

Research Application Summary

**Capacity building for bean improvement in Sub-Saharan Africa**

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**Abstract**

This paper highlights experiences focusing on the first author's journey as an undergraduate student through postgraduate training. She was supported by the IPM CRSP and the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM). She is currently working as postdoctoral research fellow with the International Centre for Tropical Agriculture (CIAT) and has engaged in training postgraduate students in partnership with Makerere University.

Key words: CIAT, Research and training

**Résumé**

Cet article souligne les expériences se concentrant sur le voyage du premier auteur comme une étudiante de premier cycle à travers la formation post-universitaire. Elle a été soutenue par IPM CRSP et le Forum régional des universités pour le renforcement des capacités en agriculture (RUFORUM). Elle travaille actuellement comme chercheur postdoctoral avec le Centre international d'agriculture tropicale (CIAT) et s'est engagée dans la formation des étudiants de troisième cycle en partenariat avec l'Université de Makerere.

Mots clés: CIAT, recherche et formation

<sup>1</sup> The first author completed a Bachelor of Science degree in Agriculture in 1998 at Makerere University, Kampala, Uganda with her dissertation focusing on disease and insect pest resistance of dual purpose cowpea (*Vigna unguiculata*). She completed a Master of Science in Agriculture, Makerere University (Crop Science: Plant Pathology) where she conducted participatory research with women farmers in Kumi district, Bukedea sub county (E. Uganda) on the management of Rosette and Cercospora leaf spot of groundnut (*Arachis hypogea*) in the year 2000. She then worked as an Agricultural Officer in Kabale district (SW Uganda) for a period of three months before joining the International Centre for Tropical Agriculture (CIAT) as a research assistant. As a research assistant to the CIAT regional pathologist, Dr. Robin Burruchara, she worked with small scale bean seed producers in Eastern Uganda focusing on training small scale bean seed producers on the recognition and management of major pests and disease of common beans (*Phaseolus vulgaris*) and on producing good quality disease free seed. After a period of two years through linkages with Makerere University and Professor Adipala, she was granted a two year study leave to pursue her PhD study in Plant Breeding under the African Centre for Crop Improvement (ACCI) program at the University of KwaZulu-Natal, Pietermaritzburg, Republic of South Africa which she completed in April 2008. She conducted her PhD research at CIAT-Uganda on improving resistance to Fusarium root rot (*Fusarium solani* f.sp. *phaseoli*) of common bean. She has published her research on groundnut rosette and cercospora leaf spot of groundnuts and fusarium root rot of beans in various journals. She is currently employed by CIAT as a Post-doctoral fellow (Plant Breeding/ Pathology) and a network breeder for the Pan-Africa Bean Research Alliance (PABRA).

## Background

The common bean (*Phaseolus vulgaris* L) is a major food crop in East, South and parts of West Africa feeding up to 144 million people. About 6.3 million ha are grown annually by resource poor farmers particularly women in Africa. There has been a rapid evolution with beans moving from being a traditional subsistence crop to a market oriented modern sector crop. Sale of beans now exceeds US\$ 500 million annually (FAO, 2011). However, the crops production trend has not kept pace with the annual growth rate. Stagnant yield trends have been reported in the last 10 years due to a number of abiotic, biotic (pests and diseases among others) and socio-economic constraints (Wortmann *et al.*, 1998; Katungi *et al.*, 2011). Biotic constraints include, pests and disease; abiotic include, drought, low soil fertility, excessive rainfall, others include, poor crop management practices, low adoption of improved varieties, etc. In some countries beans are still considered a poor man's food hindering investment in the bean enterprise. Due to the ever increasing population pressure, farmers are growing beans into traditionally non-bean growing areas which are drier (low rainfall) creating new challenge, e.g., common bean is now being grown at altitude as low as 5 masl in Mozambique to 2000- 2800m in Southern Ethiopia. Micronutrient malnutrition, the so-called hidden hunger, affects more than one-half of the world's population, especially women and preschool children in developing countries (Pfieffer, 2007). Bio fortification, a new approach that relies on conventional plant breeding and modern biotechnology to increase the micronutrient density of staple crops, holds great promise for improving the nutritional status and health of poor populations and beans are one such crop that can be used to provide these micronutrients. The International Centre for Tropical Agriculture (CIAT) one of the 15 CGIAR centres of the world, through the Pan Africa Bean Research Alliance (<http://www.ciat.cgiar.org/work/Africa/Pages/PABRA.aspx>) has been addressing the challenges facing bean production in Africa with the goal of Improving nutrition and health, gender equality, food security, incomes and natural resource base for sustainable and livelihoods of resource poor women and men farmers for more than 20 years now (Buruchara *et al.*, 2011) (Fig. 1).

