

Integrated Breeding Platform (IBP) a service provider of choice to add value to your funding proposals

Crop Breeding: a key component in which to invest for impact on food production

General rationale in support of breeding modernization

Demand for increased productivity in Africa is growing at a rapid rate. Overall, consumption of food crops is increasing with this demand met, largely, through costly food imports. Together with better access to inputs and seed distribution channels for smallholder farmers, there is considerable potential for crop production, in well-defined delivery chains, to play a very significant role in addressing the challenges of food insecurity and rural poverty.'

New and more productive cultivars of staple food crops are the most effective technology for improving farm livelihoods, satisfying consumer demands, and combatting environmental challenges. Crop breeding is, and will continue to be, a very important part of the agricultural research & development landscape.

Breeding modernization focuses on four (4) pathways of impact:

- **Digitizing breeding activities** – through the use of a purpose-built software suite, (e.g. BMS Pro – Breeding Management System); implementing proper policies for the management and sharing of breeding data; and bringing information technology to the field
- **Modernizing breeding methods** – implementing modern breeding strategies, including the use of molecular markers, as needed, and supported by reliable field location, suitable experimental design, and powerful statistical analysis.
- **Integrating demand (producer, market and consumer) within breeding protocols** – connecting the dots between value chain actors (researchers, producers, certifiers, distributors and consumers, among others) through participatory selection, product evaluation, and entrepreneurship
- **Enabling the rise of a new generation of breeders** – through training, dedicated support and community spaces, and by embedding their activities in academia and youth initiatives.

On the necessity and promises of digitization

About the need for breeding digitization more specifically

Attempting to modernize breeding without a reliable data management system in place doesn't make much sense and is a risky endeavor. Many research projects and breeding programs remain short of delivering on their objectives because of poor data quality, lack of documentation, and the loss of, or failure to capture, institutional memory. A shift to digital operations, with appropriate systems and support, allows breeders to access the information they need more efficiently, whether it has been generated by themselves or by peers. This digitization of breeding activities is critical: it increases the effectiveness of seed management, and of data capture, quality control, documentation, and analysis.

It enables an organization-wide cumulative learning built-up for more accurate selection decisions at all breeding stages. Establishing routines to standardize the storage of germplasm information (pedigree, phenotypes and genotypes), of metadata (location, climate, etc.), of breeding protocols and trait ontologies, also creates a multiplicity of data mining and sharing opportunities across a wider range of environments and teams. In short, digitization enables a better use of breeding data and knowledge – an institution's most valuable asset – and greater collaboration; which in turn allows it to produce better varieties in less time, and at a lower organizational cost.

Expected outcome

Our goal is to enhance the ability of national programs within a regional network to increase their breeding productivity through digitization. We expect this component to help deliver fully functional and integrated regional crop networks for target crops, with state-of-the-art data management strategies and practices which fully support their breeding programs; and, more generally, a regional community of better educated, well-equipped and active African plant breeders in the use of information technologies. As a result, the component will have contributed to enabling plant breeding programs in their development and promotion of climate resilient, improved crop cultivars for local environments, following a demand-led varietal design – and thus have them deliver on National Agricultural Plans more effectively.

Proposed solution

About the deployment of BMS Pro by the Integrated Breeding Platform (IBP)

There is a unique opportunity to leverage on complementary programs at a regional level to maximize the benefits from the work proposed here. This will require conscientious attention to information management. The information generated during the breeding process must be digitized and managed in an integrated information system for plant breeding programs to be effective in a modern environment.

Indeed, the adoption of a good crop management system is a must for institutions to create institutional memory and ownership, and to facilitate data exchange between teams within and across their organization.

The Integrated Breeding Platform (IBP – <https://www.integratedbreeding.net>), together with its African partners (National Programs, Universities and Regional Organizations), has implemented a solid strategy over the last decade in deploying BMS Pro – Breeding Management System, and in supporting the adoption of modern breeding practices, with a particular focus on enabling institutional change. As a result, the IBP has successfully deployed 17 BMS Pro instances in Sub-Sahara African Institutes over the last 3 years alone, and a dozen National Programs across the region are using it as their core data management system for a diverse number of projects, breeding programs and crop species. More than 300 African breeders and technicians are using BMS Pro to run their breeding activities. A key success factor in the sustainable adoption of new breeding technologies is the IBP's collaboration with local universities to train the next generation of scientists. The IBP currently partners with 7 universities in West and East Africa, who train their students on using BMS Pro as part of the MSc curricula in Plant Breeding, and/or have MSc and PhD students using it to manage their research theses and projects.

