumed in the lowlands are produced in the highlands and exported to markets in lowland zone. For example, bean consumed in western lowland zone in the DR Congo are imported from the highland production zones in eastern parts of the country, especially in North Kivu province. Because of the poor communication system, beans are either airlifted or transported by river for more than 1000 km. As a result, prices in Kinshasa and other markets are relatively high because of the high transportation costs, and are hardly affordable to the urban poor, contrary to the popular belief that bean is a 'poor man's meat'. For example, beans were retailing at more than US$ 1.25 per kg in Kinshasa markets in July 2004. INERA (Institut National pour l'Etude et la Recherché Agronomiques) has identified bean as a priority crop for production in lowland zones of DR Congo. Interest for local bean production is growing in Congo (Brazzaville), Cameroon, Central African Republic, Cabinda (Angola) and other countries in the tropical humid lowlands of west and central Africa. Considerable potential exists to improve bean production in lowlands. A collaborative program between the regional bean program and INERA was initiated to identify bean genotypes adapted to the lowland humid tropical zones in western Congo and neighbouring countries. This reports highlights progress in this program.

Materials and Methods: Bean germplasm was introduced to INERA-M'vuazi from INERA research stations at Mulungu, Gandanjika, FOFIFA (Madagascar) and University of Nairobi (Kenya). The collection comprised of 80 sugar bean lines and 40 BILFA 5 nursery lines from Mulungu, 8 entries from FOFIFA bean program, more than 86 F_2 and F_3 segregating populations from the regional multiple constraint nurseries at University of Nairobi, PNL Gandanjika, and local collections. The collection was evaluated at M'vuazi, Kisantu and several on-farm sites in Bas Congo, Kinshasa and Bandu Provinces. M'vuazi, the main coordinating center for bean research is located at latitude $5^o27'$S, longitude 14^o 54'E and 470 masl. It has mean annual temperature of 23.6^oC and receives 1425 mm rainfall per year. All trial sites were below 1000 masl. The evaluations were conducted in collaboration with farmer groups, NGOs and community based organizations (CBOs).

Results and Discussion: Twelve bean varieties adapted to lowland conditions have been released and are being disseminated in association with NGO's and farmers' associations. The varieties are: Moore 88002, PVO 14 (local landrace), PVO 14/2, T-3, A445, Diniania, Ntendezi (local landrace), Manseki, Nguaku-Nguaku, Tuta (Congolese landrace), G20854 and Lundamba. Ten varieties are in pre-release stages. These are Mbindi (from local germplasm), G22258, L4 (Congolese germplasm), I7 (Congolese landrace), G22501, Lyamungu 90, G16157, BF12 (Congolese landrace), BF10 and G8047. BILFA lines performing well include ZAA 5/2, G22258, Mwamafutala and AFR 593. Two lines KS 65-2 (sugar) and KS 47-1 (medium yellow) selected from regional nurseries have been identified for release. KS 47-1 was in Kinshasa markets in July 2004.

Dissemination of the varieties is being conducted in collaboration with 14 NGOs and farmer's associations in areas near Mvuazi, and with INERA's Research and Development (extension) section and farmer associations and field schools in Kisantu, and with CADIM in Plateau de Bateke. Beans are grown over three seasons in the lowlands: Season A (November to February) is the main season. Season B (April to May) is used for seed production. In season C (June-October) beans are cultivated in valley bottoms on residual moisture. Cultivation in seasons A and B is on the 'uplands'. Major disease constraints to production in the lowlands include common bacterial blight, web blight, bean common mosaic virus, root rot, and rust. Major pests include bruchids, aphids and foliage/stem beetle (with symptoms similar to bean stem maggot). A visit to Kinshasa markets revealed that several released varieties were being traded. Yellows, whites and sugars dominated the markets in Kinshasa. Yellows were the most expensive (CFr 560per kg) and dark browns, the cheapest (CFr 200 per kg).

INERA M'Vuazi has been instrumental in disseminating bean germplasm to other countries in West and Central Africa. Some of the genotypes distributed to Liberia, Central African Republic and Congo-Brazzaville are presented in Table 110.

Table 110. Bean germplasm adapted to humid tropical lowlands distributed from INERA-M'vuazi, 2002-2003.

Destination	Type of Material	Number of Accessions
Liberia	Advanced lines and released varieties (2002)	15 (A445, T-3, G8047, G16157, G20854, G22501,Diniania, Ntendezi, L4, Tuta (GG), SEQ 1007 and PVO 14/2)
Central African Republic	MCR lines (2003)	15
	White bean (2003)	8
	Sugars (2003)	11
Congo-Brazzaville	Released varieties (2003)	12 (Moore 88002, T-3, A445, PVO14, Lundamba, L4, Fleetwood, SEQ 1007, Mbindi, G22258, G8047 and G23070)

These results suggest that bean may be more plastic than expected. Some of the varieties performing well in lowlands (as low as 470 masl) such as Lyamungu 90 were selected for highland zones. Additionally, climbing beans are traditionally grown at high altitudes. Several climbing bean varieties were performing well at Mvuazi (470 masl). It appears that there is considerable potential for expanding bush and climbing bean production to lowland agroecological zones.

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4.1.13 Evaluation bean germplasm for aluminium tolerance in low fertility acid soils in East and Central Africa

Rationale: Low soil fertility is a major constraint to bean production in east, central and southern Africa. The major stresses are low soil P, low soil N and soil acidity. More than 60-85% of the cultivated area has soils deficient in phosphorus (Wortmann et al, 1998). More than 60% of the soils in the cultivated areas are deficient in nitrogen. Bean production occurs in acid soils with a pH between 5 and 6. However, in the Great Lakes Region, where bean is an important crop, proportion of acid soil is higher and soil related constraints seem to be even more severe. Over 20% of bean production in southern Africa occurs in acid soils (Wortmann et al, 1998). Annual losses due to aluminum and manganese toxicity in Africa are estimated at 163,900 t. Over 16.7 % of bean in eastern Africa and 28% in southern Africa are produced in areas where the major soil type is orthic ferralsols. These soils are generally low in nutrients. Aluminum and manganese toxicities are of high or moderate importance (losses of 100-200 kg ha^{-1}) in eastern DR Congo, parts of Rwanda, Burundi, Madagascar, north-eastern Tanzania, central and western highlands of Kenya, western Angola, northern parts of Malawi and Zambia and eastern parts of South Africa.

Although soil acidity can be corrected by application of amendments such as lime, most of the resource-poor smallholder farmers cannot afford and rarely apply fertilizers to their bean crops. Application of organic manure is constrained by availability and cost of application. Consequently, organic manures are applied infrequently and normally below recommended quantities. The identification of genotypes adapted to soils with inadequate nutrient supply and low pH associated nutritional disorders is an indispensable component of an integrated soil management strategy, and is now considered as the most appropriate approach to improving bean productivity in this region. The materials of interest should be tolerant to Al/Mn toxicity prevalent in acid soils, with an effective uptake system, and efficient utilization of the low levels of available nitrogen and phosphorus. This report highlights progress in identification of bean lines tolerant to aluminium toxicity and soil acidity in East and Central Africa through the Bean Improvement for Low Fertility Adaptation (BILFA) nursery. Our objective was to screen segregating populations, advanced lines and accessions for tolerance to aluminium toxicity in low fertility acid soils.

Materials and Methods: Two nurseries were screened, BILFA 4 and BILFA 5. BILFA 4 had 300 entries, which comprised of F_3, F_4 populations, advanced lines and cultivars. The germplasm represented five market classes: red mottled, red kidney, navy (small white), pinto and small red. BILFA 5 nursery had three germplasm sets: 127 germplasm accessions and 41 aluminium tolerant lines from CIAT, Colombia and 26 F_3 red mottled families derived from crosses between low soil fertility susceptible and resistant lines from the regional program at Kabete. The germplasm was selected for three consecutive cycles (2001B, 2002B and 2002B) in field plots with toxic levels of aluminium in single row plots with two replicates, or without replication. Grain yield was the primary selection criterion. N, P, and K at 17 kg ha^{-1} were applied to correct deficiencies. Diseases and pests were controlled following recommended practices. Lines selected in each cycle were re-evaluated in subsequent cycles. Lines selected after the third cycle were evaluated in 2003A at three sites: Nyamunyunye near Mulungu, in eastern DR Congo, Tonga and Gikongoro in Rwanda. At each site, the experimental design was randomized complete block with three replicates of 4-row plots. Susceptible and resistant check varieties were included after every 10 test rows. In trial sites in DR Congo the resistant checks were MwaSole and Mwamafutala. Kirundo was the susceptible check variety. In Rwanda ACC714 was the resistant check. The trial site at Nyamunyunye (1730m) has very acid soils with more than 40% aluminium saturation and intermediate organic matter (5.5%). Soils at the trial site at Tonga (1400m) has low P (2.2ppm), pH 4.8, low organic matter (2.3% carbon) and more than 42% aluminium saturation. At Gikongoro, soils are very acid, low in P (4.2 ppm), organic matter (5%) and high aluminium saturation (>62%).

Results and Discussion: Of the initial 115 red kidney lines evaluated at Tonga and Gikongoro, only 28 were selected. Twenty-eight red mottled were selected from the 100 lines tested. Five navy, nine pinto and 10 small red were selected after three cycles from the initial 43, 19 and 32 lines screened, respectively. From BILFA 5, 74 lines were selected from a germplasm pool of 194 lines. Only 33 lines were selected at Nyamunyunye from 300 BILFA 4 lines. Table 111 shows the performance of these lines at Nyamunyunye. Only three lines had better yield than the tolerant line MwaSole under both stress and non-stress conditions. A few lines showed limited yield loss in stress and non-stress conditions. The aluminium tolerant lines showed up to three fold yield advantage compared to the susceptible line Kirundo.

Table 111. Grain yield bean lines under Al stressed and non-stress conditions in Nyamunyunye, DR Congo.

Line	Grain yield (kg ha^{-1})		Yield loss due to Al toxicity (%)	Yield advantage over check in stress (%)
	Stress	Non-stress		
VTTT 923-6-1	1494	1588	5.9	310.6
HM 21-7	1317	1455	9.5	273.8
AFR 593-1	1040	1801	42.2	216.2
MwaSole	999	1264	20.9	207.7
ARA 8-5-1	957	1394	31.3	199.2
AND 932-A-1	932	1206	22.7	193.8
BZ 12984-C-1	866	874	0.9	180.0
Mwa Mafutala	625	1510	58.6	129.9
Kirundo	481	988	51.3	100

The results showed that Al tolerant lines can reduce yield losses associated with acid soils. A desirable line is that which shows small losses under Al stress but responds to improved conditions. It should be stable across environments, with a high yield potential in its market class. Some of the lines tolerant to acid soils have been released. These include RAB 487 in Rwanda, ACC 714 and Mwamafutala in DR Congo, Mwasole in Congo and Burundi. MLB-49-89A is released in Congo and is widely adopted in western Kenya. Wider dissemination of these varieties has the potential to improve grain yield in areas with toxic levels of aluminium and soil acidity. The results also indicated that the Great lakes region is a potential source of germplasm with tolerance to low soil fertility acid soils.

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4.1.14 Developing drought tolerant bean varieties for smallholder farmers in Eastern Africa through a regional project

Rationale. Drought is one of the most important constraints to bean production in Africa. Each year more than 395,000 t of bean are lost due drought related stresses in Africa. Drought is an important constraint in Ethiopia, Kenya, Sudan, Tanzania, southeastern Rwanda, and parts of Burundi. Drought is a major contributor to the frequent food shortages in east, central and southern Africa. Although effects of drought stress can be reduced by irrigation and conservation of soil moisture, these are not practical options for resource-poor smallholder farmers with limited access to irrigation. Drought, which includes moisture and heat stresses, acts in conjunction with biotic stresses, especially diseases and pests (Amede et al, 2004). Soil fertility related stresses, the most important being low soil P and N, soil acidity and the associated aluminium and manganese toxicity, aggravate drought effects. Developing drought tolerant bean varieties is a critical component of an integrated strategy of reducing losses due to abiotic and biotic stresses in sub humid and semi-arid regions in eastern Africa. Several initiatives have been started to develop bean lines tolerant to drought including the formation of a regional working group known as 'Bean improvement for water deficit in Africa' (BIWADA). In this report we highlight progress in identification of drought tolerant lines in Eastern Africa.