## Capacity Building at CIAT

CIAT's research is based on a broad R&D framework where a student-research can be plugged in on-going efforts and make a contribution to address national and regional research challenges. This also allows building on sequential or parallel research conducted by both MSc and PhD research. CIAT's research programme is closely linked to, complements, and is

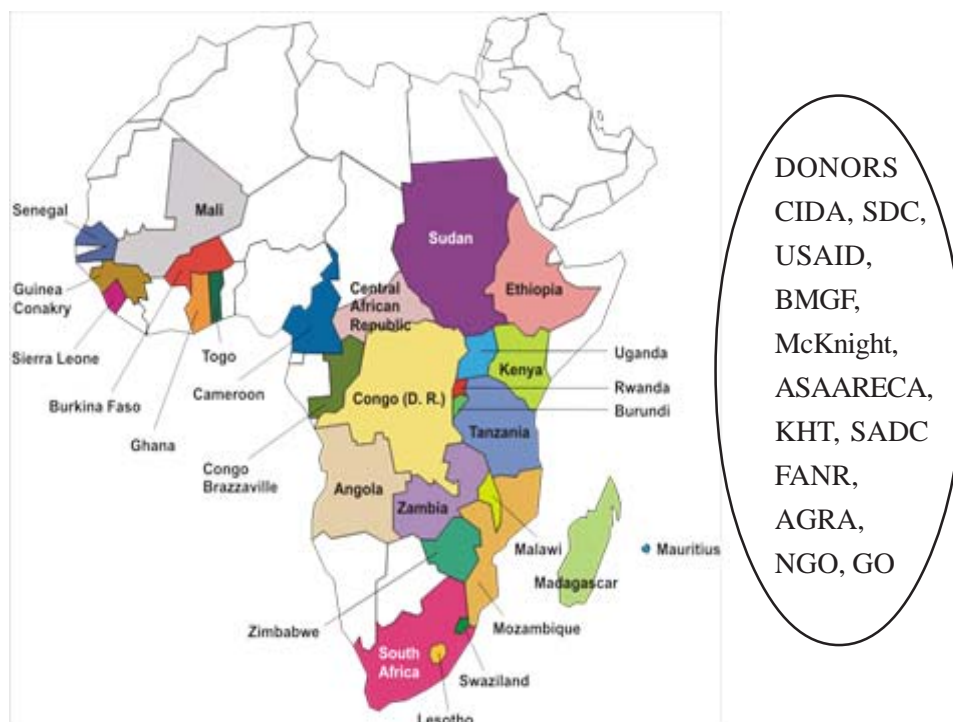


Figure 1. Pan-Africa Bean Research Alliance (PABRA).

executed in partnership with the national programmes. It is therefore possible for students' research to contribute to national and regional priorities. CIAT facilitates partnership efforts and enables linkages with the NARS to reach end-users. Training offered by CIAT is aligned towards building practical skills that can be applied to address and develop client-oriented solutions. For example CIAT has a long history of enhancing the development relevance of University postgraduate training in Uganda through collaboration in joint projects.

