

Innovation Lab for Legume Systems Research

Leveraging Technology for Effective Systematic Change Strategy Whitepaper Update

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Presented here is the Feed the Future Innovation Lab for Legume Systems Research Strategy Whitepaper in support of the award extension Cooperative Agreement No. 7200AA18LE00003. The Lab first met in Saly, Senegal, in February 2020, with over 50 legume systems researchers and stakeholders to develop a global strategy for the Lab. The Lab convened virtually in February 2021, virtually in March 2022, and in-person in Livingston, Zambia, in February, 2023 to update the Strategy to inform future efforts. The meetings had constructive discovery and dialogue, the results of which were captured here in this strategic white paper and has informed the work of the Lab over the last five years. At each of the annual convenings, this strategy statement has been updated through further dialogue based on the findings and results of the research being conducted under the aegis of the Lab. The strength of the Legume Systems Innovation Lab's design lies in its innovative and vibrant research to scaling strategy using a systems approach expressed through the Product Life Cycle (PLC), value chains, and Multi-stakeholder platforms (MSP). Supported projects are diverse in research focus and address both the development and placement of innovative technologies with a thorough understanding of the system they will impact, thus leading to successful handoff to scaling partners, which will be a focus of the Lab in its next funding cycle. The main focus of the Lab's research has been the three areas of inquiry (AOI) defined in the Lab's original proposal:

- AOI-1 Integration of legumes into sustainable smallholder farming systems and agricultural landscapes;
- AOI-2 Integration of legumes within local and regional market systems, including trade;
- AOI-3 Analysis of motivators or barriers to legume utilization within social and economic systems.

Casting a Common Vision

These priority research areas have been pursued through the development of innovative and transformative legumes research for scaling using a systems approach targeting the placement of innovative technologies and key information at optimal insertion points for system wide impact. The initial convening in Saly, Senegal, identified three key impact areas that defined the Lab's first phase successes:



Networking & collaboration: integration across stakeholders; communication and collaboration at multiple levels; and partnerships for scaling.



Measurable impact: communication around lessons learned; well represented and showcased in conferences, publications, seminars, etc.; improved productivity, and product lifecycle gateway criteria leading to workforce development.



Capacity building: long- and short-term knowledge and skills development sustainably adapted to national contexts as measured through capability gap analyses for individuals, institutions, and systems as a whole, including degree acquisition, institutional performance indicators, and system measurements.

Setting Short-Term Goals and Long-Term Strategic Directions

For each of the three Areas of Inquiry, we set long-term (20 years) strategic directions and short-term (three years) strategic goals. The three-year goals became the basis for strategy directions for the Lab over the following first five years of the award, resulting in high level outcomes and impact.

AOI 1

Integration of legumes into sustainable smallholder farming systems and agricultural landscapes

Current challenges

- Traditional extension, low use of improved crop varieties.
- Low production/little coverage by legumes compared to cereals.
- Small margins for improved seed, poor quality grower seed.
- Smallholder farmers do not buy (quality) seed.
- Indiscriminate use of pesticides.

Intermediary Strategies

- Farmers using improved seed; systems growing new legume varieties less than 5-10 years old.
- Use of good agricultural practices coupled with basic IPM.
- Strong Farmer-led extension approaches.
- Community-based seed production systems.
- Consumer-preferred trait selection.

Future Goal

- Strong public/private seed industry with farmer access to high quality seed.
- Multiple resistant varieties based on end user demand.
- Sustainable biological production, pest suppression by use of sound IPM practices.
- Agro-ecological approaches to production systems.

AOI 2

Integration of legumes within local and regional market systems, including trade

Current Challenges

- Low access to quality seeds; research not oriented to markets.
- Limited value-added products.
- Poorly integrated markets with low market participation, low access to market by farmers and low volume of legumes in markets.
- Information asymmetry, lack of and/or transparency of and access to pricing data.
- Absence of and/or weak regulatory and policy framework for variety development and seed systems at country and regional levels.

Intermediary Strategies

- Improved market varieties that respond to consumer preference.
- Better information systems and information flows in legume systems.

Future Goal

- Improved legume trade through integrated value chains (MSPs)
- Availability in markets of improved varieties and yield for better nutrition and income for farmers.
- Information for farmers and consumers.
- Better integrated value chain (locally and regionally).