Materials and Methods: Four trials were conducted at Katumani, Kiboko and Kabete (Kenya) and Amaro (Ethiopia) to screen new bean lines for tolerance to drought. Katumani (1400m) and Kiboko (1000 masl) are located in a semi-arid region in eastern Kenya with high frequency of droughts. Amaro (1200 m) is a drought prone area in the southern Rift Valley of Ethiopia. In the first trial, 30 bean lines from the BIWADA nursery were evaluated at Katumani. The trial was laid out in randomized block design with three replicates. Spacing was 10 cm within rows and 50 cm between rows. Kat B9 was the check. In the second trial, 36 entries from the International Drought Nursery were evaluated in single row plots at Katumani and Kiboko. The trial was laid out in a lattice design with three replicates. In third trial, 138 F_7 lines and three checks (DOR 390, Tio Canela and A774) received from CIAT, Colombia were advanced for two generations at Kabete and Thika. In the fourth trial, 164 $F_{1.3}$ families developed through gamete selection in the regional program were evaluated under severe drought stress at Amaro. Grain yield was used as the primary selection criterion.

Results and Discussion: Results indicated significant genotypic differences ($P < 0.05$) for duration to flowering, maturity, 100-seed mass and grain yield at Katumani. Some characteristics of the best six lines from BIWADA nursery are shown in Table 112. The lines flowered in 33 to 42 days and matured within 81 days. Duration of rainfall rarely exceeds 60 days in the semi-arid areas of Kenya. MLB Y 91023 flowered and matured earliest. MUS 97 and DN 1004 had the highest grain yields under drought conditions. These results indicate that good yields can be obtained from the selected lines with normal rainfall regimes at Katumani. Final phases of grain filling can occur under residual moisture. Earliness can effectively contribute to drought escape.

Table 112. Duration to flowering and maturity, 100-seed mass and grain yield of six bean lines selected at Katumani, Kenya from BIWADA nursery, 2003/04.

Line	Days to 50% flowering (d)	Maturity (d)	100– Seed mass (g)	Seed yield (kg ha^{-1})
DN 1004	40.3	74.3	31.3	1388
DN 1009	40.3	76.7	27.8	1158
MLBY 91023	32.7	75.0	32.7	1167
BAT 85	37.3	77.7	21.0	1243
POMPADOUR	42.0	81.0	21.2	1209
MUS 97	38.7	77.7	26.4	1577
FB/GP/377-6-1	38.3	75.7	25.2	1386

Some characteristics of the seven best performing lines at Kiboko and Katumani are shown in Table 113. These lines flowered within 40 days and matured in 83 days or less. *P. acutifolius* accessions G40068 and G40159 had the highest yields. These results confirm our 2003 report that RAB 636, SEA 16 and RAB 618 were among the ten best performing lines under drought stress, in trials conducted at Thika and Kabete over three years. High yields of G40068 and G40159 at Katumani compared to Thika suggest possible genotype x environment interactions.

Table 113. Duration to flowering and maturity, 100-seed mass and grain yield of six bean lines from the International Drought Nursery, at Katumani and Kiboko, Kenya, 2003/04.

Line	Days to 50% flowering (d)	Maturity (d)	100-Seed mass (g)	Seed yield (kg ha^{-1})
RAB 619	39	78	25.7	1161
RAB 636	38	83	27.2	1161
RAB 618	39	80	29.1	1063
APETITO	37	81	24.4	1164
SEA 16	39	80	28.3	1056
G 40068	40	73	15.0	1651
G 40159	37	72	17.5	1554

At Kabete, most of the 137 F_7 drought lines succumbed to black root, suggesting the existence of necrotic strains of bean mosaic viruses at the location and I-gene in these lines. This necessitated within line selection based on resistance to black root, pod clearance and yield potential. The selected plants within a line were bulk harvested. Out of 138 F_7 lines, 97 F_8 were selected and sown at Thika and Kabete during the short rain season (November 2003 to February 2004). F_9 lines were sown at the same locations during the long rain season (May-August 2004).

Seventy-one families were selected from 164 $F_{1.3}$ families based on grain yield, tolerance to low soil fertility, common bacterial blight, angular leaf spot and haloblight at three locations (at Kokat, 2150m, Awassa 170 and Amaro) in 2004A. The 71 families were sown at Amaro during

2004B (August-October). With only one shower, 9 $F_{1.3}$ families dried up due to severe drought stress. However, 12 families with remarkable drought tolerance were selected. Yield of these lines varied from 1173 kg ha^{-1} (CAW-02-04-7-7) to 1549 kg ha^{-1} (CAW-02-04-7-7). At Selian (Arusha, Tanzania), six lines were selected from BIWADA nursery. These were CNF 5547, UBR (92) 17, UBR (92)9, MUS 97, RWR 109 and MMS 243. MUS 97 was also selected for drought tolerance at Katumani. The international drought nursery was distributed to Ethiopia, Kenya, Tanzania, Rwanda and Sudan in May, 2004 for further evaluation. These results indicate that some lines are ready for on-farm evaluation in drought prone areas.

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4.1.15 Southern Africa Regional Bean Yield Trial (SARBYT)

Rationale: Many national programs in the SADC region do not have a bean breeding program. The network co-coordinates the regional germplasm nurseries and trials, which contain improved lines and released cultivars generated by various bean-breeding programs in the region, including CIAT and the private sector. The main objective of these activities is to share germplasm within the network so that each national program or private sector can benefit from the research that is carried out by others in the region. In particular, the beneficiaries are the weaker national programs that are not able to run a full-scale breeding program. Over time, several countries in the network have released varieties, which were accessed through such germplasm exchanges.

Material and Methods: There were 20 sets of SARBYT that were distributed to: D R Congo (3), Lesotho (1), Malawi (2), Mozambique (3), South Africa (3), Swaziland (2), Tanzania (2), Zambia (2) and Zimbabwe (2). Each set contained 19 entries, but each country had to add a local control to make 20 entries. The entries included promising cultivars or varieties that had been released in some countries. Each set had 4 replicates, which were planted at each site, using a standard protocol across sites. Data were collected on soil type, rainfall, weather, diseases and grain yield.

Results and Discussion: At the time of compiling this report, data were available from 5 sites in 4 countries. Several diseases were recorded angular leaf spot (ALS), common bacterial blight (CBB) bean common mosaic virus (BCMV), floury leafspot (FLS), halo blight (HB), and anthracnose (ANT) at various sites (Table 114). Most diseases were not severe, except ALS (Bembeke and Uyole), rust (Chitedze and Uyole) and FLS (Chitedze and Bembeke). A few cultivars were consistent in showing resistance to ALS at Bembeke and Uyole with scores ranging from 3-4. These were in both, small-seeded Mesoamerican genotypes (RJB-1 and ECA0638) and large-seeded Andean genotypes (GCI-CAL-28-AR, CIM 9314, CIM 9314-2 and CIM 9314-31). Among the large-seeded, all were red mottled and most of them were selections from CIM 9314. The two small-seeded cultivars and CIM 9314 were also good for FLS, with scores ranging from 3-4. This indicates that some lines might have resistance to more than one disease.

Table 114. Disease assessment of advanced cultivars in the SARBYT at different sites in the SADC region, 2003/2004

	ALS				CBB			RUST			FLS		HB		BCMV			ANT	ASC	seed	
Variety	**CTZ**	**HAR**	**BBK**	**UYL**	**CTZ**	**HAR**	**BBK**	**CTZ**	**BBK**	**UYL**	**CTZ**	**BBK**	**DEL**	**CTZ**	**CTZ**	**HAR**	**BBK**	**BBK**	**BBK**	**size**	**Color**
AFR 708	2	1	3	5	2	2	1	5	1	5	4	4	3	1	2	1	1	2	3	30	Calima
UYOLE 96	1	1	5	4	3	1	3	4	1	2	4	7	3	1	2	2	1	2	3	43	Red
DC 12496-50	4	1	7	3	3	1	2	5	2	8	3	3	2	1	1	1	1	1	2	32	Pinto
CAL 143	1	1	3	5	3	2	1	4	1	4	4	5	3	1	1	2	1	1	3	38	Calima
SUG 135	1	1	5	4	3	1	2	4	1	2	4	4	5	1	2	2	1	2	3	47	Sugar
DC 95-170	5	1	7	6	2	1	1	5	1	3	4	4	5	1	1	1	1	1	2	40	Pinto
MCR 2301	3	1	8	3	3	1	1	3	1	2	3	5	3	1	1	2	1	2	2	28	Calima
CIM 9314-31	2	1	4	4	3	1	2	4	1	3	5	4	1	1	1	1	1	2	4	47	Calima
CIM 9314-2	2	1	4	3	2	2	2	5	1	4	5	5	1	1	1	1	1	2	4	37	Calima
PC 512-B4	2	1	7	5	3	2	2	6	1	4	4	5	3	1	2	1	1	1	6	32	Sugar
CIM 9314	2	1	4	3	2	2	2	4	1	4	4	4	1	1	2	2	1	2	3	38	Calima
DC 96-95	2	1	7	5	3	1	2	5	1	4	5	4	3	1	1	1	1	1	3	33	Sugar
RJB –1	2	1	3	2	3	1	2	4	1	1	3	4	1	1	2	1	1	1	2	26	Red
ECAB 0638	2	2	2	2	3	1	2	4	2	4	4	3	3	1	1	1	1	1	3	19	Navy
CIM 9302-1	2	1	5	3	3	1	1	4	1	3	3	5	3	1	1	1	2	2	4	42	Calima
GCI-CAL-28-AR	2	1	3	4	2	2	2	5	1	3	4	5	3	1	1	1	1	1	4	39	Calima
F6 BC3 Davis old (19)	2	1	7	5	3	1	2	5	1	4	4	6	3	3	1	2	1	1	3	35	Sugar
BOA 4-3/4	2	2	6	9	3	2	2	4	1	5	3	7	6	1	1	1	1	2	4	34	Sugar
BOA 1-5/20	2	1	4	2	3	1	2	3	1	5	3	5	3	1	1	1	1	1	3	32	Red
LOCAL	2	1	7	2	3	1	2	4	1	1	3	6	1	1	1	1	1	7	2		

Diseases: ALS= Angular Leaf Spot; CBB= Common Bacterial Blight; BCMV= Bean Common Mosaic Virus; HB= Halo Blight; ANT=Anthracnose; FLS= Floury Leaf Spot ASC = Ascochyta Blight

Sites: CTZ= Chitedze (Malawi); BBK = Bembeke (Malawi); DEL= Delmas (South Africa); HAR= Harare (Zimbabwe); UYL= Uyole (Southern Highlands of Tanzania)

Yield data were analyzed by site, then across sites. The differences among cultivars were statistically very highly significant ($p<0.01$) at all sites except Swaziland (Table 115). The sites mean yields were high, over 2,000 kg ha^{-1} at Delmas (South Africa, Harare (Zimbabwe) and Uyole (Tanzania). The across sites analyses showed that the genotype x environment intercropping were statistically, highly significant ($p<0.01$), as were the differences among the cultivars. The top 5 yielding cultivars across sites were GCI-CAL-28-AR with 20% yield advantage above CAL 143, followed by AFR 708, CIM 9314, CIM9314-2 and SUG 135. All of them are large seeded, in calima (red mottled) grain market class, except SUG 135, which is cream mottled. It was interesting to note that among the top 5, three of the cultivars GCI-CAL-28-AR, CIM 9314 and CIM 9314-2 were also on the list of cultivars with resistance to ALS. One of them CIM9314 was also on the list of lines with resistance to FLS. Thus some cultivars combine acceptable market class, good yield potential and multiple disease resistance.

