LEGUME INNOVATION LAB FOR COLLABORATIVE RESEARCH ON GRAIN LEGUMES

FY 2015 WORKPLAN FORMAT

Project Code and Title: SO1.B1 IPM-omics: Scalable and sustainable biological solutions for pest management of insect pests of cowpea in Africa

Lead U.S. Principal Investigator (PI) and affiliated Lead U.S. University:
Dr. Barry Pittendrigh, University of Illinois at Urbana-Champaign (UIUC)

Host Country and U.S. Co-PIs and Institutions:
Dr. Manuele Tamò, IITA-Benin (HC-PI)
Dr. Clémentine Dabiré-Binso, INERA-Burkina Faso (HC-PI)
Mr. Laouali Amadou, INRAN-Niger (HC-PI) (Requested replacement for Dr. Ibrahim Baoua)
Dr. Ibrahim Baoua, University of Maradi (collaborator with INRAN)
Dr. Stephen Asante, SARI, Ghana (HC-PI)
Dr. Haruna Braimah, CRI- Ghana (HC-PI)
Dr. Julia Bello-Bravo, UIUC (US Co-PI)
Mr. Eustache Biaou, INRAB-Benin INRAN-Niger (Requested replacement for Mr. Leonard Hinnou)

I. Project Problem Statement and Justification: *(Please describe constraint to be addressed, its importance, and status of research progress to date) Maximum 4000 characters*

Insect pests of cowpeas dramatically reduce yields for cowpea farmers in West Africa, many of who live on less than $2 per day. Arguably, the greatest biotic constraints on cowpea (*Vigna uguiculata* [L.] Walp.) production are insect pests. The major pests of cowpea in the field in northern Nigeria, Niger, and Burkina Faso include: (i) the legume pod borer, *Maruca vitrata* Fabricius; (ii-iii) the coreid pod-bugs, *Clavigralla tomentosicollis* Stal and *Anoplocnemis curvipes* (F.); (iv) the groundnut aphid, *Aphis craccivora* Koch; and, (v-vi) thrips, *Megalurothrips sjostedti* Trybom. Foundational work has been initiated to understand these insect pests in the areas where we propose to work to develop and deploy solutions. This foundational work, has positioned us well to have a better understanding of pest biology and population structure (due to molecular tools) – which will help direct current and future pest control strategies. Up until our last phase of this project, there were few alternatives to pesticide sprays for many of these pest species. Our program, over the past several years, has developed multiple promising integrated pest management (IPM) solutions for the pests of cowpeas. Additionally, for *M. vitrata*, there exists a potential biotechnology-based pest control solution. Transgenic cowpea expressing the *Bt*-protein Cry1Ab, effective against *M. vitrata* already exists, but has not been released, and may be a component of IPM in the next phase of this project. However, before transgenic Bt-cowpea can be released there will be a

need for an insect resistance management (IRM) plan and our program has already set the stage for just such a plan (Onstad et al., 2012). *Bt*-cowpea, even if/when it becomes available to farmers, will only control one of many pests that attack cowpea. For more immediately tangible control strategies, we have other pest control solutions at hand for *M. vitrata*. Host plant resistant traits are being brought forward by Dr. Phillip Roberts at California at Riverside (UC-R), some of which is being done in collaboration with our collaborators at INERA and IITA. We will continue our work with the aforementioned investigators, to bring forward such host plant resistance traits. However, over the past phase of this project we have developed multiple IPM pest control options for cowpea systems, many of which will require the next phase of research to bring them forward to larger-scale release and testing of impact.

Although biocontrol agents, transgenic plants, and traditional plant breeding for insect resistant varieties are all potentially effective methods for controlling pests of cowpeas, a continued refinement of our understanding of pest populations is needed in order to integrate these, and other, pest control options into an overall integrative pest management (IPM) plan to maximize cowpea production in the field. IPM refers to a pest control strategy where a variety of complementary approaches are used to minimize the negative effects of pests on a given crop or cropping system. As we develop, refine and deploy IPM strategies, we must understand the important life-history parameters of these pest insects in relationship to their environment. In the past phase of CRSP we developed a more in depth understanding of *M. vitrata* populations and have recently determined that *M. vitrata* living on cowpea have a great diversity of alternative host plants and common populations – this insight (due to the use of genomics tools) is extremely important as it means all alternative host plants, for *M. vitrata*, can likely act as a refuge for *Bt*-cowpea and when releasing biocontrol agents onto alternative host plants, programs can choose the host plants that are most useful and cost effective. We term the use of genomics tools to help direct IPM strategies as IPM-omics. The IITA group has demonstrated that the release of biocontrol agents, for *M. virata* control, on different alternative host plants can be done with varying levels of cost-effectiveness. Thus, as we move forward over the next four years we will determine the population genetic structure of the other pests of cowpea. We have developed molecular tools to accomplish such a task (Agunbiade et al., 2013). We will also investigate the presence of these insects on cowpea and the population structure of these species, as well, if they prove to be pests causing significant economic losses.

Over the upcoming year we will research, develop, implement and determine the impacts of an IPM-omics program for cowpea in West Africa. We will research and develop scalable solutions, with the potential and actualization of larger-scale impact through donor community buy-in.

II. Planned Project Activities for the Workplan Period (October 1, 2014-September 30,

2015)

Our objectives all emerge from the following vision, with three critical major objectives, supported and intertwined with the fourth objective of capacity building.