AOI 3

Analysis of motivators or barriers to legume utilization within social and economic systems

Current Challenges

- Input subsidies on starchy staples vs legumes.
- Consumers unaware of new opportunities for legume benefits, use, and consumption.
- Low private sector involvement in seed production, mostly researchers in some countries (low participation of private sector also applies to value added products).
- Low adoption of new technologies by producers.

Intermediary Strategies

- Cowpea and bean producers including women and youth are empowered to meet consumer demand and contribute to resilient livelihoods.
- Better information about legume consumption (benefits, preparation skills).
- Legume systems are integrated (policy, production, research).

Future Goal

- Improved processing and value-added products.
- Varieties adapted to climate change.
- Malnutrition is drastically reduced.
- Legume systems are integrated (policy, production, research).

Seeking Synergies Between Projects and Innovation Labs

In addition to the strategic directions, much was achieved through existing projects and collaborations with other ILs through synergies in agro-pastoral systems, crop-livestock tradeoffs, legume systems product diversification, agronomy, sustainability of production, technology dissemination, post-harvest loss, soil nutrient management, legume processing, women and youth, empowering partners, and the policy environment, as is evidenced by additional funding for commissioned activities, collaborative awards, cross-cutting seed grants, and minority serving institution incentives that reflect these priorities.

Strategies by Area of inquiry

Additional funding through the Lab was guided by the strategies elaborated at the initial Saly Convening the three Areas of Inquiry. While not all strategies were accomplished within the Lab's funding period, the Lab prioritized those strategies with greatest system impact in additional funding.

AOI 1

1. We aim to improve sustainable production intensification of cereal/legume farming systems by improving soil fertility, agronomy, crop-livestock integration, and integrated pest management.

- This will be achieved through activities in:
 - Agroforestry: utilizing varieties, screening and pilot testing.
 - Bio agents: community-based production of biopesticides and use of biocontrol agents as part of IPM.
 - Dual purpose cowpea: feeding trials, evaluating quality of cowpeas and maximizing the feed/fodder tradeoffs for maximum economic advantage for farmers.
 - Conservation Agriculture; promoting crop diversity and suppressing pest damage.

This strategy was meant to address gaps in linkages between different cross-cutting themes under consideration by individual projects, entrepreneurship opportunities for youth organizations, gender considerations as impacted by our innovations, and innovation fair/demonstration farms for technology transfer.

2. We aim to improve varieties by international germplasm sharing, improving market knowledge, reducing trade barriers.

- This was achieved through activities such as:
 - Expanding breeding program data exchanges.
 - Reducing import transaction time/costs.
 - Surveys of production / farmers/ local markets.
 - Survey consumer preferences (cooking time, color & taste).
 - Providing content/composition of nutrition information.
 - Providing timely consumer information for products and traders.
 - Improve seed quality and information.
 - Create regional information platform for supply and demand.
 - Reduce barriers in policy and practice.
 - Engage RECs to facilitate implementation of Harmonized Regulatory Seed Systems.

This strategy would address knowledge gaps in varieties, quality seed, supply and demand, publicly available consumer/product data, private sector participation, consumer awareness of varieties' nutritional value, and access to credit.

3. We aim to develop and deliver improved bean and cowpea varieties by developing breeding

pipelines and increasing the scale of farmer adoption by 50%.

- This will be achieved through activities in:
 - Optimization of breeding pipelines.
 - Improving seed systems.
 - Learning from successful seed production by smallholders with focus on community based seed enterprises.

This strategy would produce sustainable platforms for addressing knowledge gaps in varieties, quality seed, supply and demand, publicly available consumer/product data, private sector participation, consumer awareness of varieties' nutritional value, and access to credit.

AOI 2

1. We aim to improve information systems for legume value chains by providing more information to actors in the value chain, linking the actors to the source of information.

- This will be achieved through activities by:
 - Developing tailored information products for stakeholders.
 - Delivering information through information and communication technologies.
 - Enhancing market information systems.
 - Enhancing capacity for the use of information delivery methods.
 - Strengthening linkages and dialogue with the RECs relevant technical committees.

This strategy would address gaps in policy, networking infrastructure, youth and gender participation in the value chains, coordination between actors and the value chain, economic value for farmers & others in the value chain, language barriers, and intra- & inter- regional trade.