Table 115. Grain yield performance of advanced cultivars in the SARBYT at different sites in the SADC region, 2003/2004

		Seed yield in kg ha^{-1}							**Seed**	
Rank	**Variety**	**CTZ**	**BBK**	**DEL**	**HAR**	**SWZ**	**UYL**	**Mean**	**Size (g)**	**Color**
1	GCI-CAL-28-AR	1108	1852	4193	4094	1209	2428	2481	39	Calima
2	AFR 708	1444	1141	4164	4156	1060	2249	2369	30	Calima
3	CIM 9314	1474	1469	3758	3917	1177	2151	2324	38	Calima
4	CIM 9314-2	1292	1333	4185	3458	963	1974	2201	37	Calima
5	SUG 135	1042	1432	2378	4833	923	2407	2169	47	Sugar
6	CIM 9302-1	1247	1190	4336	2990	845	1973	2097	42	Calima
7	CAL 143	1235	1305	3448	3281	1194	2111	2096	38	Calima
8	ECAB 0638	608	1000	4435	3542	1114	1632	2055	19	Navy
9	BOA 1-5/20	1318	1172	3609	2563	1188	1950	1967	32	Red
10	CIM 9314-31	1422	1266	3536	2531	1036	1624	1903	47	Calima
11	F6 BC3 Davis old (19)	2117	612	2794	1938	1041	2365	1811	35	Sugar
12	RJB –1	453	1677	2378	2135	1456	2242	1724	26	Red
13	DC 12496-50	316	813	3221	2104	1307	2017	1630	32	Pinto
14	MCR 2301	1229	760	2432	2250	983	2072	1621	28	Calima
15	UYOLE 96	731	924	1555	2979	1218	2262	1612	43	Red
16	DC 95-170	1549	883	1281	2344	1045	2004	1518	40	Pinto
17	PC 512-B4	1457	599	1633	2333	912	2070	1501	32	Sugar
18	DC 96-95	1189	555	2854	1177	1120	2027	1487	33	Sugar
19	BOA 4-3/4	599	964	2221	2115	1190	1746	1473	34	Sugar
20	LOCAL	1258	286	2997	3552	1210	2076	1897		
	Means	**1154**	**1062**	**3070**	**2915**	**1110**	**2069**	**1897**		
	CV (%)	29	31	29	28	23	12	20		
	SE +- Loc									
	Var.	170	164	448	411	130	127	226		
	LxV									
	Signif. Loc							**		
	Var	***	***	***	***	ns	***	**		
	LxV							**		

Sites: CTZ= Chitedze (Malawi); BBK = Bembeke (Malawi); DEL= Delmas (South Africa)
HAR= Harare (Zimbabwe); UYL=Uyole (Southern Highlands of Tanzania)

Conclusion: Various nurseries and yield trials were again distributed to NARI's partners. These are particularly helpful to the NARIs that did not have breeding programs. Results from SARBYT indicated that some cultivars, which were distributed, combine multiple attributes like, grain market class, high yield potential, and resistance to one or more diseases. Such lines will be potential candidates for future releases. During this reporting period, Tanzania had released one cultivar, DRK 124, as *Uyole 03*, which was introduced to Tanzania from CIAT through network germplasm exchange.

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4.1.16 Implementation of IPM with African farmers through participatory methods

Rationale: The promotion of bean IPM strategies among bean farming communities in eastern and southern Africa had in the past three seasons focused mainly on the management of bean insect pests using both traditional and improved technologies. During the reporting period however, the dimension of the promotional activities was expanded through additional funding support to include the promotion and dissemination of products/outputs from other bean research projects. These include disease tolerant germplasm, improved high yielding pest tolerant varieties and soil fertility management technologies that have been generated from activities supported by different NARS programmes, ECABREN, CIAT, NGOs and other active partners.

Methodology: The participatory approach continued to be adopted with the involvement of innovative farmers, farmer groups and locally active partners from the local government administration (policy makers, extension personnel, etc.), NGOs, community based organizations-CBOs (civil and religious), local schools and the private sector (market traders and input suppliers). Participating farmers, collaborators and partners at activity sites continued to play the major role in planning, implementation and evaluation of project activities with backstopping from the other stakeholders. Traditional and improved pest management technologies were promoted in pilot and satellite sites. Farmers were reached through the standard farmer field school (FFS) approach in the case of south western Uganda and parts of western Kenya, and the modified farmer field school approach (MFFS), i.e. farmer research group (FRG) approach as were the cases in parts of Kisii district in western Kenya, northern and southern Tanzania and central Malawi. Linkages with existing partners were maintained and strengthened. New farmers, farmer groups and partners joined in to support and participate in project activities. The MEDIEA Company Ltd produced a radio programme (Pilika Pilika) on agricultural production, i.e. crops (with focus on beans) and livestock in Kiswahili. The programme has been aired in 4 national radio stations (3 private, 1 public) in Tanzania from March 2004. Pilot studies to document community behaviour in IPDM uptake have been initiated with a Masters degree student in Hai district site in northern Tanzania. More and new promotional materials were prepared and distributed to target village information centres and partners.

Findings/Observations: Project activities and IPDM awareness creation have spread to wider and new areas during the reporting period and more farmers have received the message (Table 116). The participatory farmer research group approach, farmer meetings, field demonstrations combined with field days and exchange visits), promotional materials including farmer activity reports, village information centres, small seed packets, local farmer seed displays and exchanges, visits to farmer groups (by local administrators and policy makers, donor representatives, CIAT DG and other staff), radio, etc. are proving to be very effective tools in getting the message to the bean farming communities. Observations show that these tools work differently at different sites depending on the community culture and behaviour. No one tool seems to be self propelling at any of the active sites. Participating and non-participating farmers are happy with the approach of involvement in management of their own resources. Partners are willing to contribute to costs involved in farmer exchange visits when such activities are linked to areas of priority for their development goals in those particular communities.

The government policy makers in each of the participating countries (Malawi, Tanzania, Kenya and Uganda) have declared a "YES" to the community group approach. Tanzania has gone ahead to declare the community group approach for its new national planning policy with a district focus in rural development and community empowerment for food security, poverty eradication and in addressing the HIV/AIDS pandemic. In the uptake studies, 39 farmer groups (out of 77) in 27 villages (out of 54) in Hai district, northern Tanzania have been surveyed. Data processing is in progress. Project promotional materials have been on high demand by participating and non-participating partners. Postage on the CIAT website has led to demands from outside the continent, e.g. a recent request for the leaflet on "Cultivation of climbing beans" from Chile.

Table 116. Spread of Bean IPDM project message in eastern, central and southern Africa as per June 2004

Pilot site	Satellite sites	Number of farmers reached with at least 1 technology	Estimated number of farmers aware of bean IPDM message
Malawi (Dedza)	Kasungu	500	> 1000
Tanzania - Southern (Mbeya and Mbozi)	Mbeya, Mbozi, Iringa, Njombe, Chunya,	7000	>10000
Tanzania - Northern (Hai, Lushoto, Arumeru)	Babati, Rombo, Moshi,	8800	>31000
Kenya (Kisii, Kabondo)	Homabay, Gucha, Marani, Rachuonyo, Vihiga, Hamisi, Kakamega	2500	>3000
Uganda	Kabale, Bushenyi, Kisoro, Iganga		
DR Congo	Katana, Kavumu, Mudaka		
Rwanda	Runyinya		

Discussion:

The FFS and FRG members and participating partners were instrumental in training new farmers and helping in the formation of groups. For example, in south western Uganda, the Kabamare FFS members trained 4 new groups including a polytechnic school community. The FFS group leader has trained several neighboring farmers, helped in setting up demonstrations for the five groups at his site and trained groups collaborating with other partners including NGOs. The whole concept is to use trained farmer groups to be trainers of community members at their locations. These innovators were also the key players in spreading the word by mouth to neighbouring farmers and relatives and to the various visitors. Farmers were very happy learning together, sharing information, experiences and resources (e.g. seed, etc.). For example, Rombo district farmers invited by Shari village IPDM groups in Hai (~ 150 km away) for a field day with a bean seed sharing event in March 2004, brought local bean seed for 6 different cultivars and in exchange they selected both improved (from bean programme) and local bean cultivar seed from Hai to experiment with in Rombo. In the same field day, visiting Babati farmers collaborating with and sponsored by Farm Africa, also selected some of the bean seed for experimentation in their fields.

The tools used in disseminating bean and other crop and livestock production products among bean farming communities have helped the project reach farmers beyond expectation. The radio programme in Tanzania, has played a key role in sending the message across communities in the past six months because every bean growing community that we have interacted with have farmers asking questions pertaining to the programme captions. Some of the farmers have participated in the radio question time and won prizes that were contributed by the national bean research programme (improved bean seed packs) and the IPDM project (leaflets).

More farmers in Malawi, Tanzania, Kenya and Uganda have accessed the improved high yielding and pest tolerant bean variety seeds (from the national programmes) and high yielding pest tolerant germplasm (from NARS, ECABREN and CIAT). Dissemination of improved pest tolerant bean varieties particularly focused on products generated in previous bean research projects in the southern highlands of Tanzania, Malawi and Uganda. Despite the unreliable weather conditions that prevailed in most areas in the region during the past bean production period, a number of farmers received the seed and some were able to harvest the grain.

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4.1.17 Varietal releases in Latin America and Africa during 2003-2004:

Latin America:

Country	Name	Year of release
ARGENTINA	A 281	2003
ECUADOR	CANARIO “SIETE COLOINAS” (INIAP 426) TIB 3042 x G11732	2004
HONDURAS	MACUZALITO*	2004

* participatory breeding with CIAL’s farmers from Yoro region (ASOCIAL-FIPAH-EAP)

Africa:

Country	Varietal Name	Year of release
BURUNDI	Mwasole (INERA)	
ETHIOPIA	DICTA 105	2003
	DOR 554	2003
	MAM 48	2003
TANZANIA	WANJA (A 197)	2003
	Uyole 03 (DRK 124)	2003
	Urafiki (Kabanima x Canadian Wonder)	2003
UGANDA	NABE 4 (POA 2)	2003
	(MAC 31)	2003
	NABE 5 (Sugar 73)	2003

Country	Varietal Name	Year of release
D.R. CONGO	LSA 144	2003
	M50/98	2003
	ACC 714 (INERA)	2003
	GR 13P	2003
	CNF 5520	2003
	G1810	2003
	NAMULENGA	2003
	G11460	2003
	Moore 88002	
	PVO 14 (local landrace)	
	PVO 14/2	
	T-3	
	A445 (CIAT line)	
	Diniania	
	Ntendezi (local landrace)	
	Manseki	
	Nguaku-Nguaku	
	Tuta (local landrace)	
	G 20854	
	Lundamba (INERA)	
	Mwamafutula (INERA)	
	Mwasole (INERA)	
	MLB-49-89A (INERA)	

Progress towards achieving output milestones:

- More fixed lines and cultivars combining acceptable market type, high yield potential and resistance to diseases will be made available to NARIs partners for further evaluation in various countries within SABRN in the next crop season.

- Improved IPDM practices are estimated to have reached more than 31,000 bean farmers in Tanzania where the effort to diffuse practices initiated, and an additional 14,000 users in other countries.

- The community group approach employed for the diffusion of IDPM practices is receiving wide attention in official circles, boding well for its deployment and future efforts for diffusion.

Activity 4.2 Development of sustainable seed systems to support wide dissemination

Highlights:

- There was a significant increase in number and diversity of partners for bean research and development in the PABRA region, particularly in support of decentralized seed systems. Formalization of working relationships among partners was done through memoranda of understanding.

- Partners facilitated awareness creation, knowledge and skills enhancement about new or existing technologies through development and dissemination of diversified tools and approaches including promotional and training materials, field days, radio talks, agricultural shows, etc.