First, we define IPM-omics in the following "equation":

IPM-omics = ***define the pest problems*** + ***appropriate solutions*** + ***scaling of solutions***

In order to define "IPM-omics" we will (1) define IPM, "omics," and how these dovetail together, and (2) the operational approaches we will take over the next 4-years towards our goals. **IPM** was first defined in 1967, by Smith and Van Dan Bosch, as a concurrent application of multiple control measures to reduce damage caused by insects to crop plants. In practical terms, this involves understanding pest systems in detail to define when and where they are a problem, defining ecologically and economically viable solutions, suppression of pest populations below an economic threshold level for increased yields and sustainable solutions. **Omics** is a term used in molecular biology to describe biological processes in large scale or high throughput. We use it to describe large-scale approaches now available to us in IPM. Thus, we define **IPM-omics** as the use of scalable technologies to understand, develop and deliver pest control solutions. IPM-omics is both a paradigm shift in how we need to think about best control in the present and in the future based on the use of cutting edge technologies available to us right now.

In our IPM-omics "equation" we must first ***define the pest problems***. First, we must ask what are the paradigms and technologies that are in our "toolbox" and how can we use them? At the current moment we have the follows "tools" to work with: (1) scouting, field experiments, light traps; (2) genomic markers to define pest and biocontrol agent populations – movement patterns and sources of the outbreaks; (3) computational modeling; and, (4) GIS systems – understanding pests in the background of their ecology and life history. These aforementioned combined tools will be focused on a regional understanding of pest problems on cowpea across West Africa.

In our IPM-omics "equation" the second step is ***appropriate solutions***. We have developed a Biocontrol/Biopesticide pipeline, in order to develop a series of environmentally and economically appropriate pest control solutions. This is not a pipeline of "magic bullets", but instead a diversity of technologies to provide farmers with a variety of solutions to suppress pest populations.

The final step in the IPM-omics "equation" will be the ***scaling of solutions***. When solutions have been developed we need mechanisms to effectively deploy them in a cost effective and sustainable manner. Discovering and testing such scaling pathways will be critical to determine which approaches will be most successful for scaling. Solutions, for scaling, fall into three categories: (1) direct release into the environment and natural establishment; (2) educational solutions; and (3) private sector and NGO involvement. **Direct release into the environment and natural establishment** has and will involve the release of bio-control agents that ultimately become endemic in the environment and

suppress the insect populations. The most effective places to deploy these bio-control agents is directly influenced by the knowledge we gain from our studies of "Defining the pest problems" and such agents come directly from our bio-control pipeline. **Educational solutions** are and will be pest control strategies that will require primarily educational interventions. Our past program has taken two educational approaches: (1) farmer field flora (FFF) (labor intensive, but scalable through partner organizations) and (2) cell phone animations (potentially highly scalable) voice overlaid in many West African languages and can be distributed by a variety of electronic mechanisms (through the Scientific Animations Without Borders, SAWBO, program). We will study models of deployment and scaling of solutions through these approaches. Two major questions arise around these. First, for the cell phone approaches we need to determine (experimentally) what people learn, what they retain, and what are their changes in behavior and what are the benefits for the farmers and their communities. In the past phase of the Legumes Innovations Lab (Dry Grain Pulses CRSP) our team collaborated with the INRAN team and Dr. Mywish Maredia's team to ask the question regarding if these animations would increase adoption of pest control technologies as much as a visit by an extension agent. A recent analysis of the results demonstrated that this approach is statistically no different than extension agents – in other words they were basically as effective as an extension agent to encourage adoption of a pest control strategy - suggesting that animations have the potential to be a highly effective tool for adoption of pest control strategies.

The next issue is we need to determine the most efficient pathways for deployment of such educational content. How do we make it accessible and who will use it with the greatest impact? This is something that we are well positioned to test experimentally. Second, for FFF how can we make this approach scalable through educational programs and technology packages for NGOs and other extensions groups, and can we demonstrate that these groups have had positive impacts in their target communities (e.g., increased production or reduced labor/input costs). Finally, solutions requiring **private sector involvement** (e.g., where a "product" needs to be produced and distributed) will be explored and implemented through co-operatives and other business models that empower women and unemployed youth. Finally, we will refine our online interfaces and create Apps that allow for the use of our "solutions" well beyond our own team – thereby allowing for greater impact. An App has already been created and tested over the past year with a limited set of users – a final version is in progress and pending release upon completion of data accumulation software and all legal disclaimers/approvals by UIUC. This has been paid for through funding from the UIUC Chancellors Office. The App will be made available for free use and downloadable from a variety of websites and offline file sharing systems. Briefly, a user can choose the country they are in, the language they want, and the topic – where we have the content available they can then download it onto their phone (e.g., at a WiFi location). Then, when they travel to a location to do a presentation the animation can be shown on the cell phone/tablet and then transferred to local cell phones using Bluetooth®.