2. We aim to empower legume cowpea and bean producers, including women and youth, to meet consumer demand and contribute to resilient livelihoods through increased productivity and inclusive commercialization, infrastructure investments, including virtual legume information systems, and an enabling policy environment for legume systems throughout the value chain.

- This will be achieved through activities such as:
 - Design and disseminate a public awareness campaign on nutritional benefits of cowpea and bean.
 - Assisting breeders to identify consumer-preferred nutritious legume varieties to achieve our goals.
 - Identify inclusive market opportunities for nutritious legume-based processed products.
 - Promote farming systems that double production and regenerates land.
 - Identify value chain stakeholders.

This strategy would address gaps in demand and supply constraints, production sustainability, and public awareness on the importance of the legume sector, including government and civil society.

AOI 3

We aim to improve the integration of legume systems stakeholders in policy, production, research, and the like by encouraging government(s) to create policies and facilitate the development of legume products, promoting public private partnerships, breaking down silos between institutions (NARS, extension), and facilitating strong communication between subsystems and components.

This will be achieved through activities such as:

- The development of an information hub for stakeholders, including low-literacy groups.
- Community engaged scholarship that shares information through the training of trainers.
- Product research, development and diversification.

- Drawing lessons from private sector involvement in soybean VC in Southern Africa.

The strategy will address gaps in connectivity/communication, knowledge in policy, production, and research resources, and engagement of key actors.

Strategies by Region

In the first phase, the Lab was focused on two geographical regions: West Africa and Southern Africa. In West Africa, we host projects in Senegal, Ghana, Benin, Burkina Faso, Mali, Niger, and Nigeria. In Southern Africa we are working in Mozambique, Malawi, and Zambia. Each of these regions has their own sub-strategies that are region specific and are detailed here.

West Africa

In addition to the areas of inquiry, the West Africa strategy focuses on the following:

- Provide platforms for information sharing that will help integrate the cowpea value chain in West Africa.
- Map major actors in the value chain network for cowpea, pigeon pea, and common bean.
- Support the work of CIAT/PABRA to collect information on common bean for the Bean Atlas.
- Develop the capacity of NARS in the target countries of Benin, Nigeria, Niger and Senegal, to develop data collections methods and mechanisms.

Southern Africa

In addition to the areas of inquiry, the Southern African strategy focuses on the following:

- Coordinate activities more closely with regional agencies CCARDESA, SABReN, and CIAT/PABRA.
- Analyze existing varieties of common bean, cowpea and pigeon pea for their inter-cropping potential, especially with maize (with the International Center for the Improvement of Maize and Wheat, CIMMYT).
- Improve seed systems and make them more responsive to producer and consumer demand.
- Strengthen national breeding programs through closer collaboration with the NARS.
- Introduce and promote gender responsive variety breeding through the Gender Responsive Researchers Equipped for Agricultural Transformation (GREAT) program.
- Explore possible new processed legume products for cowpea, pigeon pea, and common bean.

Future Directions

As we approach the conclusion of the Lab's five-year funding cycle, we want to ensure that the achievements of the Lab coalesce and are framed in such a way that any Lab successor will be well positioned to build on what has already been achieved. With that in mind, we are commending to the next Management Entity of the Lab the following strategic directions to guide their funding and oversight. These directions were discussed at the annual virtual convening in May, 2022, and are organized in the following around the three phases of the production cycle: pre-production, production, and post-production.

Pre-production

- The next phase research should target the interface between environmental and production factors such as water use efficiency (WUE) nutrient use efficiency (NUE), and resistance/tolerance to abiotic and biotic stresses (diseases, pests, climate.) and the interaction among all these components with the environment (climate change, drought, heat, flooding, etc.) for efficient productivity in the main and at the margins of farming systems as more land must be forced into production to accommodate a growing global population. Interaction among these components is complex and should be considered from a long-term resilience perspective, simultaneously developing current as well as contingency products and processes for short-term adaptation to unforeseen system shocks. It should strike a delicate balance between basic and applied research for final product delivery.