- Through enhanced partnerships, a total of about 12,000 M tonnes of assorted bean varieties were produced and made accessible to about 2.5 million farmers in PABRA region.

- Eight case studies on seed relief to assist disaster-affected and chronically stressed communities were completed are being compiled for publication.

4.2.1 Partnership development: a key to wider utilization and enhanced accessibility of improved bean based technologies to farmers

Rationale: The increasing contribution of beans to farmers' income and household food security, national and regional economies in East Central and Southern Africa (ECS- Africa) coupled with highly appreciated and newly developed varieties and with increasingly differentiated consumer demands have encouraged differentiated bean seed demand in relation to specific varieties and seed channels. However, many farmers still have inadequate access to new varieties of their choice to respond to emerging agro-ecological situations and market demands. The growing involvement of commercial seed sector in the bean seed marketing is still inadequate with regard to quantity of seed supplied (their annual bean seed supply is estimated at about 1% across the region). Furthermore, the sector focuses only on already popular varieties thereby narrowing farmers' choices and exposure to new improved bean varieties. In the ECS- Africa region, the majority of farmers mainly obtain their bean seeds and information about varieties from local seed systems (farmer saved seeds, seed from other farmers and local seed traders), thus strengthening local seed systems greatly improves the access to quality seeds of improved bean varieties to farmers, enhances decentralized support service delivery and ultimately improves farmers' living conditions.

However, this initiative requires partnership with a range of service providers offering complimentary services e.g. National Agricultural Research Institutes (NARIs), government seed regulatory bodies, development agencies (government and non government), seed traders, farmer/community based organisations, local farmer seed producers. Preliminary results of this initiative across the ECS Africa are encouraging and similar efforts across crops are being initiated

Process: Across the 19 member countries of the Pan –Africa Bean Research Alliance (PABRA), various rural service providers (NGOs/ CBOs, GOs and individual farmers) are involved and interested to support farmers to access quality seeds of improved bean varieties and related support services as a deliberate effort to alleviate poverty or/and increase food and nutritional security of vulnerable households. However, the majority of these service providers are neither adequately aware nor linked to bean research products and services. Early efforts by NARIs alone to support local seed systems did not create much change due inadequate involvement of partners who could offer complementary services to existing capacities of NARIs and local seed systems. The following steps are being encouraged to develop sustainable partnerships in facilitating accessibility of quality seeds of improved bean varieties and other non-variety technologies:

1. To identify target areas based on intervention objectives
2. To identify interested and involved potential partners such as Non Government Organisations (NGOs), Government Organizations (GOs), and Community Based Organisations (CBOs), Farmers' Organizations (FOs), commercial seed actors, individual farmers, policy makers in the target areas or at the national level in each of 19 PABRA member countries.
3. To understand and analyse existing seed systems e.g. roles, motivation and interests of each partners, participatory analysis of existing seed systems (strengths, weaknesses, opportunities, threats and potential conflicts)
4. Draw and implement a joint action plan to respond to partners' interests and with focus on partnership building and development. Generally the following points emerge as part of the action plans:
    - Carry out community dialogue on seed issues, understand local seed systems and how to strengthen them (using them as a springboard)
    - Understand farmers' bean variety preferences through their knowledge/ information on existing bean varieties and exposure to new promising ones
    - Build partners capacity in both technical and organisational development (pre and post bean harvest aspects, seed/agro-business development, train farmer seed producers and suppliers in pre-and post-harvest skills and seed business management to ensure social and financially sustainable of in the scheme
    - Promote awareness of new varieties through field days, posters, leaflets, seed fairs and any other public awareness opportunity.
    - Ensure two-way linkages between partners and bean research programs for a continued flow of promising varieties, expanding this most often to include other crops
    - Build a strong research and development partnership through focus on the comparative advantage of each institution
    - Enhance a co-learning process from participatory monitoring and evaluation (PM&E) schemes based on regular reviews, interactions and exchange of information and experiences among partners.
    - Assess informally and formally the efficiency of the system

Results and Discussion:

Strategic alliances: With support from CIAT and bean regional research network staff, NARIs in each of the PABRA countries have established, consolidated and are still establishing strategic alliances with major partners based on their comparative advantages. Table 117 illustrates the status of partnership including categories of partners, the number and status across the regions. Table 118 illustrates the partners' profiles and responsibilities in building their partnership for research and development.

There is a growing trend at national level to build a common vision and agree on the partnership development processes. More often the partners formalize the working relationships through memoranda of understanding (MoU) for an agreed period of time (generally between three and five years) with clearly stipulated objectives and responsibilities

Technology Dissemination and Support Services: As result of partnership development, actors are also involved in others support services to bolster technology dissemination, especially focusing on building the capacity of decentralised seed producers and suppliers and also the farming communities. Table 119 illustrates some of support services provided through partnership in ECS Africa. The awareness raising and the partnership development have stimulated the demand of bean varieties and Table 120 illustrates the amount of seed produced and supplied to partners in the year 2004. There have been contributions and synergistic roles of both informal and informal seed producers.

Table 117. Status of partnership development for bean research and development in 14 PABRA member countries in year 2004

	Types and number of partners			
	GOs	**UN/International NGOs**	**Commercial seed companies**	**Local NGOs/ CBOs**
Total	58	87	15	112
Status of partnership	Government through Institutional linkages	54 formalized through Memoranda of understanding (MoUs)	3 formalized through MoUs	20 formalized through MoUs

Table 118. Partners' profiles and responsibilities in the PABRA member countries.

Partners' category	Profile	Major Responsibility	What do partners expect from NARIs/Bean Network/CIAT
Government Organisations	Government owned or bilateral rural development programmes and local (district) based extension service delivery unit	-Enhance Extension service delivery (skills and knowledge building) -Facilitate the accessibility of agricultural inputs (seeds) -Design and production of information and training manuals	-Information on new improved and promising varieties -Skills/knowledge (agronomy and organisation development) building for staff
UN-International NGOs	FAO food/seed security programmes and emergency project programmes International NGOs which are predominantly International NGOs with offices in each PABRA country: WVI, CRS, CARE	-Enhance Extension service delivery (skills and knowledge building) -Facilitate the accessibility of agricultural inputs (seeds) -Design and production of information and training manuals - Support to grassroots organisations and sometimes assets transfers	-Information on new improved and promising varieties -Skills/knowledge (agronomy and organisation development) building for staff -Engage them and farmers in testing promising options
Seed companies	National medium-size seed companies marketing between 100-500 metric tones per year each.	Contracting farmers to produce certified seeds, supplied to NGOs, UN-Agencies, GOs, traders and farmers	-Information on new improved and promising varieties -Skills/knowledge (agronomy and organisation development) -Accessibility to foundations/basic seeds on cash and carry basis
CBOs (community based organisations	Umbrella of farmers' organisations with legal status	-Members' resource mobilisation -Sometimes enhanced extension service delivery -Operations aiming at large economy of scale -Production of local seeds (farmers' seeds and quality declared seeds) done at individual or groups	-Information on new improved and promising varieties -Skills/knowledge (agronomy and organisation development) building for staff -Engage them and farmers in testing promising options
Individual farmer seed producers (limited)	Large scale farmers producing bean seeds/grains to market as seeds/grains	-Production and supply of local farmers and quality declared seeds -Provide information, knowledge and skills to local farmers -Testing and popularising improved varieties	-Information on new improved and promising varieties -Skills/knowledge (agronomy and organisation development) building for staff -Engage them in testing promising options -Provision of seed market information
National Agricultural Research Institutes /organisations (NARIs)	Government funded research bodies (parastatals, government research department and universities)	-Varietal development -Development of information and training manuals for improved concepts and technologies -Production of prototypes -Provision of national leadership in R &D -Facilitate relevant national fora -Supply of breeder/basic seeds	-Provision of wider range germplasm -Support and exposure in the new concept formulation -Play a catalytic role in bringing actors together -Skills, knowledge and practice building (institutional support)

Table 119. Types of support services offered by the partners in PABRA countries .

Category of support services	**Types and their number**	**Developer/actors**	**Audiences targeted**	**Estimated number of material produced**	**Estimated audience reached**
Promotional materials developed (varieties)	Posters for 15 new varieties	NARIs and UN-NGOs/CBOs	Extension staff and farmers	31,800	100, 000
Promotional materials for non variety technologies	Posters of 3 new soil fertility management options	NARIs and UN-NGOs/CBOs	Extension staff and farmers	3,800	12,100
Bean seed production training manual translation into local languages	Translation in Swahili Chewa Luganda, Runyakore and Amharic	NGOs and NARIs	Farmers and extension	1,000	5,000
Field days and demonstrations		NARIs, UN-NGOs and CBOs	Farmers, extension staff, local leadership	50	2,050
Radio talks on bean and agric. shows		NARIs, UN-NGOs and CBOs	Farmers, extension staff, policy makers and traders	Done in 6 countries on regular basis	Listeners
Training on pre-post harvest management aspects of bean seed enterprise, business skills at national level	Training of trainers (about 10 held)	CIAT, Bean Research networks, NARIs, GOs, NGOs, CBOs, FOs	Extension service providers		

Table120. Amount (metric tones) of bean seeds produced by partners in 14 PABRA countries and estimated number farmers reached in Yr 2004

Category of Seed suppliers	**Estimated amount of basic seed (tones)**	**Estimated amount of seeds produced (tones)**	**Estimated number farmers reached**
NARIs	106.5		
Seed companies		4,050	810,000
Farmers supported by NGOs, CBOs & GOs.		8,010.3	1,602,000
Total	106.5	12,063.3	2, 412, 000

The amount of seed produced by farmers with partner support is much higher than what is being recorded by partners. The seeds are more often exchanged among farmers, or sold as grains in the local market to traders who later sell them as seed (at planting time). Despite tangible results achieved, the unavailability of basic seeds on cash and carry at NARIs level or lack of private sector involvement in the supply of basic seeds limits the production of seed by formal and informal producers. The possibility of stimulating the private investment in basic seed production especially for popular bean varieties will be explored in the course of next year.

Contributors: J.C. Rubyogo, R. Muthoni and R. Buruchara
Collaborators: NARIs and their partners (GOs, NGOs, UN-bodies, CBOs, Commercial Seed Companies, Farmers' organizations, bean traders, farmer seed producers)

4.2.2 Strategies developed for supporting seed systems in both acute and chronic stress

<u>Seed Systems Under Stress Program: overview</u>

Within the last 20 years, disaster situations—drought, civil strife, floods, crop plagues, or combinations of these—coupled with systemic poverty, have become the norm for most countries of eastern, central, and southern Africa. Humanitarian relief practitioners, although skilled in quickly delivering short-term food aid, usually do not understand the technical complexities of the agricultural context. Even though seed aid began in the early 1990s, the long-term effectiveness of such activities remains disappointing. Both food and seed aid are still being delivered to many countries year after year.

Because they base their diagnoses on food assessments, relief practitioners are typically ignorant of or misunderstand stress situations as they apply to agriculture. For example, they commonly assume farmer seed systems to have collapsed or to have been inadequate in the first place. Yet field results show that seed systems are resilient. For example, in Rwanda, even after its genocidal war, local seed markets continued functioning, and crop diversity profiles remained stable.

Even research institutions tend to view disasters as opportunities to expose farmers to "improved" varieties of current crops or to alternative crops. But evidence shows that system resilience, not only productivity, is also key to recovery and sustaining household food security after disasters.