It is important to note that through another grant that the UIUC team has received from the ADM Institute for the Prevention of Postharvest Loss, to work in Ethiopia, we have

had success with engaging local partners to invest in the development of deployment strategies for the animated content. In this separate project we worked with an Assistant Professor of Business at Adama Science and Technology University (Adama, Ethiopia) and the Ethiopian Agricultural Transformation Agency (ATA) to created animated content on the reduction of Postharvest Loss in teff. ATA purchased 640 tablet computers, loaded our animations onto these tablets, and distributed these devices to extension agents across the country. These extension agents are responsible for educating a total 168, 000 teff growers (http://news.illinois.edu/news/14/0519sawbo_BarryPittendrigh.html). Additionally, we have engaged NGOs in host countries in Africa, including one in Ghana that has included our animations both in their extension programs and as part of their ICT training sessions. SAWBO has both trained their group directly in ICT approaches and participated in online ICT training sessions where their group has organized the participants in-country. We will continue to make efforts to engage partner groups who can use our content for their educational programs. For example, Professor Wale Adekunle, Director of Partnerships and Strategic Alliances, Forum for Agricultural Research in Africa (FARA) has received internal funding from FARA to visit the SAWBO team at UIUC (fall of 2014) to integrate SAWBO content, including all of our animations on cowpea pest management, into at least a subset of FARA educational programs. We have and will engage other programs within the Legumes Innovations Lab and other Innovations Labs (*e.g.*, the Innovation Lab for the Reduction of Post-harvest Loss) for creation and use of our educational content in their programs. We will continue to explore pathways for "pass off" of our educational content to other groups that can integrate these materials into their educational and extension programs.

It is important to note that we have recently received notification on funding from the Bill and Melinda Gates Foundation on a planning grant involving an interactive IPM-omics system for identifying pest insect populations, making of management decisions and pushing back of solutions to farmers. This separate online system complements our work in this project, however, it is separate and beyond the scope of what we proposed to do in this project. It will focus on a developed of a new App focused on assessing pest problems in the field and delivery of recommendations. We will start with *M. vitrata* in Southern Benin and our efforts will build on the insights gained in the last phase of the CRSP/Innovations Lab. We would hope that this planning grant would lead to a subsequent grant bringing in all our Legume Innovation Lab host country partners to scale this approach out across multiple countries in Africa.

However, it is important to note that multiple aspects of the IPM-omics equation are researchable questions that we expect will allow us to develop efficient pathways from IPM innovations to scaling of these solutions. We will also test the impact of IPM approaches on farmer incomes, through studies with Dr. Mywish Maredia at MSU. As part of the development of our scaling pathways, we will work with multiple local and transnational programs such as AATF, FARA, and CORAF to play active roles in bringing pest management solutions to cowpea farmers. We will continue our ongoing work in Burkina Faso, Niger, Benin, and Ghana on all the above activities.

Objective 1: ***Define the pest problems***. First, we must ask what are the paradigms and technologies that are in our "toolbox" and how can we use them? At the current moment we have the following "tools" to work with: (1) scouting, field experiments, light traps; (2) genomic markers to define pest and biocontrol agent populations – movement patterns and sources of the outbreaks; (3) computational modeling; and, (4) GIS systems – understanding pests in the background of their ecology and life history. We expect to work on Steps 1 and 2 in our impact pathway for "1 – defining pest problems". In terms of "Program Logic" we will work on Step 4.1 - Collection of pest populations using scouting throughout the year on cowpea crops and wild alternative host plants in Ghana, Burkina Faso, Niger, and Benin. Insects will be genotyped at UIUC to determine pest movement patterns within regions (on cowpeas and alternative host plants). We will also develop interfaces to summarize our findings in a visual format.

Collaborators:
Dr. Brad Coates, USDA, Iowa State University (Genomics)
Dr. George Czapar, UIUC (GIS systems)
Dr. Phil Roberts, UCR (Genomics)
Dr. Baoua Ibrahim, University of Maradi (Pest Insect Biology)

Approaches and Methods:

The following activities will occur in FY15 (Step 4.2 in our Program logic document). IITA, INERA, INRAN, CRI, and SARI will scout for insects in their respective countries, both on cowpea plants and on wild alternative hosts. Technicians and students will be trained at each institution to properly indentify each species as well as the host plants where they are known to occur. We also will work with SO1.A5 on the collection of insects from their field tests. This information will be placed up against GIS data (at UIUC) to better understand the impact of environmental parameters on the pest biology. A website on this is currently in development and will be operational in FY15. The scouting will occur when and where appropriate in each host country during the time intervals when cowpeas are not being grown. Once cowpeas are planted, the scouting intensity will increase to upwards of once a week (where appropriate) both in cowpea fields and on wild alternative host plants. Samples of these insects will be sent back to UIUC for SNP and microsatellite analyses. For example, in Burkina Faso the sampling is done through different agro ecological zones of Burkina Faso (Pobé, Kamboinsé and Bobo Dioulasso). Once by trimester (outing lasted ten days) insects will be collected, labeled and stored in box for molecular characterization studies in BF and US. Again, for example, the INERA team in the cowpea growing off-season, in cowpea seed production plots, will investigate damage on cowpea due to new emerging pests. Understanding such pest problems and developing solutions has the potential to allow farmers in some areas to ultimate develop a second season crop of cowpea – thus, these studies are extremely important for potentially increasing overall cowpea production. Samplings of insects on cowpea will be performed at the INERA/DI research station on the Sourou River, Bagré plain and the Kou valley near Bobo-Dioulasso, where foundation seeds

are yearly produced.

Thus, all host country teams, except INRAB, will continue to perform field collections on cowpea pests on alternative host plants for genetic analysis. Field collected insects will be sent back to UIUC for analysis. We have performed such an analysis with *M. vitrata* and we published this work in PLoS One in 2014 (Agunbiade et al., 2014). We will take the same strategy with the other pest insects of cowpea: collect insects on cowpea and wild alternative hosts. The UIUC team will continue to receive aphid samples from the Dr. Phil Roberts URC team – a collaboration we started in FY14.