- If legumes are to become the alternative to livestock intense food production systems, the next phase should prioritize human nutrition, targeting biofortification and biodigestibility in breeding and processing. Increasing mineral content may not be enough if those minerals aren't in the right molecular form to be absorbed/utilized.
- Supplemental legume-based products must be developed in addition to regular legume consumption by breeding for alternative/additional end-use traits for legume fractionation (powders, flours, extracted protein). It will significantly impact legume acceptability and consumption.
- Molecular breeding through genetic modification, gene editing, and marker assisted breeding opportunities should be explored as a “proof of concept” approach to shorten breeding timelines and increase breeding efficiency.
- Improvement of the physical infrastructure of breeding programs in local countries (labs, greenhouses, irrigation systems, cold storage, equipment, etc.) as well as scientific capacity either through the Lab or in partnership with other organizations.
- Increased knowledge and use of the product life cycle (PLC) and other product/customer profile tools, inclusive of gender responsive tools, should be pursued to maximize gains across value chains and increase adoption and scaling of new technologies.
- Cropping intensification and improvement of agronomic practices in cropping systems – intercropping, double cropping, alternative cropping arrangements, planting dates, etc. – should become part of the systems approach of the Lab. Production system approaches should be studied from a food security standpoint, such as, would it be better to harvest two diverse crops with intermediate yields instead of one crop with longer-term yields? Economic analyses are needed.
- Genotyping cultivars for crop/environment interactions to produce climate responsive databases and other tools can help to understand variety selection under different climatological conditions.
- Seed systems: this one is very important. Continued support is needed for both formal and informal seed production systems. How can we ensure that seed production is a profitable and resilient activity that responds to producer, processor and consumer demand?
- A generation of well-trained legume scientists are retiring. Who is going to replace them? Additional training is needed at the MSc and PhD levels. Capacity development systems should be developed in formal education systems, starting already at the primary school level through the PhD level, and non-formal systems to ensure that legume production systems are well equipped capacitated at every level from farmers, seed producers, to traders, to processors, to technicians, to researchers, and beyond. A systems approach should be taken to these capacity development approaches to ensure that systems are optimized.

Production

- For resilient legume production systems, future work of the Lab should focus on soil health, agronomy, and IPM.
- Our priority for Africa, in general, should deal with non-responsive soils, characterized by extreme low organic matter/low carbon (C), how to make them productive again, and how to make them more climate resilient.
- We need to look at soil health in a holistic manner, including soil biota, fertility, and water availability. Scenario solutions should be developed and tested in order to be responsive to rapidly changing climate conditions on short notice. Prediction systems combined with a menu of alternative approaches is the best way to prepare for rapid response to climate shocks.
- Enhanced intercropping with crops or shrubs, crop residue management, and integration of bio-fertilizers and mycorrhiza for improving P-uptake are essential for survival in light of the ongoing shortage and resulting rising cost of synthetic fertilizers. All these interventions must aim for and succeed at increasing the soil organic matter/soil C.

- We recommend that future iterations of the lab not neglect Central America and Asia. Expanding interventions to these regions will require better insight into the diversity and complexity of the prevalent legume systems. We will need to perform legume systems assessments for clarity on the demand for legume products and to identify potential strategic interventions.
- In terms of IPM interventions, our priorities beyond the lifespan of the project will continue to reside in expanded bio-based solutions such as biopesticides and biocontrol agents for the African legume systems and beyond. The long-term environmental and social costs of the use of pesticides and other pest control options should be calculated for all approaches rather than basing decision-making on short term results alone.
- It was mentioned that we need to pay attention to empowering farmers to understand the complexities of nature-based and eco-friendly solutions, to make sure we raise their confidence in the approach. To this end, educational tools based on modern digital advances will be a priority.
- Regarding expanding to Central America, a number of local biopesticides have been used by farmers in bean systems, so we will need to get clarity on the most promising ones through research.
- In Asia, the focus should be on reducing the use of pesticides, and again, digital tools are expected to be a game changer in educating and empowering farmer to take informed decision for more sustainable approaches.
- All proposed interventions should continue to be context relevant, address gender inequalities, support biodiversity, and be climate resilient.
- Extremely important for any future endeavors is evidence of scale-readiness in line with USAID priorities and the PLC.