CIAT, in partnership with relief and developmental agencies, facilitates the Seed Systems Under Stress Program, which concentrates on:

- Helping to shape emergency relief, particularly in terms of seed and germplasm
- Analyzing the effects of different types of disaster (war, drought, flood, or crop plague) on the functioning of a seed system (including its crop and variety diversity)
- Evaluating emergency operations to further refine practices of seed system maintenance and strengthening
- Working with policy makers to institutionalize "best practices"
- Developing robust assessment tools for use during and after disasters to diagnose the strengths and weaknesses of surviving systems, and thus target response

This Program's success depends on its links with many collaborators. These include the Eastern and Southern African bean networks, SADC Seed Security Network and Germplasm Resource Center, NGOs (e.g., Catholic Relief Services, World Vision International, Save the Child and Action Aid), IARC collaborators, and international relief practitioners (particularly FAO and the U.S. Office for Foreign Disaster Assistance).

Seed Systems Under Stress Program: Projects and updates

The Program currently executes two main projects:

Project 1: Assisting disaster-affected and chronically stressed communities in eastern and central Africa: small-farmer seed systems

This project is USAID-funded and is implemented jointly by CIAT, CRS, and CARE/Norway. Goals are to develop diagnostic tools (SSSA= Seed System Security Assessments) to determine the effects of a stress, either natural or man-made, on agricultural and seed systems (including on crop and variety diversity) and to analyze the effectiveness of various support strategies in reducing constraints. Action-oriented fieldwork evaluates on-the-ground implementation in Ethiopia, Zimbabwe, Burundi, Kenya, Uganda, Malawi, and Mozambique. Case studies and Project Briefs determine interventions appropriate to acute versus chronic seed-stress situations. They also address the various challenges to achieving seed security in terms of availability, access, and use.

Milestone: All eight case studies were completed in 2004. They are now being prepared for (first an USAID Project Volume- then elaborated into a formal book)

- **Burundi:** Drought, civil strife, and seed vouchers and fairs: the role of the trader in the local seed system
- **Kenya (west):** The use of informal seed producer groups for moving root-rot resistant varieties during periods of acute stress
- **Kenya (East):** Comparison of Seed Voucher and Fairs (SV&F) and Direct Seed Distribution (DSD): Lessons Learned in Eastern Kenya and Critical Next Steps
- **Mozambique:** Crisis management when the staple crop is destroyed by disease: The case of Cassava Brown Streak Disease in coastal areas of northern Mozambique
- **Uganda:** Seed vouchers & fair and agro-biodiversity in western Uganda
- **Zimbabwe:** Relief seed assistance in Zimbabwe
- **Ethiopia:** Relief seed assistance in Ethiopia
- **Malawi:** A review of seed security strategies in Malawi

Milestone:: Annotated Bibliography of Seed Systems and Seed Relief Completed. This bibliography is geared for use particularly by Seed Aid Program Managers and Humanitarian Relief Practitioners. It was particularly challenging to compile as the large majority of works are in the (very) gray literature. The compilation of 55 references sought particularly to identify web-based reference resources—quickly downloadable and hence widely available.

Collaborators: Catholic Relief Services (CRS); Care/Norway (CN); International Plant Genetic Resource Institute (IPGRI)

Project 2: Seed aid and germplasm restoration in disaster situations: synthesizing lessons learned and promoting more effective practices

This IDRC-funded project analyzes trends in seed aid and germplasm restoration practice, and their possible interconnections, particularly in Africa. It reviews c.25 classic cases—developed through documentation, interviews, and selected field visits—to analyze current situations and provide a basis for improving practices over the next decade. More than 15 organizations are involved in synthesizing current practices, and raising global awareness of options for making progress. The list below highlights the germplasm restoration cases being analyzed, for several reasons. One of the rationales for CGIAR genebanks (including the Global Trust) is to allow for 'restoration', if necessary. The list below, however, suggests that there seem to be relatively few purported cases of CG restoration (that is, to farming communities and fields), and under closer scrutiny, most of these have not been as extensive as surrounding CG publicity would suggest (for instance, restoration of local germplasm *per se*, was not required after the Rwandan genocide/war). The restoration analyses, conducted by a range of IARCs are also posing questions of: what the goals of restoration might be (returning the system to 'what was'? strengthening the system against future stress?) and what the subject of restoration should be (germplasm/seed? skills to maintain germplasm? local knowledge—or that which adds additional value?)

<u>Key cases : (possible) restoration of germplasm</u>

Intervention	CG Center/Other leading effort
1. Somalia –early 1990s (drought/war)	IPGRI
2. Rwanda (genocide/war)	Seeds of Hope (CIAT lead)
3. Philippines, Cagayan Valley (floods/drought, MVs, storage..)	IRRI/PhilRice
Liberia, Sierra Leone, Côte d'Ivoire, Guinea, Guinea Bissau (civil strife)	WARDA
4. Native tubers in the Andes (disease/virus build up)	CIP
5. Eritrea millet (war)	ICRISAT
6. India finger millet (intensification)	ICRISAT
7. Afghanistan (war/drought)	ICARDA?
8. Mozambique (flood)	(studied by Noragric/ICRISAT)
9. Ethiopia (drought)	IPGRI/ Biodiversity Institute

Major Contributors: Louise Sperling; other IARCs: International Plant Genetic Resource Institute (IPGRI); International Center for Research in the Semi-Arid Tropics (ICRISAT); West Africa Rice Development Association (WARDA); NGOs: Catholic Relief Services (CRS); World Vision International (WVI); Save the Children (SC); Action Aid; VECO (Zimbabwe); African Regional Networks/Institutes; SADC Seed Security Network; SADC Germplasm Resource Center

Progress towards achieving output milestones:

- Two hundred and sixty-two new and existing partners improved their linkages with research institutions and are currently involved in knowledge and skill enhancement and dissemination of varietal and non-varietal technologies.

- About 2.5 million farmers were reached by seed of new and existing improved varieties**.**

- Fifty-eight governmental agencies, 87 international NGOs and/or UN agencies, 15 commercial seed companies and 112 local NGOs or CBOs are involved in alliances for the diffusion of improved seed and agronomic practices.

Activity 4.3 Socio-economic activities

Highlights:

- Demand for beans on the market is influenced by grain color, and prior knowledge about cooking time and taste of the variety.
- Market studies of bean sub-sector in Uganda and Kenya show rising production and consumption trends of fresh and dry beans in Uganda but a stable consumption level in Kenya. Insufficient production in Kenya and demand in other countries offers opportunities for regional exports of dry beans from Uganda, while significant growth market opportunities for Kenya exist for green beans on international markets.
- The bean market price at the time of harvest in Malawi was primarily influenced by the supply and demand.
- Researchers and extension agents that work with farmers in both NARIs and NGOs in the Andean region should be aware of the profitability of bean production. For this reason we have started an analysis of the cost-benefit ratio of climbing versus bush beans in the production systems in practice in the region.

4.3.1 Development of participatory monitoring and evaluation (PM&E) in PABRA

Rationale: The PABRA conceptual framework for the period 2003-2007 is established on three outcome level deliverables, namely (a) Increasing utilization of Bean Based Technologies (b) Enhancing capacities of communities to plan and manage initiatives to meet their needs and (c) Strengthening Institutional and organizational capacities of PABRA, constituent sub-regional organizations and partners. The framework is based on Result Based Management (RBM) as a major tool for Participatory Monitoring and Evaluation (PM&E). The RBM is a management philosophy and approach that emphasizes development results in planning, implementation, continuous learning, and reporting. As a mechanism for PM&E, the RBM framework facilitates the management of project effectiveness; involvement of partners; incorporation of lessons learned; and reporting on the project impact.

Methods and Materials: The approach for developing PM&E in PABRA assumed three broad steps:

a) Determining baseline data as sets of conditions existing at the onset of the five year PABRA work plan.
b) Strengthening and consolidating the PABRA performance framework and
c) Establishment of Participatory Monitoring and Evaluation (PM&E) in ECABREN and SABRN and member countries

Results and Discussion:

Baseline data**:** In the absence of baseline data as the starting point from which change could be measured, the first step in the performance measurement process was to seek baseline data from both ECABREN and SABRN countries. The process was guided by indicators along the three outcome levels in the PABRA work plan and against indicators. Baselines were obtained largely from existing databases on bean based technologies, from secondary sources (especially from network publications, research studies, program documents and trip reports). 75% of baseline data for outcomes and outputs relating to increased bean based technologies; enhancing capacities of communities and for strengthening institutional and organizational capacities have been collected and entered in a database. Results will be measured against the acquired and incoming data.

Strengthening and consolidating the PABRA performance framework:

During 2004, the PABRA performance framework was consolidated to include logically interconnected steps for measuring results in a result chain. These steps were analyzed and presented in two categories of information namely (a) identifying what to monitor and (b) determining the methodologies for monitoring. Key results were discussed and entered in the PABRA RBM framework under the following headings (a) performance indicators for qualitative and quantitative development activities and resources (b) baseline data (c) data sources (d) methods of data collection (e) frequency of data collection (f) and roles and responsibilities of partners in delivering results in the framework.

Participation is an important aspect of RBM, ensuring that activities for Research for Development reflect the needs, priorities and vision of stakeholders is critical to managing results. In February and March 2004, two workshops and five working sessions were conducted with regional and national scientists, breeders, pathologists, Participatory Monitoring and Evaluation specialists, and social economists from CIAT and NARS to review outcomes, outputs, and impacts in the PABRA conceptual framework. In total, five regional scientists from CIAT and four national scientists were part of this process.

The workshop participants reviewed consolidated PABRA performance frameworks with a view to prioritize indicators for key results. This process of engaging partners from various disciplines led to the development of methodologies for data collection and for reporting that is adapted to various technologies being developed in PABRA. The result was a set of tools developed for analyzing information from various technologies. (Tables 121 and 122)

Establishment of Participatory Monitoring and Evaluation activities in ECABREN and SABRN and member countries:

Establishment of Participatory Monitoring and Evaluation (PM&E) in ECABREN and SABRN is based on the following: identification and analysis of existing M&E systems in member countries; building capacity for Participatory M&E (PM&E); institutionalizing mechanisms for PM&E; and developing systems for collecting, analyzing and recording data, for use in decision making, reflection and for learning.

The first step undertaken was the launching of PM&E in Uganda, Tanzania, Ethiopia, Madagascar, Rwanda, Burundi, DR Congo, Kenya, and Sudan in an ECABREN steering committee. During the ECABREN steering committee meeting in April 2004, principles and guidelines for undertaking PM&E were introduced to representatives of member countries and their partners. The results of the meeting were: (a) launching PM&E, (b) soliciting partners interest in monitoring and evaluation by means of the RBM framework for managing programs and projects; and (c) encouraging better reporting to ECABREN network. A similar meeting is planned for SABRN national partners and regional scientists during the upcoming SABRN steering committee scheduled for the end of October 2004.

The second step in establishing PM&E is a research process whereby PM&E principles and guidelines are tested in the Bean Based Technology transfer project under the Ugandan National bean program. A component of this project is capacity building of national project scientists and technicians in mechanisms that include data collection, analysis, recording and dissemination. A result of this activity has been the use of multiple methods and tools for data collection. On this account, project reports now carry impact related information that is of greater interest to partners. Future work in this endeavour is to link PM&E at the national project framework level to the broader regional PABRA conceptual framework.

Contributors: R. Muthoni, R. Buruchara, P. Mukishi, R. Chirwa**.**
Collaborators: S. Kaaria (ERI), J. C. Rubyogo, national partners**.**

4.3.2 Social and economic impact of beans in Africa

Rationale: The objective of these efforts are to evaluate and document the impact of improved bean varieties in all seven key bean producing countries in PABRA (i.e Uganda, Malawi, Tanzania, Rwanda, Ethiopia, Congo, and Kenya).

Methodology: A team of three PABRA social scientists is assisting scientists in member countries to implement country proposals developed by the countries to conduct impact assessment studies. The studies use household level formal surveys, participatory rural appraisal, and analysis of secondary data to construct a data set for estimating impact. Descriptive statistics, social and economic analysis tools are used to evaluate the impact of improved bean varieties released during the past 17 years.

Summary Progress: Two impact studies have been completed in Uganda: a) An ex-post Impact study, and b) A longitudinal impact monitoring study. The results were presented at a PABRA steering committee meeting held in Mozambique in April 2004.