CIAT-PABRA's strategy for capacity building seeks to build a critical mass of people that are informed and are providing improved services to end users along the bean value chain. Approaches used include

- i) Establishment of a networking platform for interactive knowledge sharing and collaboration among PABRA scientists and national partners where exchange of Knowledge, skills, and information in network forums takes place.
- ii) Support for degree-related training in the form of BSc, MSc/MA and PhD research on topical issues reflecting

- themes in the PABRA outcome areas and the cross cutting issues of gender and monitoring and evaluation.
- iii) Non-degree related training (short courses, field days, workshops, etc) to target researchers' and farmers' skills and knowledge in areas such as participatory variety selection, post harvest management
  - iv) Provision for acquisition of equipment and materials that allow trainees to apply technical skills and knowledge acquired during capacity building.

PABRA scientists and regional resource persons (national experts engaged to technically support and train national partners in different PABRA countries) take responsibility for assessing capacity needs and tailoring responses effectively. Universities constitute a key component of the system of institutions which have played a critical role in the process of increasing agricultural productivity and attaining food security in the World. CIAT Africa Uganda office based at the National Agricultural Research Laboratories (NARL) in Kawanda have been conducting capacity building trainings in Bean pathology and breeding for many years. Students' projects are designed to fit into the PABRA framework (Fig. 1) and contribute greatly to the scientific research conducted by CIAT. CIAT is currently collaborating with the RUFORUM on an internship program to train students pursuing MSc degree in Plant Breeding & Seed Systems that aims to provide a high level of both theoretical and practical training in plant breeding. Through this collaboration the students get practical training on on-going research activities at CIAT-Uganda and also conduct their thesis research within the on-going projects. The major aim of PABRA's breeding program is to develop resilient bean germplasm (adapted to fluctuations and extremes of climatic, edaphic factors, pests and diseases) and maintain stable bean production and quality in the presence of diverse stresses; enhancing the capacities of the communities to cope with stresses (Buruchara *et al.*, 2011). Student research always is fitted within the PABRA framework and is designed to be useful to the students home country. Under this logical model, student's research is at output level as shown in Figure 2.

However, CIAT's contribution and comparative advantage in addressing the issues are wide and go beyond CIAT-Uganda. CIAT has in its custody the largest collection of common beans, cassava and forages germplasm. It has extensive capacity in soils research, partnerships (approaches, types and numbers),