Post Production

- Climate change issues and conflicts are risk factors for the current regions, especially in West and Central Africa. Developing system approaches that address these two system factors requires strengthening legume systems to respond to these two factors.
- Processing of legume based products is still an emerging sector. With increasing urbanization, greater demands for processed food products will become central to future food systems. This will require greater understanding of the nutritional needs of urban populations and the development of fresh and processed food production systems to address those needs from a holistic nutritional perspective. Better understanding of consumer needs, preferences, and demands should drive this research as well as linkages to markets.
- Information systems to ensure that legumes have access to markets, market information and data and linking to private sector partnerships are yet to be developed. These tools must be accessible, timely, and accurate if they are to have system impact. Strong linkages with the private sector will be needed to keep these information systems innovative, responsive, and up to date.
- The policy focus on legumes is weak and will need to be strengthened *vis a vis* grain cereals such as maize and rice. More and better policy research is needed to promote evidence-based policy making.
- Opportunities for markets are mixed, in some high, in others low. Understanding market integration inter-regionally is needed.
- Scaling at the regional level and even and within countries is yet to be achieved. Scaling approaches of existing technologies should be part of the research that the Lab undertakes.
- Synergies and cross learning between different regions in Africa and between Africa and other regions of the world would be useful.
- Processing and value addition has huge potential but is just emerging, with benefits for youth and women job creation. Modernization of legume agro-processing with a focus on women and youth in all segments of the legume value chains holds great promise. Constraints for growth of women agro-processors abound – lack of technical and business skills, lack of access to appropriate equipment,

lack of access to financing, low access to infrastructure such as electricity, networks – creates barriers to their participation. These barriers must be studied and where possible removed.

- There is a need for better understanding of constraints to adoption and use of equipment and technologies for mechanization.
- Post-harvest storage technologies need to be understood and explored. Adoption of technologies such as PICs bags should be researched and promoted.
- Digitalization of legume value chains and information generation needs to be improved. Almost no attention is paid to legumes leading to great inefficiencies in the productions systems.

Additional Conclusions

- There is a strong desire among sponsored projects for joint learning and greater joint impact.
- There should be a continued focus on the development, testing, and the identification of pathways for uptake of new varieties that respond to producer and consumer needs as a core activity of the lab.
- Improving the flow of information throughout the bean and cowpea value chains is essential for improved efficiency and effectiveness.
- The lab should implement a GAP/IPM framework that seeks to identify the safest cost effective and efficacious approaches to sustainable crop production and pest control while building healthy soils
- The goal (direct or indirect) of all lab activities should be to improve food security and nutrition through legumes and support for legume systems and to make legumes part of a nutritional response to food security. (Indicators for this goal will be at impact level and should have direct relationship to specific SDGs and should be reflected in all impact assessments of the Lab. Other lower level indicators should ultimately contribute to this goal.
- There must be a continued focus on policies that support the growth of the legume sector and facilitate regional legume trade integration. (how this to be achieved will require pro-active involvement of the RECs who are key in facilitating trade and reducing barriers between countries and sub-regions. In this regard, the relevant AU technical officers overseeing the Africa Continental Free Trade Area process will also be key actors to collaborate with.)
- All research activities should seek to be aligned with NARS priorities and resilience frameworks of USAID Missions, where applicable, and all cross-cutting issues should be addressed in support of resilience.
- From the beginning of the Lab we have advocated a ‘systems approach’ to addressing the needs of the legume sector. Five years into the award we now have established a process for implementing the systems approach through the use of Multi-Stakeholder Platforms (MSP). These informal social networks are key to identifying all system actors and establishing the connectivity needed to drive production, scaling and marketing. Inherently inclusive, the MSPs, once formed, connect the dots for system actors making them self-sustaining post award.

Next Steps

We commend this White Paper to the Legume Systems community for their consideration with the hope that USAID will continue to fund legume research as one of the most important responses available to food production systems to address the emerging triple challenge of climate change, population growth, and urbanization. We are proud of the accomplishments of our researchers and are confident that these strategic directions, if pursued, will contribute to a more prosperous and healthy global community.

Sincerely,



Dr. Barry Pittendrigh, Director

Strategy Paper Breakout Sessions Comments

Livingston, Zambia, in February, 2023

The following feedback on the future of a Legume Innovation Lab was solicited from project teams at the annual Legume Innovation Lab meeting held in Livingston, Zambia, in February, 2023. The teams were divided into three groups to discuss i) pre-production, ii) production, and iii) post-harvest issues in legumes. Similar priorities for all regions.