Five studies are being implemented in Tanzania, Rwanda, Malawi, Ethiopia, and DR Congo. The studies are being led by social scientists from these member countries with close technical support and collaboration by PABRA resource persons. The resource persons have helped train staff and initiate the studies in five countries. They continue to make regular monitoring visits and participated in data collection, cleaning, and analysis. Rwanda and Tanzania are expected to have completed the studies by December 2004.

Contributors: R. Kalyebara R. (NARO), Andima D. (KARI), Mugisha K.S. (CIAT/PABRA).

Collaborators: NARS Programs in Uganda, Malawi, Ethiopia, Rwanda, and DRC Congo, Tanzania.

Table 121. Information Analysis for PM&E system in the PABRA Performance Framework

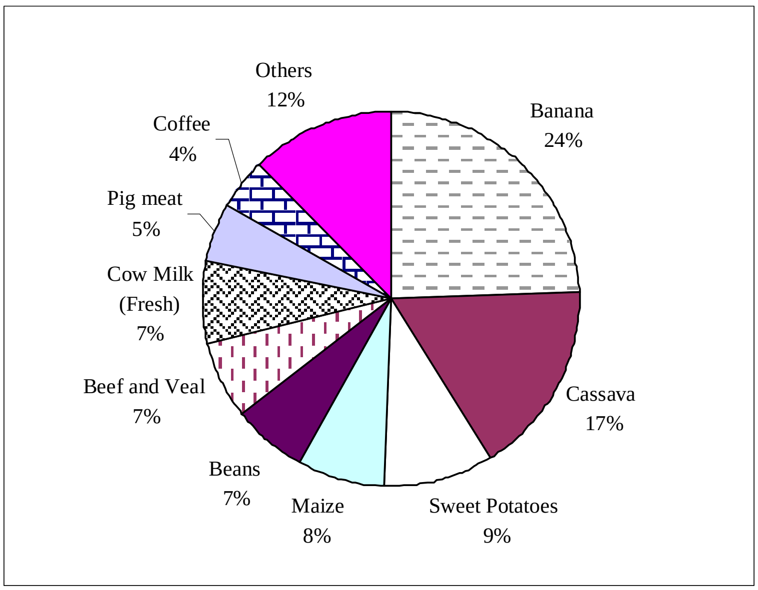
Determining what to monitor				
Result Expectations	**Performance Indicators**	**Baseline Requirements for period 2003**	**Activity analysis**	**Milestones**
(As in Log frame) Outcome #2 Enhanced capacity of 25 villages / communities in the projects 3 pilot areas to plan and manage initiatives to meet their needs Outputs#2. (Outputs that combine together to generate Outcome #1) Increased skills of men and women to achieve gender equity at the community and household levels	(As in Log frame) Indicator PI #1 x x x Indicator PI #2 Perceptions of who has access and control over agricultural resources (Land, income, labour, inputs, information) within the household	The PME system seeks to obtain the "before" situation for the purpose of adding value to the "after" situation Baseline situation obtained to be assembled	(Determining what needs to be done to achieve the objectives i.e. defining key activities; to include content and process related activities that occur simultaneously in the project: ➢ Election of men and women committees for enterprise development, experimentation, and monitoring and evaluation ➢ Ensure representation of men and women in all community project meetings is equal ➢ Facilitate experiential learning that enables women to empower themselves and speak in an organized manner ➢ Increase gender awareness campaigns ➢ Capacity building in community based participatory M&E ➢ Facilitation in leadership, group development skills, conflict management, and gender awareness training ➢ Establish community monitoring groups ➢ Train community monitoring groups in monitoring and documentation of events ➢ Train community development facilitators in designing and establishing PM&E systems	(What shows that you are successfully progressing from one stage to the next in the right direction?) ➢ Involvement of women in formulating and implementing community by laws ➢ Men and women consulting on major investment and expenditure decisions ➢ Change in gender roles ➢ Women and men demanding rights ➢ Economic independence of men and women ➢ Household conflicts

Table 122. Information analysis for PM&E system in the PABRA Performance Framework

Determining how to monitor							
		Milestones (Key results of your activity sets at various project stages) as given in worksheet # 1	**Developing performance questions (**What question do you need to ask to get a status report of on each of your milestones & how often will you ask the question?)		**Determining the source of your information**	**Developing quantitative and qualitative tools for CARD** (Collecting, Analyzing, Reporting and Disseminating) information	**Sharing roles and responsibilities for CARD amongst NARS, Partners and Networks**
Result Expectations	**Performance Indicators**		**Performance question i.e. seasonally, quarterly, annually**	**Frequency i.e. start of season, mid term, end of season**			
(As in Log frame)	(As in Log frame)	Involvement of women in formulating and implementing community bylaws	What is the extent of involvement of women in formulating community bylaws?	Annually	Farmer research Committees PM&E committees	Diaries & Field books for process documentation Activity reports	Farmer research Committees PM&E committees
Outcome #1 Enhanced capacity of 25 villages / communities in the projects 3 pilot areas to plan and manage initiatives to meet their needs	Indicator PI #2 Perceptions of who has access and control over agricultural resources (Land, income, labor, inputs, information) within the household	Men and women consulting on major investment and expenditure decisions	What is the extent of consultations on major household investments?	Ditto	Community development facilitators	Field journals Outcome journals and progress markers	Community development facilitators
Outputs#1.1 (Outputs that combine together to generate Outcome #1)		Change in gender roles	What is the nature of family resources controlled by men and women?	Ditto	NGO's	Group development journals	NGO's
		Women and men demanding rights	Are men/women involved in activities previously predominantly done by women/men?	Ditto	CBO's	Community and group profiles	CBO's
Increased skills of men and women to achieve gender equity at the community and household levels		Economic independence of men and women	What are the perceptions of men and women on their economic independence?	Ditto			
		Household conflicts	What are the perceptions of men and women on household conflicts?	Ditto			

4.3.2.1 Social and economic impacts of improved bean varieties in Uganda

Background: Beans are a major food and cash crop for the majority of Ugandan farmers and consumers. In terms of gross contribution to the country's GDP, beans account for 7% of the total national agricultural GDP, ranking 5th behind bananas, cassava, sweet potatoes, and maize (Figure 73). The estimated economic value of total bean output when valued at market prices in 2001 was higher than total earnings from coffee which has been Uganda's chief export commodity. Though not a very accurate measure of value, this illustrates one important point: any changes in output resulting from investment R&D will have major implications on the welfare of Ugandans.

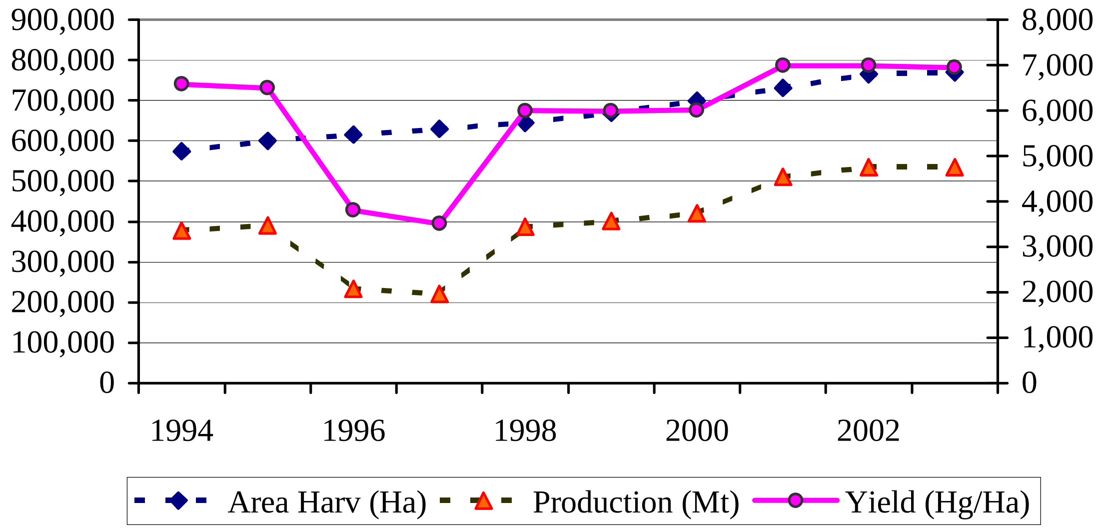


Data source: FAOSTAT database, 2002.

Figure 73. Share of Beans in Total Agricultural GDP (2001)

Production is entirely by small-scale farmers and is concentrated mainly in the Central, Eastern, and Western regions. The average plot size ranges from 0.25 to 1.0 acre per household (David and Hoogendijk, 1997). Most of the country grows bush beans, whereas climbers have traditionally been limited to highland areas constituting about 20% of total bean acreage. Typically, bush beans are grown in intercrops with various crops, the most popular intercrops being maize, cassava, cotton, bananas, and groundnuts. Climbers are mostly intercropped with maize or grown in pure stand. The majority of beans are produced under low input labour intensive agriculture, with no purchased inputs apart from seed purchases to supplement own stocks.

In the last 10 years bean output has more than doubled (Figure 74). Production has increased due on account of area expansion, but also a significant improvement in yields coinciding with the introduction of improved varieties that were more disease resistant.



Source: FAOSTAT database, 2003

Figure 74. Uganda's Bean Production 1994 - 2003

Rationale: Considering the major role that beans play in alleviating poverty and food insecurity, significant resources have been invested in Research and Development to develop and disseminate improved technologies to farmers. Nine bush and five climbing bean varieties have been released over the last 10 years by the National Agricultural Research Organization (NARO) in collaboration with and CIAT and other partners. Various stakeholders have expressed interest in establishing the extent and level of impact generated across different target groups, and returns to investment in R&D. There is some evidence from case studies that past Research and Development (R&D) on bean varieties has generated significant impact particularly through improvement in household incomes and food security (David and Sperling, 1999; David et al., 2000), however no detailed evidence is available on wider and long term contributions of new bean-based technologies. This study examined the impact of eight improved bush bean varieties and complementary management practices released between 1994 and 1999. The study was conducted by NARO with collaboration from CIAT and PABRA between July 2003 and February 2004. The objectives of this study were to:

(a) Estimate the social and economic impact of improved bean varieties in Uganda.
(b) Estimate the return to past investments in bean R&D.

Methodology

Data sources

The data was obtained through a formal survey of 529 bean farmers for two seasons in 2003 in six districts, representing six major agro-ecological zones: south-western highlands, eastern highlands, eastern mixed farming zone, Lake Victoria crescent, western mixed farming zone, and mid-northern mixed farming zone. Additional information was obtained from key informant discussions, participatory rural appraisal (PRA), experimental data, and secondary data from the Uganda Bureau of Statistics (UBOS) and FAO. The main focus of household surveys was to collect quantitative data on household socio-economic characteristics, bean adoption, acreage, yields, output, utilization, marketing; and social and economic impact parameters.

Social Impact Assessment

The analysis involves use of social analysis tools to investigate social impacts; and economic analysis which is mainly concerned with estimating the financial value of benefits and costs. Social impact assessment on the other hand specifically seeks to document the effects of technological change on the wellbeing of communities and changes in social organization and social relations. Social equity, poverty reduction, and food security are central concerns in social analysis.

Estimation of Economic Returns from Bean Research & Development (R&D)

Benefits from adoption of improved varieties are examined from the point of view of increasing incomes to households and society from investment in bean R&D. The efficiency of technologies and R&D systems in generating surpluses (profits) is investigated. Aggregate benefits to society are calculated using the economic surplus method. Benefits are computed from farm level data provided by the household survey, and aggregate bean production statistics. Research and development costs are calculated using historical data obtained from NARO, FAO, the Ministry of Agriculture, and the Uganda Bureau of Statistics (UBOS) for the period 1986 to 2003.