The intent of these experiments will be to determine the location and host plants that provide a reservoir for the pest populations that ultimately move to the cowpea crops during the cropping system. In terms of the IITA budget $5,000 of salaries will be used for this effort and $500 in benefits, along with $6,000 in travel and $2,000 in supplies and costs. In terms of the INERA budget $5,000 of salaries will be used for this effort and $500 in benefits, along with $1000 in travel and $1000 in supplies and costs. In terms of the INRAN budget $5,000 of salaries will be used for this effort and $500 in benefits, along with $1000 in travel and $1000 in supplies and costs. Both at SARI and CRI the following budget will be used for these activities: (1) $1000 in salaries, (2) $100 in benefits, (3) $500 in travel; and $350 in supplies. Our primary focus will be on the pests beyond *M. vitrata*. The samples will be sent to UIUC for SNP and microsatellite analyses (the $66,497.00 in salaries and in $29,705.00 benefits along with $13,200 supplies will benefit this section and the development of the interface to make the outputs available to the rest of the community). The UIUC and IITA team (in conjunction with the MO) has received funding for a planning grant from the Bill and Melinda Gates Foundation (BMGF) to develop a complex IPM-omics interface to collect data on pest populations (using cell phones) and deliver solutions (using cell phones) back into the field for people to make pest management decisions and push out to them educational solutions. However, we are currently (as part of this project) in the process of creating a much simpler website to make our work and insights highly transparent to other researchers and outside groups that can help deploy our IPM approaches. We have found from our experience with the SAWBO program that making such materials available online in an easy to follow manner is important for bringing in other outside groups that can help us scale. Such will could then be feed into a more complex interface system; however, the BMGF site system will be about a highly interactive approach to capturing pest problems in real time and then guiding farmer pest management decisions in real time (using cell phones). Thus, there is no funding overlap in terms of interfaces and our interface (for this program) will be focused on helping IITA and NARS programs make better IPM decisions within the context of this project.

Objective 2: In our IPM-omics "equation" the second step is ***appropriate solutions***. We have developed a biocontrol/biopesticide pipeline, in order to develop a series of environmentally and economically appropriate pest control solutions.

During this phase we propose (1) to test novel natural enemies of the pod borer, including novel parasitoids from South East Asia (IITA); (2) to continue scaling up for the rearing and releases of thrips parasitoids in all countries (IITA and NARS programs – funds for this work in Ghana will come from the IITA budget – however, they will interact with the NARS programs as part of these releases); (3) to develop and test novel release devices for egg parasitoids of pod sucking bugs (IITA) (including potential work with sex pheromones); (4) to develop and test endophytic strains of biopesticides (IITA); (5) and to address technical aspects of cost effective, income-generating production of bio-pesticide products by youth and women groups (IITA) and (INRAB); and (6) interact with the UCR group to develop in field tests for potential host plant resistant/tolerant varieties that we will test in our FY15, and onwards, program (INERA). We expect to work on Steps 1-4 in our impact pathway for "2 - Discover, document, and set the stage for scaling of appropriate solutions". In terms of "Program Logic" we will work on Step 4.2 for this section: (a) novel *Maruca* parasitoids from Asia introduced to the IITA laboratories for initial screening; (b) scale-up the rearing and release of the thrips parasitoid in all participating countries; (c) sex and aggregation pheromones for pod sucking bugs investigated; (d) PCR techniques developed for detecting endophytic strains of *Beauveria bassiana* in the different tissues of cowpea; e) feasibility of storing *Maruca* virus both as liquid and solid substrate investigated (IITA).

Collaborators:

Dr. Ramasamy Srinivasan, AVRDC, Taiwan (Biocontrol agents of *M. vitrata*)
Dr. Rousseau Djouaka, IITA, Benin (Molecular biology)
Dr. Ousmane Boukar, IITA, Nigeria (Resistant varieties)
Dr. Phil Roberts, UCR, USA (Resistant varieties)

Approaches and Methods:

During FY15 we plan to conduct the following activities:

In terms of scaling up activities, our in country teams will perform the following activities. (1) Continue to investigate host range, biology and ecology of novel parasitoids of *Maruca vitrata* while at the same time carrying out confined experimental releases (IITA). (2) Scaling out rearing of most promising new parasitoids in the IITA biocontrol agent pipeline (IITA). (3) We will continue to scale up the rearing and releases of the flower thrips parasitoid *Ceranisus femoratus* in all participating countries. For this purpose, nursery plots of *Tephrosia candida* will be established 9 months ahead of the planned releases, targeting the Sudano-Sahelian zones of Burkina Faso (INERA) and Niger (INRAN/University of Maradi) as well as in Ghana (SARI/CRI). (4) We will continue investigating sex and aggregation pheromones in pod sucking bugs for developing rearing-cum-release devices for their egg parasitoids (IITA). Olfactometric studies at IITA will be continued to detect responses of the egg parasitoid *Gryon fulviventre* to pheromones of the brown pod bug *Clavigralla tomentosicollis*. (5) We will continue to develop and test molecular techniques