BMS Pro includes modules for data management, statistical analysis and decision support, all accessible through a central dashboard interface on top of a solid crop information database, to support the various stages of cultivar development, from conventional breeding through increasing levels of marker use. BMS functionality allows for the storage and management of pedigrees and phenotypic data dynamically, and in full synchronization with breeding steps (<http://www.bmspro.io>). Most importantly, the data stored in the core database of BMS Pro will always remain fully owned and managed by the institution using it, which will help create a sense of ownership and accountability in the establishment of their own intellectual property and data management policies. Last but not least, the IBP's unique sustainability model as a Non-Profit Organization ensures that its products and services will remain well within reach of just about any crop breeding program, should they choose to continue using the software after the end of the grant period.

Finally, the implementation and use of technology are only one part of the digitization process. Indeed, stakeholders will not only need to install and adopt these new tools, but also commit to a shift in perceptions as to how data is generated, conserved, used, shared and transformed. The IBP puts great care and expertise in accompanying institutions through this necessary organizational transformation, namely by helping them implement proper methods and policies for data management.

In short, the digitization of breeding data management will bring tremendous added value and relevance across teams through better data exchange and analysis to stimulate research partnerships across the region. BMS Pro has been developed specifically to cater to the needs of plant breeders, and allow them to transition into the digital era.

Key activities for implementation

The digitization process will be achieved through both regional and local components, each offering leadership, design, infrastructure, capacity building and coordination on the basis of their respective abilities and scope of responsibility (to be defined at the proposal stage). The work to be done drills down to the following activities:

- **Infrastructure planning:**

Although it is possible to start the process of institutionalizing the management of breeding information with relatively modest resources, it is essential to have a reasonable level of internet connectivity and capacity to fully implement multi-user shared systems that will facilitate teamwork and secure knowledge at the institutional level. An IT development plan will be produced and implemented for each partner institute, to secure their adequate capacity in terms of internet connectivity, access to local or cloud servers, and having proper equipment such as laptop or desktop terminals, label printers, barcode readers, and tablet devices for electronic data capture. The plans will phase targets to ensure that the infrastructure remains viable at the end of the project.

- **Deployment of a crop information system:**

The bulk of the work will involve migrating historical information into BMS Pro. The needed information will be migrated to BMS Pro by the IBP Data Management Team in partnership with the crop lead Centers (regional) and the target National Institutions (Local). Once this data is migrated, it will form a solid basis for establishing the breeding database. For future crops and national programs for which this baseline information will not have been collected within the scope of the current proposal, local projects can be established to get that data collected directly into BMS Pro, under guidance from the regional coordinating component.

- **User training and support:**

A series of workshops and visits (two per cycle) with users during successive breeding cycles will be organized. Ideally, this will take place at the beginning of the season in order to help breeders in using BMS Pro to prepare their cycle (parent line selection, crosses, populations and trials, experimental designs). Follow-up visits will also be planned to assist users with field data capture (at flowering time and/or during harvest) and data analysis. Local focal points will have to be identified and trained to ensure sustainable support onsite, but users will have access to the IBP's online Help Desk to overpass any operational or logistical bottlenecks.

- **Data management strategy:**

The IBP will work closely with Senior Management at each institute to guide them in the development of their respective Research Data Management strategies and policies. The commitment of management at the local level will be an inescapable factor in the success and sustainability of the digitization effort as a core element of their strategic plans.

Potential beneficiaries

The ultimate beneficiaries of a digital revolution in plant breeding are smallholder farmers in developing countries – especially women farmers – and their families, for whom higher yields and more resilient, quality crops will enhance food security and household incomes. The tools, services, knowledge, resources and peer interactions facilitated by the use of BMS Pro will enable breeders – the immediate beneficiaries of this project component – to adopt best practices, use new tools, and integrate breeding approaches that will let them save time and increase accuracy in developing cultivars that are better suited to local environments. In short, it will increase the rate of genetic gain delivered to farmers and accelerate the turnover of improved cultivars in response to local and market demand.

Finally, the scientific community has long been looking for ways to bridge the gap in terms of access to information, education and professional advancement for women and youth. Having access to technologies such as BMS Pro levels the playing field: it provides equitable access to resources and knowledge, and gives everyone the chance to contribute data, and to get an impartial visibility for results. This is especially the case for the next generation of women plant breeders at the early stages of their careers. By developing the skills they need to embrace modern breeding, young breeders will be equipped to take on emerging economic opportunities with confidence.

Detailed workplans, timeline and budget allocation

The IBP will gladly provide all needed information for the purposes of including breeding digitization as a component within a larger proposal. Detailed workplans, timelines, and budget allocations will be determined with the lead project coordinators within the scope they have in mind for this component. For further information and assistance, please contact the IBP at deployment@integratedbreeding.net.