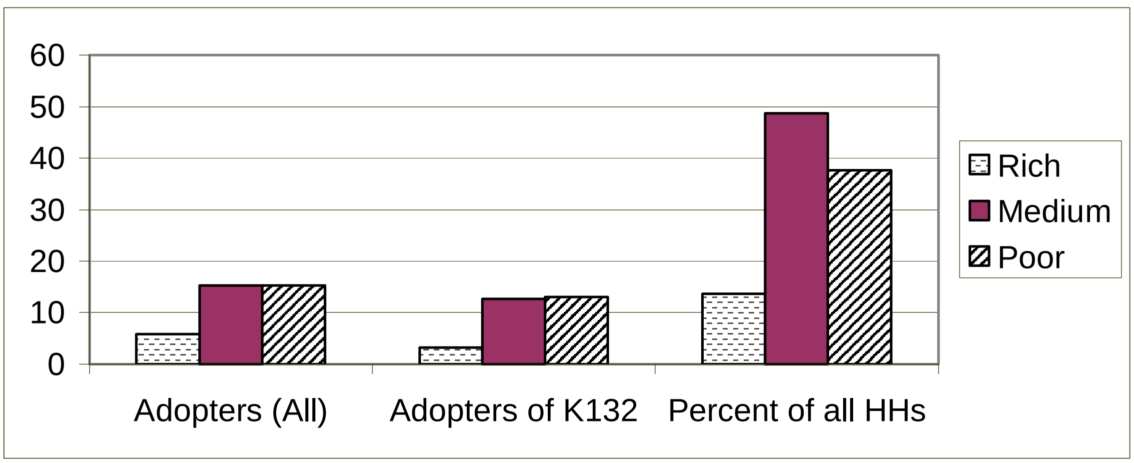
Longitudinal Impact Monitoring

Uganda has been a site for a longitudinal study of bean impacts that has been going on for the last 10 years. This involves a series of Impact assessment studies repeated after an interval of 4 years in order to monitor and evaluate changes in social and economic impact over time. This is the second in a series of such studies. The impact study monitors the impact of new bean varieties that were initially disseminated to women groups in three neighbouring villages in Eastern Uganda in 1994. The focus is on in-depth social and economic impact assessment; however unlike the earlier studies, this second study also evaluates the impact of bean varieties on the nutritional status of children in 1 case study village.

Results and Discussion: Results from a formal household survey of six districts, indicate that new varieties particularly K132 (CAL 96), K131 (MCM 5001), and NABE 2 have an average yield advantage of 37% (20-196%) over farmers' varieties under farmer conditions. The observed average yield of 855 kg ha^{-1} for new varieties under farmer conditions is a significant improvement over the observed average yield of 625 kg ha^{-1} for farmers' varieties; however it is still far below the potential yield of 1.5 – 2.0 tonnes per hectare under optimal farmer management as reported by the national bean programme of NARO.

K132 released in 1994 is still the most widely adopted variety mainly due to its high yield potential and high market demand. However its acreage is declining due to its susceptibility to bean root rot. About half (53%) of the sample households had adopted at least one new variety, while 40% had adopted K132. When extrapolated to national estimates, the observed adoption of new varieties is equivalent to approximately one million households adopting new varieties, which is a very promising result in anticipation of achieving the PABRA goal of reaching 10 million households in the whole PABRA region by the year 2008.

The majority of adopters are in the 'poor' and medium wealth categories (Figure 75). This is indicative of the major role played by beans in poverty alleviation, and also confirms that poor households are accessing improved varieties. However benefits to the poor are limited by access to complementary resources such as land: the average bean plot for poor households is just over one third of the average plot size for rich households.



* HH stands for 'household'.

Figure 75. Proportion of adopters by wealth category (national survey), N = 529.

Regional distribution of impact

The number of adopting households is lower (20 - 50%) in the southwest, northwest, and western regions; and relatively high in the eastern highlands and central regions (40 – 80%). The distribution of new varieties corresponds closely with access to major markets, and extent of formal seed dissemination efforts by government institutions and NGOs. There is concern that new varieties are not yet easily accessible in some areas due to limited seed dissemination and low market access.

Contribution of new varieties to bean output

Survey results showed that new varieties have contributed 41% of total bean output in the sample with K132 alone contributing 36% of total bean output. The increase in total bean output due to improved varieties is attributed to partial replacement of old varieties by new ones which have a 37% yield advantage.

Marketing and utilization

There is a clear differentiation by farmers between varieties grown for sale and those for home consumption (Table 123). The data confirms the previously observed trend that new varieties are mainly grown for marketing than home consumption. An important finding is that the share of output sold by the poor is close to that for the rich. In the case of Uganda this has a major implication for poverty reduction: incomes of the poor can be enhanced through improved access to new varieties.

Table 123. Share of bean output sold per household by wealth category (national survey), N = 529.

Variety	Rich	Medium	Poor
K 132	71	77	60
Kanyebwa	54	62	54
Ocuc	44	49	45
Masindi Yellow	31	33	41

Impact of new varieties on household bean consumption and income

Average annual household bean income has more than doubled since introduction of new varieties, while annual household bean consumption has increased by just 37%! New varieties account for 67% (97,657 Ushs yr^{-1}) of annual household bean income; and 45% of household bean consumption. Whether this implies that new varieties have had a greater impact on household incomes than food consumption is a question that is answered by a nutrition study.

Poor households earn about 40,000 Shs ($23) from beans annually compared to 60,000-70,000 Shs per year ($34 - 40) earned by wealthy households (Table 124), indicating that beans are contributing relatively more to poverty reduction given that the rich have bigger bean plots, and other sources of income. The poor eat more beans per capita than the rich! Not very surprising but a good indicator of the contribution of beans to food security for the poor. Per capita bean consumption varied according to the level of adoption of new varieties. For example in Mbale (Eastern Uganda) where adoption (of K 132) was high, adopters consumed more beans (50% - see Annual Report 2003) than non-adopters. However, there was no difference in per capita bean consumption between adopters and non-adopters at a national level (Table 124). This is partly explained by the fact that adoption levels varied widely across the country, with areas that had low access to improved varieties (and therefore low adoption) consuming more traditional varieties per capita. The other reason was that a larger proportion of the main new variety adopted (e.g. K 132) was sold because of its high market demand.

Table 124. Impact on household income (in Uganda Shillings) and bean consumption (kg) by wealth category (national survey), N = 529.

	Rich	Medium	Poor
Annual bean income today (UShs)	54,250	104,583	42,667
Income from K132 (Ushs)	69,188	99,300	40,390
Per Capita Daily Bean Consumption (Adopters) kg	0.15	0.12	0.20
Per Capita Daily Bean Consumption (Non-adopters) kg	-	0.14	0.20
Amount of Beans Sold per Year (kg)	167	180	105

Reaching disadvantaged groups

Reaching and empowering disadvantaged target groups is a key pillar of CIAT's efforts to eradicate poverty. In this study, we investigated access to benefits of improved varieties by the poor, women, and children. Results are encouraging. There is more participation of women in decisions regarding adoption of new bean varieties: In 41% of surveyed households, women were responsible for decisions to continue growing new varieties (Table 125). This may be surprising to some, given that the Ugandan society is male dominated; but it confirms the notion that because beans play a major role in household food security, a lot of decisions related to beans lie in the hands of women. The total area sown to beans is much larger for women as compared to men. The longitudinal survey revealed that between 1998 and 2002, the women from three pilot villages in Eastern Uganda increased the area under beans four fold while during the same period, men increased their acreage by about 0.2 times. The area sown to women's plots accounted for 19 ha while that sown to men's plots was a mere 5 ha. This result confirms that women still maintained significant control of bean output as its level of commercialisation increased, and suggests that women have considerable control of bean income since in this society men and women own separate plots.

Table 125. Changes in household welfare due to K132 perceived by farmers, Sironko district, Eastern Uganda (N= 80)

	Percent of respondents	
Change	**Positive Changes (%)**	**Negative Changes (%)**
Total household income	100	0
Availability of beans during times of shortage	100	0
Family health	96	4
Work done by women	8	92
Prices offered by traders	19	81
Amount of wood fuel used	73	27

Growing new bean varieties was perceived by farmers as having had significant positive welfare effects through household income, availability of food during periods of food scarcity, family health, and amount of fuel wood required for cooking; and negative impact by increasing the amount of work done by women, and reduction in bean prices. Generally the poor and medium wealth households perceived much higher positive impacts due to new bean varieties compared to the rich.

A preliminary investigation in one case study village in eastern Uganda indicated that beans have a significant correlation with the growth status of children: the height of children aged 1-5 years was found to be positively correlated with availability of beans for household consumption. The results indicate that children living in households that produce enough beans for home consumption are less likely to suffer from malnutrition. This proposition will hold depending on the amount of beans consumed by the child. Further studies are needed to confirm the contribution of beans to child nutrition relative to other factors. However, it is evident from this study that the effect of beans is more pronounced among the poor as the data indicates that the poor eat more beans per capita than the rich (Table 124).

Returns to investments in Bean R&D

The Net Present Value (NPV at 2003) of benefits to Uganda, from public investments in bean R&D by Uganda alone for the period 1986 to 2010 (25 years), is approximately 476 million dollars with an average return of 16 million dollars per year (Table 126). The internal rate of return from the investment at a nominal market interest rate of 15% is 41%. This is relatively higher than the IRR found by Laker-Ojok (1994) for competing crops (maize 27%, groundnuts 23%, and sesame 27%). Wesseler et al. (1999) observed a very similar IRR of 45% for improved bean varieties in Uganda. This confirms that investment in bean R&D is beneficial to society. This is based on the assumption that research costs of international centres are sunk costs. It is not known how profitable bean research would be if developing countries were to fund their own breeding programs and pay royalties for imported germplasm.

Table 126. Benefits and returns to investments in bean research and development

NPV of Bean R&D Benefits (US$)	471,591,817
Average NPV per Year (US $)	15,719,727
Total Investment in R&D by Uganda (nominal 2003 US$)	14,021,598
Internal Rate of Return (nominal)	41%

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Collaborators: NARO Bean Program

4.3.3 Bean sub-sector market studies for Uganda and Kenya

Rationale: Systematic market studies for bean sector were planned to be carried out in Uganda, Kenya Tanzania, Ethiopia and Democratic Republic of Congo in collaboration with FOODNET. The purpose of these studies was to provide a review of the current status and research and development investment options, in the bean sub-sector for the main bean producing countries of the ECABREN/ASARECA region. The aim was also to analyze the potential for developing more robust levels of environmentally sustainable economic growth through improved systems of bean production, processing and marketing.

Methodology: The studies were based on a rapid market appraisal technique developed by Holzman (1995). Due to the rapid nature of this process the review is illustrative as opposed to rigorous and serves to prioritise options and constraints. It uses both secondary and primary data to determine market prospects. Primary data was obtained through interviews using a structured informal questionnaire with producers, traders, retailers and exporters. Secondary data was acquired through literature review and the collection of available statistics. The study reviewed demand for and trade in major market sectors including fresh and dry beans and processed bean products. An important element of the work was to examine the comparative and competitive advantages of specific bean types and their related production zones. The analysis considered bean types and the impact of new varieties in terms of their current market share and market potential. Coverage includes local, regional and international markets.

Results and Discussion: Studies have been completed in Uganda and Kenya and reports developed. Studies are underway in Tanzania and Ethiopia. Results from Uganda show rising production and consumption trends of fresh and dry beans, and rising price trends over the previous three years. Major factors influencing market prices are relief purchases by World Food Program (WFP) and the Kenyan market. Uganda is currently uncompetitive in international markets for dry and green beans implying that bean research and development efforts could focus on regional and national markets. Regional market opportunities exist in: Kenya, for a 'pure' colored dry bean (e.g. K 132 is notably dominant and successful in Kenyan export market) and South Africa for small white canning beans and speckled sugar beans.