for detecting endophytic strains of the entomopathogenic fungus *Beauveria bassiana* applied to cowpea at planting, while developing inside the vascular tissues of the cowpea plant during its growth (IITA). (6) We will continue to assess the technical feasibility of storing MaviMNPV virus both as liquid and solid substrate for facilitating the cottage industry production of this bio-pesticide by self-help women groups. Production of the virus will continue at IITA and staff from the above grouping will undergo technical training sessions on how to produce good quality viral inoculums. Specifically, we will establish farmer-participatory trials with combinations of bio-pesticides including MaviMNPV. (7) Our INERA team will continue to work with UCR to determine potential host plant resistance and tolerance traits (e.g. thrips, pod sucking bugs, etc.) for in field studies in FY15. (8) It is important to note that in the last phase of the CRSP we found that neem sprays and neem+MaviMNPV sprays were very effective in minimization of cowpea pest populations. At INRAN and University of Maradi team will continue to test and explore "pass off" of this approach to farmer groups. (9) At INERA studies on two promising parasitoids will be continued. *Gryon fulviventre* will be tested in a greenhouse for the control of pods sucking bug; and parasitoids of thrips will be tested on *Tephrosia candida* at Farakoba research station and Bama. After testing of these parasitoids, a sampling will be done to know the success level of this technology. (10) Our Ghana team (CRI and SARI) will continue to explore the potential for the development of a locally created low-cost neem press; reducing the costs of such a press and making it more portable has the potential to increase the numbers of women's groups that could enter in the neem oil production market. They have worked with (and will continue to do so) an individual(s) with mechanical skills to help determine if the development of such a device (using local materials) is feasible. They will also work jointly on this project and the same amount of funds for each of the two groups will be dedicated to this activity; both at SARI and CRI the following budget will be used for these activities: (1) $1000 in salaries, (2) $100 in benefits, (3) $500 in travel; and $350 in supplies.

The following aspect of the IITA budget will be used for both these above steps and for the testing of these approaches in the field: (1) Salaries of $10,000, (2) benefits of $1,000, (3) $3,000 in travel costs, and (4) $17,145.00 in S&E costs. For the steps above that INERA will be involved in, the following funds will be used: (1) $5000 in salaries, (2) $500 in benefits, (3) $1000 in travel, and (4) $1000 in supplies.

Objective 3: *Scaling of solutions*. When solutions have been developed we need mechanisms to effectively deploy them in a cost effective and sustainable manner. Discovering and testing such scaling pathways will be critical to determine which approaches will be most successful for scaling. Solutions, for scaling, fall into three categories: (1) direct release into the environment and natural establishment; (2) educational solutions; and (3) private sector and NGO involvement. This section some level each of the Steps 1-3, in the impact pathway, should occur within this year. In terms of Program Logic, step 4.1 will occur: 1) Releases of biocontrol agents scaled out; 2) Educational solutions - ICT training materials, online and in-country ICT training sessions available for testing with current

partners and potential new partners, FFF program available for testing of impact leading to educational packages for scaling, Potential pathways for deployment of educational videos explored, and begin testing of pathways to deploy videos; and, 3) Private sector/NGO involvement. IITA will use $5,000 in salaries, $500 in benefits, $4,000 in travel and $3,000 in supplies to work with INRAB, UIUC, and MSU to investigate potential pathways for impact. For INERA the following funds will be used for scaling of solutions activities: (1) $10000 in salaries, (2) $1000 in benefits, (3) $1000 in travel, and (4) $3000 in supplies. For INRAN the following funds will be used for scaling of solutions activities: (1) $5500 in salaries, (2) $550 in benefits, (3) $2000 in travel, and (4) $1500 in supplies.

Collaborators:

Mrs. Kemi Fakambi, Director of Entreprises Solidaires Benin (CBO)
Dr. Mywish Maredia, MSU
Dr. Byron Reyes, MSU

Approaches and Methods:

(1) Direct release into the environment and natural establishment - In FY15, we will continue to conduct inoculative releases of biocontrol agents against thrips (*Ceranisus femoratus*) and pod borers (*Apanteles taragamae* and/or *Nemorilla maculosa*) at selected locations in Burkina Faso (INERA) and Niger (INRAN) according to the priority ecological zones established in the previous phase of the project. Natural enemies will be either brought from the IITA cultures, or reared locally prior to the releases, depending on the available capacities and infrastructures. In Burkina Faso, these releases will occur in the area where we performed (in collaboration with Dr. Maredia) a pre-biocontrol agent assessment with cowpea farmers. In FY17, we will look at the post release and establishment impact on cowpea crops and their expected positive impacts on cowpea farming systems and cowpea farmers themselves.

(2) Educational solutions – Over F13-14 we developed educational packages (both online and ones that are printed booklets and CDs/DVDs) that have and will be used to train both groups on our teams and with groups outside our program for long-term scaling (funded by our Chancellor's Office). These has included and we will: (1) continue to create educational content that people can use to educate farmers about IPM techniques and about pest problems (including animations, written materials for the educators, and these materials in a diversity of formats for people to use – all will be made available online to be shared on the SusDeViKI system and the animations on the Scientific Animations Without Borders deployment sites); summarization of lessons learned from previous FFF and what the educators need to know to make these more successful along with beginning to develop training packages for educators (e.g., NGOs and extension agents) to successfully perform FFF on IPM for cowpeas and (2) refinement creation and deployment (online training

sessions and in country training sessions) of ICT packages to educators outside of our groups on how to download our current content, translation of our current content into new languages (we continue to do the actual co-creation of new language variants). The ICT training package was completed in FY14. Our Chancellor's office at UIUC already funded in FY13 an in Ghana SAWBO training session for 28 representatives from two NGOs and one university. One of these NGOs has already started their own ICT training sessions, of which the SAWBO team has participated in through Skype. The SAWBO team will host a Forum for Agricultural Research in Africa (FARA) representative (trip funded by FARA) at UIUC in order to "pass off" our educational materials to FARA, so that they can use these materials in their extension and educational programs in West Africa. We continue to work with other people and groups from West Africa, through an online collaborative network, to create new West African language variants of existing animations. A study by Drs. Maredia, Reyes, Dabire, Ba, Bello-Bravo and Pittendrigh has demonstrated that the animations are basically as effective as extension agents for encouraging the adoption of pest control technologies – suggesting real potential for the animated approach in dissemination of the technologies we have and will continue to develop. Additionally, we tested out a new "App" for easy access and download for our educational materials. We are now dealing with development of software to understand the use and impact of such an App when it is released (in collaboration with Dr. Tarek Abdelzaher in Computer Science at UIUC). We expect release of the App, for Android and iPhones, in the fall of 2014; pending UIUC approval. The Android App would allow deployers of the animations to easily access them on their cell phones, download them and then transfer them, VIA Bluetooth®, onto other simpler, but video capable phones that can be found in the hands of a significant number of farmers in West Africa. The iPhone version will allow for users to download the animations and store them on their phones – Apple does not allow for Bluetooth® transfer from "i devices" to "non-i devices".