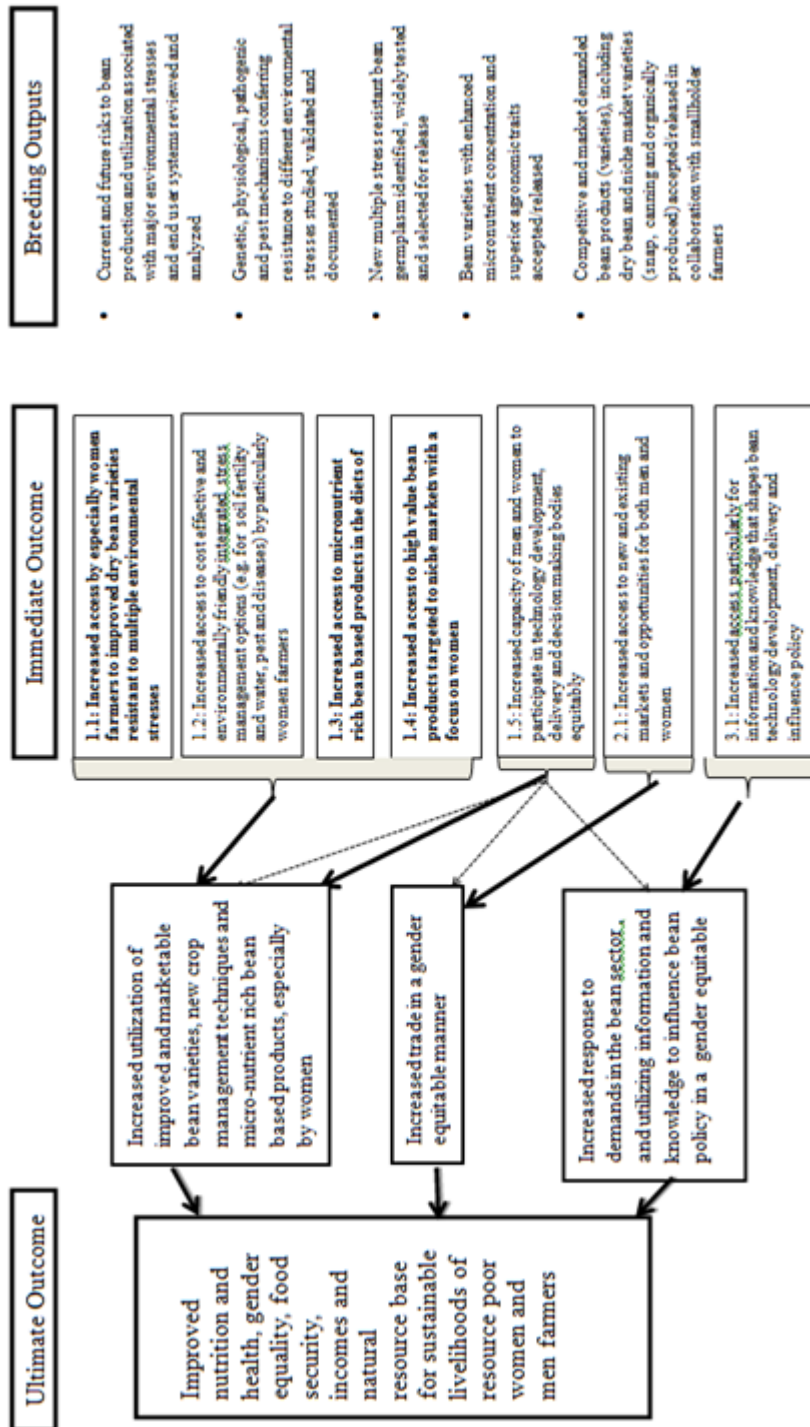


Figure 2. PABRA Logical framework (2009-2013) showing the outputs to which the RUFORUM students contribute.

socioeconomics /enabling rural innovations (ERI) approaches (PR, PPB and Agro-enterprise), Wider Impact Approach (for wider technology reach), approaches to respond to some acute stresses with great competencies being drawn from the Colombia headquarters in biotechnology, GIS, climate change, and physiology.

CIAT offers an opportunity for institutions of higher learning to translate research into development impacts in Uganda. For examples, the PABRA market-Class led breeding strategy and sharing of breeding responsibilities offers an opportunity for research products to have impact (Fig. 3). A case in point is that segregating populations developed by students through marker-assisted breeding are advanced by in-coming students who complete the work and ensure that advanced lines are produced and distributed through CIAT's regional nurseries network. Examples include; Dr Otsyula materials developed for root rot resistance at Makerere University that have been distributed to a number of East African countries and two released in Kenya. Similarly, in Uganda, through a collaborative project between CIAT-Uganda and NARO-bean program two root rot resistant bean varieties (NABE 13 and 14) originating from Rwanda were released in 2006.

In addition, the capacity building efforts attract additional resources to conduct more research. Based on