The Kenyan market for dry beans is relatively stable with approximately 450,000 metric tones of beans consumed annually. Due to insufficient production, Kenya is a major regional dry bean importer (approximately 100,000 metric tones) mainly from Uganda and Tanzania with the majority of it going through informal trade due to border tariffs. Kenyan dry bean production is becoming increasingly extensive due to declining terms of trade as the price of purchased inputs rises in comparison to that of the dry beans produced. Significant growth market opportunities for Kenya exist for green beans on international markets. Opportunities exist to increase levels of value addition in Kenya through products such as pre-packed, topped and tailed beans and frozen beans. A major challenge to green bean exports is the European Union Hazard Analysis and Critical Control Point (HACCP) legislation. Areas of moderate growth in the next five years are in ready-mixed bean based foods, e.g. githeri (bean and maize), a quick to prepare protein providing meal favored by low income urban consumers, and processed tinned beans sold to higher income groups in domestic and regional markets.

Recommendations include the balancing of research and development investment towards market opportunities for both regional and export markets, support to post-harvest activities and actors through business related services such as information provision, networking and producer group facilitation while research supports initiatives addressing technology issues.

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4.3.4 Bean market price study in Malawi

Rationale:

Despite the fact that a wide range of bean varieties are currently grown and put on the market in Malawi, very little is known about consumer choice factors for beans. Various bean varieties have different characteristics that could in one way or another determine their attractiveness to consumer. Such characteristics as grain size, color, shininess, damage level, cooking time, taste, etc. have not been adequately investigated. A study was therefore undertaken to assess factors that determine choice of beans on the markets, soon after harvest in the Central and Southern regions of Malawi. The majority of the traders indicated that most consumers preferred dark red kidney market class (Phalombe), followed by Sugar (Nanyati) and red mottled (Napilira) (Table 127).

Table 127. Bean varieties mostly preferred on the market

Type	Count	Percentage (%)
Phalombe (Dark Red Kidney)	47	63.5
Nanyati (Cream Mottled)	25	33.8
Napilira (Red Mottled)	15	20.3
Saperekedwa (Red)	8	10.8
Kamtauzgeni (Brown)	7	9.5
Kaulesi (Purple)	5	6.8
Kalima (Dark Red Mottled)	5	6.8
Nyauzembe (Dark Green)	4	5.4
Mixed	4	5.4
Total	**120****	**162.6****

** Total count and percentage exceed 74 and 100% respectively due to multiple responses. The percentages are out of 74

Napilira, which is red mottled in color, is a relatively new market type in Malawi, dating back to mid 90s when CAL 143, a CIAT line was released in Malawi. Availability of beans, coat color, and cooking time were among the factors that influenced demand and price on the market (Table 128). More than half (56.8%) of the sampled traders indicated that bean prices vary according to availability, indicating that price depended on supply. In general, the price was low soon after harvest (March to June) but it is expected to go up, sometimes even more than double, during the lean season, towards time to plant the subsequent crop between October- January, all the way until the next harvest In March-April.

Table 128. Factors determining bean price

Factor	Count	Percentage (%)
Availability	42	56.8
Cooking time	16	21.6
Coat color	16	21.6
Taste	8	10.8
Grain size	4	5.4
Damage level	1	1.4
Others	22	29.7
Total	**109****	**147.3****

**Total count and percentage exceeding 74 and 100% respectively due to multiple responses. The percentages are out of 74

On average, Napilira (red mottled) and Nanyati (cream mottled) market classes had the largest sales volume; about 8800 kg (Napilira) and 8000 kg (Nanyati) were handled by wholesalers in a month at the time of the study (Figure 76). The traders attributed this mainly to the Napilira's high yielding ability, owing to its tolerance to low soil fertility and resistance to diseases. This made it to be readily available on the market. On the other hand Nanyati was abundant because many farmers in Malawi have been growing this market class for a long time, and it occupies a larger share of the land that is put to beans. At the wholesale market, Napilira was the cheapest, selling at about MK36 kg^{-1} on average, where the range across various market types was MK30-80 kg^{-1}. (Table 129).

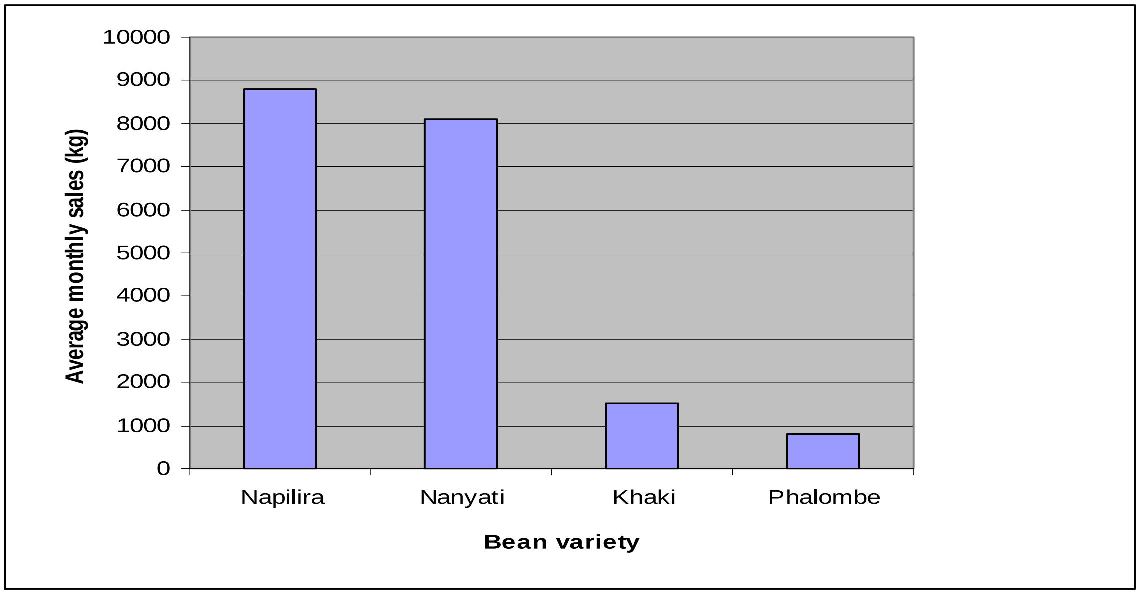

Figure 76. Wholesalers average bean sales

Table 129. Bean wholesale prices (MK per kg) by type in March/April 2004

Variety	**Minimum Price**	**Maximum Price**	**Average Price**
Phalombe (Dark Red Kidney)	35.00	80.00	46.43
Nanyati (Cream Mottled)	30.00	70.00	39.38
Napilira (Red Mottled)	35.00	40.00	35.71

Conclusion:

The bean market share in the central and southern Malawi is dominated by the dark red kidney, followed by cream mottled (sugar) and red mottled. Supply, bean market type and cooking time are some of the factors that influence the price on the market. The combination of large volumes of Napilira on the market due to its high productivity, and low market price, offers affordable protein to many rural and urban poor households.

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4.3.5 Economic analysis of climbing bean production cost-benefit ratio in Colombia

Rationale: We have begun a project to analyze the economic returns achievable with trellised climbing bean monocultures. The goal of this project is to perform a market and cost-benefit analysis of climbing beans, identifying the technology and agricultural practices (trellising, seed inputs, disease control, land management) found in various departments of Colombia, and analyzing profitability on a per unit land basis. This study will allow us to get a better idea of costs of production and profitability of climbing beans in different regions of the country and whether the bean supply is affected regionally or nationally by the new systems of production that have been implemented for climbing bean production. Our ultimate goal is to develop new varieties of beans that fit into the most accepted and profitable production systems.

Methodology: Surveys were prepared for both producers and consumers as two separate groups of interview subjects so as to ascertain the status of both supply and demand of common beans as a commodity in the regions of Colombia that were targeted. Special attention was given to the producer survey so as to obtain useful information for the cost-benefit analysis. The consumer survey was targeted to two subgroups: final consumers and intermediaries whether wholesalers or retailers. Information on planted area, harvested area, per hectare yield and regional supply were obtained from diverse sources including the Ministry of Agriculture and municipal extension offices (UMATAs) (Table 130 – Figure 77).

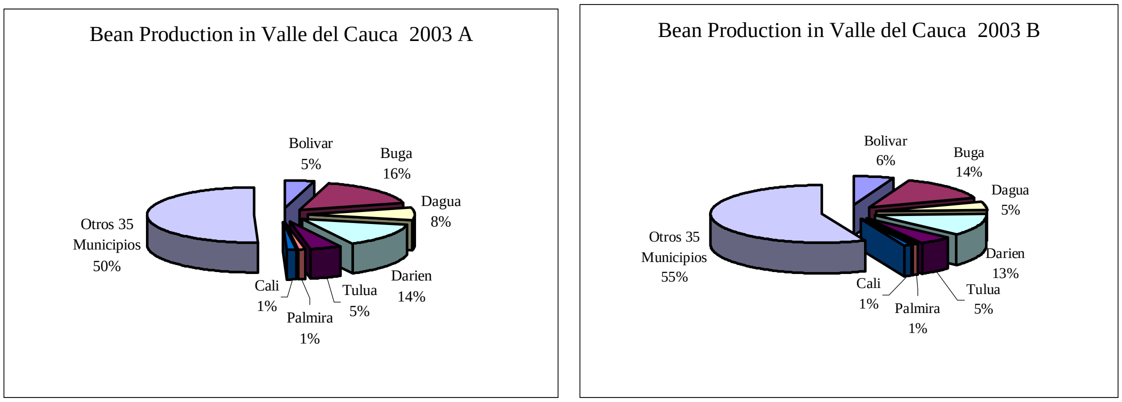
Table 130. Production of dry beans (in hectares) in municipalities of the department of Valle, Colombia in 2003.

	Semester A				**Semester B**			
	Planted Area (ha)	**Harvested Area (ha)**	**Yield***	**Total Production (MT)**	**Planted Area (ha)**	**Harvested Area (ha)**	**Yield***	**Total Production (MT)**
Buga	113.8	113.8	1.1	125.18	127.0	122.3	1.0	122.3
Darién	107.6	107.6	1.0	107.6	120.0	115.5	0.95	109.73
Dagua	72.2	72.2	0.8	57.76	55.0	53.0	0.76	40.02
Bolívar	43.9	43.9	0.8	35.12	63.0	65.5	0.76	49.45
Tulúa	44.8	44.8	0.8	35084	55.0	53.0	0.78	41.34

* yields are in tons/ha

Results: Surveys have been tested with producers and consumers in the department of Valle de Cauca during the dry season between the 2004A and 2004B seasons and although data analysis is pending, initial results suggest that the cost-benefit analysis will be difficult because climbing beans are part of complex rotation system for which individual input records for each crop are not kept. It is notable that almost no climbing bean – maize intercropping is practiced within the department of Valle de Cauca except in home gardens and that trellised climbing beans are the predominant production system.

Future Work: Additional surveys will be conducted in the departments of Nariño, Caldas, Quindío, Risaralda and possibly Antioquia y Cundinamarca. A cost-benefit manual will be written to help with future studies by officers of extension or local agricultural services departments.



Source: Unidad Regional de Planificación Agropecuaria – URPA, Ministerio de Agricultura y Desarrollo Rural del Valle del Cauca.

Figure 77. Percentage production of common bean among the municipalities of Valle de Cauca in 2003A.

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Progress towards achieving milestones:

- A completed impact study in Uganda shows that average annual household bean income has more than doubled since introduction of new varieties.

- Systematic market studies for the bean sub-sector have been completed in Uganda and Kenya and reports developed. Similar studies are underway in Tanzania and Ethiopia.

- Napilira (CAL 143), which is a red mottled bean type, is a relatively new market class, which has been in Malawi since the mid 1990s. While a formal impact study is pending, it is coming up strongly on the market, commanding largest volumes of sales per month, at harvest time. It also sold at a lower price compared to other types, offering many rural and urban poor households to access more beans, and therefore improving their protein consumption.