For the upcoming Legumes Innovations Lab, we have educational animations on a series of IPM solutions: neem sprays, solar treating of cowpea seeds, the concepts explaining biocontrol, etc. In the past phase of the CRSP we observed that the animations spread rapidly, people learned from these videos the main concepts, they found these entertaining, and with groups outside of our CRSP program we worked with testing of animations as an educational tool, with the results strongly suggesting that people could easily understand the content and repeat the techniques (funded separately and done separately from the previous CRSP). Through a past study with Dr. Michelle Shumate at Northwestern University we have developed experience working with deployment pathways for technology-based educational materials in Burkina Faso. We previously completed studies on (1) which groups in the country are the most logical to deploy the educational materials. We need to continue to place many of these videos in more local languages – we have refined a system where we can work with groups virtually in a given country (they just need Internet access and a computer with a built in microphone) to develop new voiceovers in local languages and deliver videos back to them to use in the field.

For the FFF that will be held in Niger and Burkina Faso we will work with partner groups where we will train them on proper experimental design such that from their results we will be able to obtain statistical data demonstrating potential increases in yields of specific IPM techniques. We will also incorporate animated videos into some of these FFF's to determine their usefulness in increasing learning in the FFF and potential impacts on positive outcomes of adoption of specific technologies.

(3) Private sector and NGO involvement - We will continue to collaborate with the self-help enterprise producing bio-pesticides in Benin, focusing on refining formulation and application methodology for bio-pesticides and their mixtures. Also, we will start training staff of the self-help group, with particular attention to women, in the production of pod borer larvae using the technology developed during the previous phase of the project, i.e. using cowpea sprouts. The larvae will be inoculated with the virus supplied by IITA (at least until they get their own stock cultures) and passed through the already existing biopesticide 'value chain' within the self-help enterprise. The SAWBO program has had a significant amount of success with "passing off" educational animations to NGOs and we will seek to determine the numbers and the type of impact some of these organizations have had with such videos.

(4) Assessing Market Potential - We also need to assess the market potential for biopesticides, potential groups that can develop these materials and logical "pass-off" groups in our host countries for our various technologies. In Benin, INRAB will have the mandate to assess the market potential for such biopesticides (e.g., what farmers are willing to pay, what will be the costs to enter the market place for small industries, what are skill-sets that need to be developed for womens' groups to potentially make and profit from selling such materials) and what will determine the networks of NGOs and other organizations where we can "pass-off" educational approaches (be it FFF or animations or both) for scaling. The full INRAB budget (of $7000) direct spendable will be used for these activities, including $1500 (non-degree training) of which will be used in INRAB personnel time to train IITA staff of these assessment approaches. Another $2000 will be used toward student-funded support for this project in order for the INRAB team to complete their projects where they are collaborating with the IITA team.

Objective 4: Capacity building - *To increase the capacity, effectiveness and sustainability of agriculture research institutions which serve the bean and cowpea sectors in the target FTF countries*

Collaborators:
Dr. Brad Coates, USDA, Iowa State University
Dr. Baoua Ibrahim, University of Maradi

Approaches and Methods:

Objective – Capacity Building - *To increase the capacity, effectiveness and sustainability of agriculture research institutions which serve the bean and cowpea sectors in the target FTF countries."* This section some level each of the Steps 1-3, in the impact pathway, should occur within this year. In terms of Program Logic, step 4.1 will occur (see cell 19I of the Impact pathway template as weel): 1) Ongoing graduate education across all four HC and a student at UIUC (funded by HHMI) will be fully completed her degree by the beginning of FY15 and all of her papers will be published, 2) we will release an App that will allow for easy access to our educational content, 3) technician training initiated for biocontrol agents that will be released (this will involve sending technicians across to different programs with the training primarily occurring at IITA, however the NARS programs will also exchange between Burkina Faso, Niger, and Ghana where necessary). Both at SARI and CRI $1100 of their budgets will be used for this technician training.

Approach -

Degree training – We will have one West African graduate student (PhD), at UIUC, that will have completed here UIUC PhD, supported by a Howard Hughes Fellowship, and will have published all of her thesis papers. A second U.S. citizen (female PhD student) and a Korean student will also continue to be trained (no funds from the Legumes Innovations Lab will be directly used for their training). At IITA and all NARS programs the incoming students have been identified, including several undergraduate trainees. We will continue to identify and train students at the B.S,/B.Sc., M.S. and Ph.D. levels – each country will train students at different degree-levels depending on needs and opportunities. The UIUC program will be actively looking to find another MS or PhD student from one of the HC to attend UIUC, however, this will not occur in FY15, as it will not be possible to bring in a student (from an admissions prospective) until the fall of 2015. Additionally, such a student, if identified, would be supported by UIUC funds.