Pre-production comments

West Africa (Comments)

1. As we look to Phase II of the Legume Systems Innovation Lab, what should be the top three pre-production priorities for *West Africa*?
 - A. Priority #1 Developing Improved Varieties
 - Resilience to Abiotic Stresses (drought, heat, and low fertility) and Biotic (pests and diseases).
 - Enhanced Nutritional Value.
 - Promote Improved Varieties.
 - Scaling up seed multiplication and adoption.
 - Provide demonstrations, Field Days.
 - B. Priority #2 Seed Systems
 - Policy to promote Certified and Quality Declared Seed.
 - Policies to narrow the gender gap.
 - Benefit disadvantaged groups by having access to improved seeds.
 - C. Priority #3 Capacity building
 - Training PIs, Co-PIs, NGOs, seed Industry, and Framers on managing financial accounts.
 - Gender Training.
 - Train farmers and industry in finances.
 - Train the trainees.
 - Train technicians, students and scientists in the USA.
 - Enhance partnership with private industry.

Southern Africa

2. As we look to Phase II of the Legume Systems Innovation Lab, what should be the top three pre-production priorities for *Southern Africa*?
 - A. Priority #1 Marketing of products should be prioritized especially newly introduced processed foods.

- To enhance their competitiveness in the legume value chain, it is important to empower small and medium enterprises, youth, and women.
 - Specifically, there ought to be interventions geared towards improving the linkage between producers and buyers, promoting the production of high-quality processed products, and enhancing market information systems.
 - Finally, there should be efforts to facilitate access to finance for SMEs in the legume value chain that demonstrate potential for high growth.
- B. Priority #2 – No further Priorities.
- C. Priority #3 – No further Priorities.
3. If we were to add another target region, what region should that be (Central Africa? East Africa? Latin America and the Caribbean? Asia?) and why?
- A. **Central Africa and East Africa.** Considering that countries have different comparative and competitive advantages, adding other regions will boost Africa's regional value chains as well as development of more food industries from the production of legumes which would otherwise have been excluded. Henceforth, there will be more intra-trade in Africa.
- B. **Latin America and the Caribbean.** Successful germplasm exchange with Southern Africa has already occurred. Puerto Rico's bean breeding program has developed dry beans resistant to abiotic and biotic stresses. They have been able to introgress the Tepary beans efficiently into cultivated dry beans.

Further Comments: We indicated our desire to extend our efforts under a next phase to move forward and scale up our existing and new improved breeding lines and varieties through seed systems on the product life cycle, and to continue breeding for new improved cowpea varieties for key traits (e.g., abiotic/biotic tolerances/resistance, and improved grain quality) to address climate-change and nutrition issues. This would also contribute to reducing ecological footprints in the face of increasing populations by boosting productivity and nutrition with limited land and water resources. We think the nutrition aspect of our cowpea work could be particularly valuable, especially exploring the issues of 'bioavailability' of the high content minerals and proteins. This question has been raised before, i.e., is the higher mineral content we have identified in grain of some cowpea breeding lines in a molecular form that allows uptake in the digestive system of consumers to provide nutrition benefits? This would probably entail working with nutrition scientists and involve human subjects work. This would be a natural extension of the nutrition work, coupled with release of high nutrient varieties. We also indicated our desire to extend our effort on capacity training in the next phase to focus strongly on training our students to become capable molecular breeders.

Production

West Africa Comments

1. As we look to Phase II of the Legume Systems Innovation Lab, what should be the top three pre-production priorities for *West Africa*?
 - A. To promote soil health and management in order to attain high potential yield of the legumes.
 - B. To enhance dissemination of legume innovations and genetic materials i.e., enhance awareness of improved varieties.
 - C. Enabling farmers to understand climate change and promote creation of climate change adapting innovations.
 - D. Assessing the current system of production so that the team can be able to build right mechanizations.
2. As we look to Phase II of the Legume Systems Innovation Lab, what should be the top three pre-production priorities for Southern Africa?
 - A. To encourage crop diversification to respond to climate change.
 - B. To promote good agricultural practices, including digital extension methods.
 - C. To promote dissemination of methods of legume technologies.
3. New regions (ranked)
 - A. East Africa due to its similarities with Southern African in terms of soil type and climate. (voted by 20 participants)
 - B. Latin American because has experience with the LAB and common bean production. (voted by 8 participants)
 - C. Asia because it has advanced smallholder mechanizations which can be adopted in the other regions.