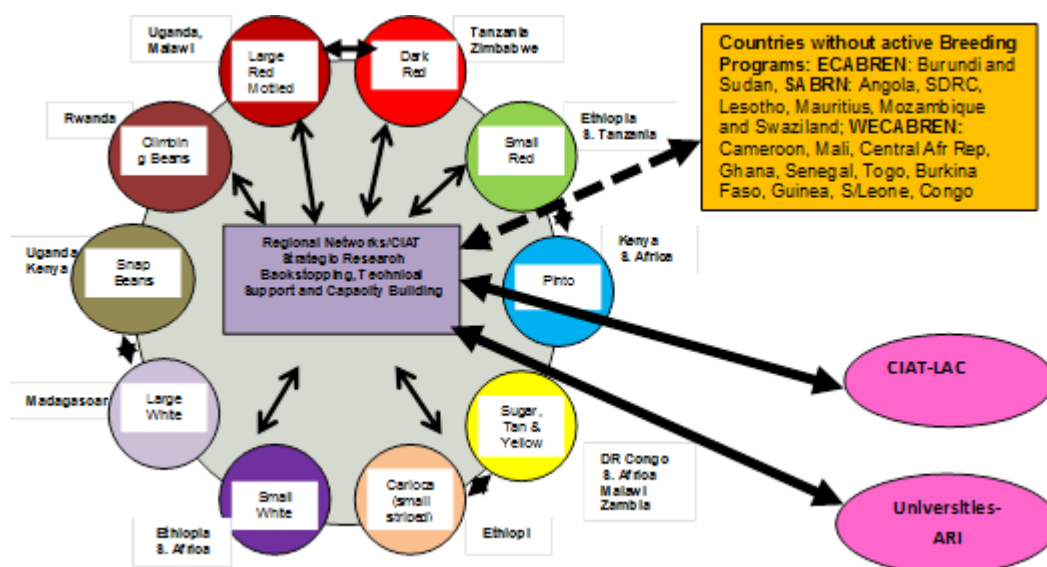


Figure 3. Market-Class led breeding strategy and sharing breeding responsibilities (PABRA, 2011).

recommendations drawn from the past research, new students with new funding continue with segregating populations developed by previous students and advance them. Publications of the research work draws both national and international interest for more donor funding and new partnerships, e.g., USDA, BBSRC-UK projects based on root rot research. The capacity building has also contribute to the enhancing capacity in African universities and NARS, the majority of the CIAT past students are working as university professors or researchers in reputable research organisations.

In 2009-2010, a total of 41 students enrolled for Bachelors, Masters and PhD studies in various universities across the world. The majority of the students were Masters level. A similar trend is reported for 2011-2012 with 37 students at varying levels (Fig. 4).

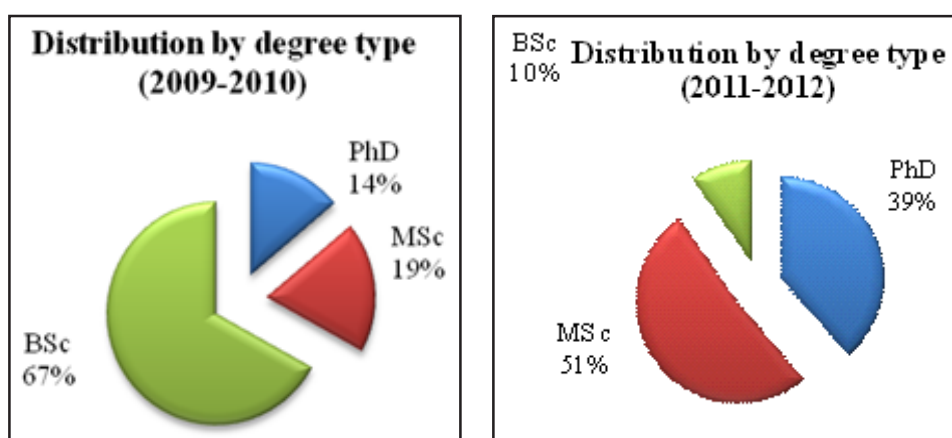


Figure 4. Degree training distribution 2009-2010 and 2010-2012.