Short-term training – We will be developing tools for short term training and testing these. We see developing approaches for scaling of short-term training as part of a solution for cost-effective scaling of our outputs. We will develop tangible educational content for training of farmers both in terms of FFF and through ICT approaches. What emerged from our efforts in FY14 is that "piggy backing" on other educational programs or existing extension/education networks it likely to provide us with the most "cost effective" to pass off educational content to other groups that can use them in their educational programs.

For the ICT approaches we will (1) continue to place our existing animations in the diversity of major languages needed for each of these countries and initiate new animations where the educational content is needed), make available that educational

content in a diversity of formats (online, on cell phones, USB-card SAWBO video libraries that people can carry in their wallets and distribute videos when needed, and we will hope to release an "App" for educators to easily gain access to content based on country, language and topics – such that they can download what they need – take it to the field and distribute it on to people's phones with Bluetooth), (2) we will promote and perform ICT training sessions for our collaborators and outside groups like NGOs, other government and international organization (such training sessions will occur online three times per year and one in-country once per year). These sessions will be important as learning exercises for us to refine materials, but are absolutely critical for us to develop the necessary networks of outside collaborators who can help scale our efforts. It is important to note that with these ICT approaches we can measure online use and downloads of materials. Partner groups can also give us feedback on their use and potential for scaling in their programs. A total of $53,057.00 will be used at UIUC to support activities to develop and implement training materials and sessions.

For the FFF program we will host a minimal of three (upwards of six) FFF in Niger and Burkina Faso. These will be hosted by outside groups that we will train and throughout the year we will work with them to develop the most effective training packages and ICT materials that can be incorporated into these programs. For INERA and INRAN each team will use $5000 for FFF and ICT activities.

Additionally, we will hold technician-training programs for the biocontrol agents that will be released. This will involve sending technicians across to different programs (training primarily at IITA, however the NARS programs will also exchange between Burkina Faso, Niger, and Ghana where necessary). This will occur where necessary and where time and resources permit. We expect at least one exchange to occur in FY15. IITA will use $11,300 of their budget for these activities.

III. Contribution of Project to USAID Feed the Future Performance Indicators:

Please see our "Performance Indicators – Targets" form for the project for 2015.

IV. Outputs:

Defining the pest problems - We expect to collect 1 year of data on the major pests of cowpeas (beyond *Maruca*) in terms of timing, location, and wild alternative host plants. We expect to perform initial molecular work on these populations and we expect to continue to lay these data over known GIS data.

Appropriate solutions – We will bring forward in the biocontrol pipeline new promising agents. We expect to bring forward biopesticides and develop tools and an understanding to take them to the next step towards commercial production (not only

the technology, but a better understanding of who to work with to "pass off" the technologies to the marketplace. We also expect to have an understanding of the potential for a low-cost neem press.

Scaling of Solutions – We expect to continue to perform inoculative releases of natural enemies in Niger, Burkina Faso, and Benin; we expect these to ultimately suppress insect populations. We expect to have developed and expanded on partnerships that can help us scale our solutions – we expect the most immediate tangible results will be NGOs using our educational materials. We expect this to be the beginning of developing larger-scale in country deployment networks for our materials. Also, as SAWBO materials have been translated into languages beyond these countries, we also expect to work with and interact with NGOs and other organizations that will use these materials in their educational programs. We also expect some of our assessments on the potential for scaling will give us important insights for continued scaling.

V. Engagement of USAID Field Mission(s)

Dr. Pittendrigh, with Dr. Larry Beach, has already met with the Ghana mission during our program planning meeting and Dr. Pittendrigh will be presenting (this will likely be past tense by time the review of this document occurs) on IPM-omics at the Innovation Lab Workshop to be held in Accra, Ghana, on July 8 and 9, 2013, a meeting involving USAID Mission staff (FY13). Additionally, one of the Ghana mission's representatives has already begun to contact Drs. Tamo (at IITA) and Dabire (INERA) about the possibility of exploring intercropping of cowpea with crop(s) important for FTF value chains. They were interested in the IPM technologies we are working on and seek opportunities for connections with their focus. Thus, we have already begun this important process of engaging missions in West Africa in regards to our program. Our Ghanaian PI's were involved in the July 8 and 9 (2013) meeting involving USAID Mission staff. In FY15 we will follow-up on the leads (including potential visits) and opportunities that emerge from these two major interactions with the USAID Mission staff. We also plan to visit with the USAID Mission staff in Niger in FY15.

VI. Partnering and Networking Activities:

Our partnering activities have several aspects to them. First, IITAs development of novel pest control solutions (both technologies and biocontrol agents), through the biocontrol/biopesticide pipeline will be handed to NARS programs for testing, use and deployment in their host countries. The FFF will be conducted in conjunction with local NGOs and other non-Legumes Innovations Lab programs (i.e., groups that we are not funding, but can use our materials in their programs). We will have FFF in Niger and Burkina Faso, with these outside programs, and after training these groups on how to properly set up experiments in the FFF we will assess the impacts on yields in the experimental plots. We will also use our ICT training sessions (both online and one in-country one – Ghana) to meet with and partner with

NGOs that can use our materials in scaling with their own educational programs. The travel funds for UIUC will be used for UIUC faculty, staff and/or students to visit with IITA and/or NARS scientists in the course of the FY15. We will continue to expand our networks with other NGO and international organizations like FARA – with the goal of "pass off" practical solutions to other groups that can integrate them in their programs for potential scaling.