Further comments: we have assumed that our contributions included in the current version of the white paper concerning details on IPM interventions are still valid, hence we did not add anything on IPM here. IPM is important and is a subset of the bigger integrated crop management/good agricultural practices (ISFM) below.

With the rising price of chemical fertilizers, we need to think about intensifying use of integrated soil fertility management (ISFM) practices in the legume farming systems. There is evidence that use of well cured manure in common beans increases yield by the same proportion as chemical fertilizers. Other ISFM options need to also be explored in this system.

Further, we need to test new Cereal-legume intercropping systems that are climate smart and proved to be successful in other countries in East Africa. For example, the mbili-mbili maize-bean-pigeon pea intercropping system in Tanzania is being promoted as a crop diversification and intensification approach. The system exploits spatial plant configurations to increase light penetration to the two legumes. Such system aims at increasing productivity of the legumes while maintaining the maize productivity and has been reported to have a higher return as compared to the conventional

For a new phase East Africa was the most preferred scaling region.

Post-production

General comments

- The West Africa cowpea program and other legumes could benefit from more work on connecting actors in the value chain. This could be through apps like the ones currently supported by the lab, information-sharing platforms for value chain actors, and or multi stakeholder platforms.
 - There is a need to increase value addition technologies in southern African countries because if these technologies are increased then food and nutrition security in these countries will be attained. Value addition can take the form of processing, as well as processing to create new varieties that suit consumer tastes and preferences.
 - There is also a need to intensify development of shelf-life technologies especially on legumes such as beans. This supports the previous point on value addition.
 - Access to technologies that extend the shelf life of products both before and after processing.
1. As we look to Phase II of the Legume Systems Innovation Lab, what should be the top three pre-production priorities for *West Africa*?
 - A. Value addition of cowpeas.
 - Need for more diversity in terms of products.
 - Need to capture local preferences in developing the products.
 - Innovative new products.
 - B. Access to technologies and mechanization
 - Technologies like PICS bags to assist with prolonging of grain storage.
 - Sensitize breeders of attributes they need to concentrate on during breeding.
 - Quality control of the technologies and mechanical equipment (for example some PICS bags have low quality).
 - Access to value added products by the population. Are there many outlets? Is information available?
 - Development and access to processing equipment.
 - Develop innovative technologies that can reduce drudgery for women and youth.
 - C. Policy to promote cowpeas into the diet of West Africans, especially in schools.
 - D. Legumes as food security crops.
 - E. Introduction of correct varieties of beans into the markets, for example white beans.
 - F. Organization and strengthening of African markets using PABRA model of corridors.

Southern Africa

1. As we look to Phase II of the Legume Systems Innovation Lab, what should be the top three pre-production priorities for *Southern Africa*?

- A. Technologies like PICS bags to assist with prolonging of the storage of grain.
- B. Quality control of the technologies and mechanical equipment (for example some PICS bags have low quality).
- C. Develop innovative technologies that can reduce drudgery for women and youth.
- D. Capacity building in terms of value addition for processors.
- E. Processors need more access to processing equipment, infrastructure, finances.
- F. Lack of market and consumer sensitization on the products.
 - The products are known by few people.
 - Awareness campaigns to sensitize on the products.
- G. Creation of markets and more investment by governments and development partners into agro-processing.
- H. Product development and product optimization.
 - Engage with bureau of standards along the processing
- I. Shelf-life extension to enhance storage, preservation
 - Production of appropriate storage materials
- J. More diversity of the products for consumers to choose from.
- K. Develop policies that promote beans, pigeon peas and cowpeas.
- L. Organization and strengthening of African markets using PABRA Model.
- M. Access to raw materials, for instance crop.

PROPOSED REGION FOR EXTENSION

- Central Africa (Similar to West Africa).
- East Africa (Most legume products move from Southern Africa to East Africa)

Further comments: In Senegal, the involvement of women in production activities is helping to increase the adoption of new and improved cowpea varieties. It should also be noted that cowpea has a very large market potential.

Further comments: A look at the pre and post production challenges need to be looked at through the product life cycle, thereafter tackling them with the relevant weighting and resources to deal with the bottlenecks of rollout.