### Research Conducted

Disease phenotyping and marker assisted selection (MAS) are the major strengths of the CIAT-Uganda site due to possessing a well-equipped molecular and pathology laboratory, screenhouses and research fields as well as human capacity to mentor and support the students research. The major disease addressed are ones that have been identified as the most important in the East and Central Africa regions and include; Angular leaf spot (ALS); *Phaenariopsis griseola* and Common bacterial blight (CBB); *Xanthomonas campestris* pv. *phaseoli*/*Xanthomonas campestris* pv. *phaseoli* var. *Fuscans*, Anthracnose (*Colletotrichum lindemuthianum*), Root rots (*Pythium ultimum* and *Fusarium solani* fsp. *phaseoli*) and Bean Common Mosaic Virus and its necrotic strain

(BCMNV). Three students conducted their thesis research under supervision of the author and based on the findings of the authors PhD thesis on Fusarium root rot genetics. They have since graduated and currently two are pursuing PhD studies at Michigan State University and Purdue University in the United States of America. In addition to disease resistance breeding the author is conducting research on drought tolerance linked to the TLII project and Iron and Zinc bio fortification through linkages with the CGIAR HarvestPlus program. Currently, two PhD (Uganda) and one MSc level (Rwanda) students are conducting their thesis research under the supervision of the author while another two (Uganda and Malawi) are conducting studies on Pigeon pea at Makerere University Agricultural Research Institute Kabanyolo (MUARIK). Two students from Rwanda and Southern Sudan are expected to conduct their research at CIAT-Uganda in the most recent RUFORUM cohort of students (Table 1).

**Table 1. Makerere University students supervised by the authors.**

| Student             | Level | Title  | Status     |
|---------------------|-------|--|------------|
| Jimmy Obala         | MSc   | Improving resistance to Fusarium root rot through gene pyramiding and validation of SSR PVBR87 marker in common bean   | Completed  |
| Ongom Patrick       | MSc   | Inheritance of resistance to Fusarium root rot in three Pythium root resistant common bean genotypes   | Completed  |
| Kelvin Kamfwa       | MSc   | Quantitative trait loci discovery and transfer of resistance against <i>Fusarium</i> root rot in crosses of meso-american x Andean varieties of common beans ( <i>Phaseolus vulgaris</i> L.) | Completed  |
| Francis Okot        | MSc   | Phenotypic Diversity of Ugandan Pigeonpea Landraces and Their Reaction to Fusarium Wilt in Ugandan Environment   | Completing |
| Nolipher Khaki      | MSc   | Evaluation of Malawian pigeon peas ( <i>Cajanus cajan</i> L.) landraces for drought tolerance and superior agronomic traits  | Completing |
| Kiryowa Moses       | PhD   | Assessing the efficacy of pyramided genes in conferring dual and durable resistance to bean anthracnose and root rots  | On-going   |
| Ddamulira Gabriel   | PhD   | Genetic enhancement of resistance to Angular Leaf spot ( <i>Pseudocercospora griseola</i> ) in common bean ( <i>Phaseolus vulgaris</i> L.) through gene stacking.                            | On-going   |
| Floride Mukamuhirwa | MSc   | Inheritance of higher seed content of iron and zinc in bean varieties grown in Rwanda.   | On-going   |
| Emma Uwera          | MSc   | ?  | New        |
| Francis Ochaya      | MSc   | ?  | New        |



## Training Courses

CIAT-PABRA also executes short training programs for its NARS partners targeting young scientists (students and technician) through the Pan Africa Bean Research Alliance that covers 28 East, West and Southern African countries. In 2009-2010 only, 435 individuals benefited from such short trainings (Fig. 5).

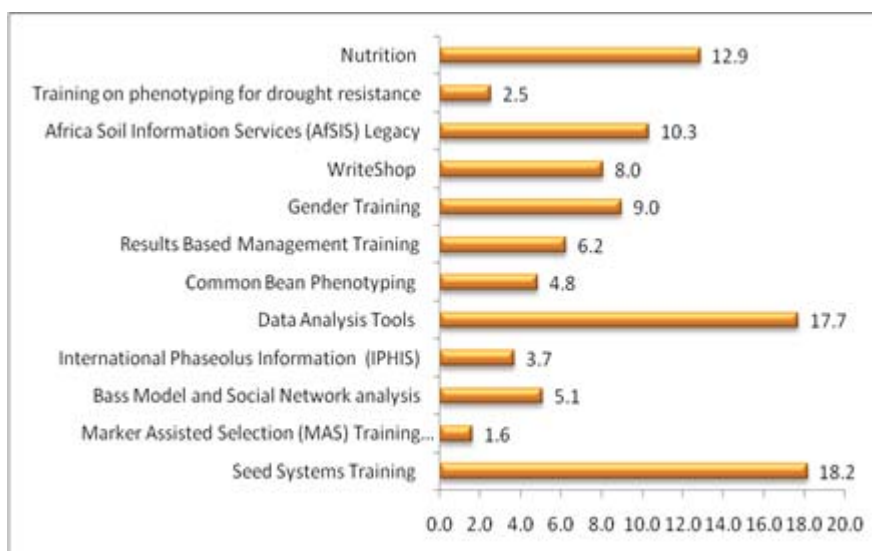


Figure 5. Percentage of trainees benefitting from demand oriented short course in 2009 and 2010 (n=435).

## Other Capacity Building Initiatives

CIAT is also engaged in other capacity building initiatives some of which include; the African Bean Consortium (ABC) of the Kirkhouse Trust Foundation ([www.kirkhoustrust.org](http://www.kirkhoustrust.org)) that covers Uganda, Kenya and Tanzania with likelihood of including Ethiopia and Rwanda in the coming years. Under this consortium, CIAT partners with the Kirkhouse Trust Foundation conduct short trainings that focus on disease phenotyping, field experimentation and marker assisted selection (MAS). The foundation offers scholarships to students through projects focusing on disease resistance breeding using molecular techniques under the supervision of key bean researchers in the region.

Most recently, a Bean Community of Practice (Bean COP) being driven by the Generation Challenge Program (GCP) was initiated and is coordinated by the author. The aim of the COP is to develop improved bean germplasm that will meet both the needs of bean research initiatives, and producer and consumer preferences and it will cover all areas associated with breeding and integrated breeding. The ultimate goal is to develop producer

and consumer preferred bean varieties with multiple traits in a short time and efficient manner, targeting to reduce the number of cycles and duration required to develop new varieties by 15-20%. The Common bean CoP takes advantage of the **Integrated Breeding Platform (IBP)**, [www.integratedbreeding.net](http://www.integratedbreeding.net), which is a web-based, one-stop shop for information, analytical tools and related services to design and carry out integrated breeding projects. The IBP promotes the use of molecular tools in breeding programs taking advantage of the enormous steps made in this field and the current low cost of genotyping. The development of the Platform is a project bringing together numerous **partners** and several key **funders**, coordinated by the **Generation Challenge Programme** of the Consultative Group on International Agricultural Research. To kick start the utilization of the IBP tools, a training program that spreads over three years cumulatively adding up to six weeks of intensive face-to-face training workshops supported by online and other resources made available through the Integrated Breeding Platform Portal was initiated. A total of fifteen young African bean breeders are participating in this training program and are expected to utilize the IBP tools.

## Conclusions

The International Centre for Tropical Agriculture (CIAT) offers an opportunity for institutions of higher learning to translate research into development impacts. CIAT continues to engage its key scientific competencies to achieve significant impact on the livelihoods of the poor in the tropics. CIAT's key strategy is mainly based on catalysing and facilitating sustainable partnerships that should continue long after the projects lifespan. CIAT aims to ensure that the in-training capacity building approaches promote institutionalization within the target partner organisations hence ensuring sustainability. Ensuring that partners are continually informed on research developments and innovations generated within the project, and related fields will strengthen the individual knowledge base and abilities leading to the transfer of capacities and adaptations

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