VII. Leveraging of Legumes Innovations Lab Resources:

The UIUC team will leverage funds from the ADM Institute for the Prevention of Postharvest Losses, endowment funds, and funds from the Chancellor's Office (UIUC). Additionally, the MO, IITA and UIUC have received a planning of IPM-omics technologies. However, it is important to note that activities for the BMGF will be kept separate from our Legumes Innovation Lab objectives (no overlap in objectives). There exist multiple complementary technologies and scaling issues that will require funding levels in keeping with a BMFG planning grant. IITA will continue to receive funding through the CGIAR Research Program on Grain Legumes, including competitive grants. We also view the use of the SAWBO animations by NGOs in their educational programs as a leveraging of the Legumes Innovations Lab resources.

VIII. Timeline for Achievement of Milestones of Technical Progress:

Please see out "Milestones for Technical Progress" form for the workplan period.

Training/Capacity Building Workplan for FY 2013 – 2014 (use format below)

Degree Training:

First and Other Given Names: Tolulope Adebimpe
Last Name: Agunbiade,
Citizenship: Nigeria (but formerly living in Ghana and previously worked for IITA)
Gender: Female
Training Institution: UIUC
Supervising CRSP PI: Pittendrigh
Degree Program for training: PhD in Entomology
Program Areas or Discipline: Entomology
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? No – This student will be funded from a Howard Hughes Medical Institution grant
Host Country Institution to Benefit from Training: Benin
Thesis Title/Research Area: IPM-omics – Use of molecular tools to make better pest management decisions in cowpea cropping systems in West Africa
Start Date: Continuation (Started Fall 2009)
Projected Completion Date (2014)
Training status (Active, completed, pending, discontinued or delayed): Completed degree in spring of 2014 – final papers in revision at journals
Type of Innovations Lab Support (full, partial or indirect) for training activity: Indirect

First and Other Given Names: Laura
Last Name: Steele
Citizenship: USA
Gender: Female
Training Institution: UIUC
Supervising CRSP PI: Pittendrigh
Degree Program for training: PhD in Entomology
Program Areas or Discipline: Entomology
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? No
Host Country Institution to Benefit from Training: Benin, Niger, Burkina Faso, and Ghana – indirectly (this student has and will continue to play a major role in the development of ICT tools for these countries as well as work on the molecular aspects of our program
Thesis Title/Research Area: To be determined
Start Date: Continuation (Started Fall 2011)
Projected Completion Date (Fall 2016)
Training status (Active, completed, pending, discontinued or delayed): Active

Type of Innovations Lab Support (full, partial or indirect) for training activity: Indirect

First and Other Given Names: Djibril Aboubakar
Last Name: Souna
Citizenship: Benin
Gender: Male
Training Institution: IITA (also interacting with INRAB)
Supervising CRSP PI: Tamò
Degree Program for training: PhD in Entomology
Program Areas or Discipline: Entomology
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID? Host Country Institution to Benefit from Training: Benin
Thesis Title/Research Area: Bio-ecology of *Therophilus javanus*, a promising biocontrol candidate against *Maruca vitrata*
Start Date: 2014
Projected Completion Date: 2018
Training status (Active, completed, pending, discontinued or delayed): Active
Type of Innovations Lab Support (full, partial or indirect) for training activity: partial

First and Other Given Names: Judith
Last Name: Honfoga
Citizenship: Benin
Gender: Female
Training Institution: IITA
Supervising CRSP PI: Tamò
Degree Program for training: MSc in Entomology
Program Areas or Discipline: Entomology
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID?
Host Country Institution to Benefit from Training: Benin
Thesis Title/Research Area: Detection and quantification of *Therophilus javaus* parasitism in *Maruca vitrata* larvae using species-specific qPCR primers.
Start Date: 2014
Projected Completion Date: 2015
Training status (Active, completed, pending, discontinued or delayed): Active
Type of Innovations Lab Support (full, partial or indirect) for training activity: partial

First and Other Given Names: Hilaire
Last Name: Kpongbe
Citizenship: Benin
Gender: Male
Training Institution: IITA
Supervising CRSP PI: Tamò
Degree Program for training: MSc in Entomology
Program Areas or Discipline: Entomology
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by

USAID?
Host Country Institution to Benefit from Training: Benin
Thesis Title/Research Area: Effect of aggregation pheromones of *Clavigralla tomentosicollis* on its egg parasitoid *Gryon fulviventre*
Start Date: 2013
Projected Completion Date: 2014
Training status (Active, completed, pending, discontinued or delayed): Active
Type of Innovations Lab Support (full, partial or indirect) for training activity: partial

First and Other Given Names: Cossi Roland Maximilien
Last Name: Belogoun
Citizenship: Benin
Gender: Male
Training Institution: IITA
Supervising CRSP PI: Tamò
Degree Program for training: MSc in Entomology
Program Areas or Discipline: Entomology
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID?
Host Country Institution to Benefit from Training: Benin
Thesis Title/Research Area: Biology and competitiveness of *Phanerotoma syleptae*, a novel parasitoid of the pod borer *Maruca vitrata*
Start Date: 2013
Projected Completion Date: 2014
Training status (Active, completed, pending, discontinued or delayed): Completed
Type of Innovations Lab Support (full, partial or indirect) for training activity: partial

First and Other Given Names: Hilaire
Last Name: Kpongbe
Citizenship: Benin
Gender: Male
Training Institution: IITA
Supervising CRSP PI: Tamò
Degree Program for training: MSc in Entomology
Program Areas or Discipline: Entomology
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID?
Host Country Institution to Benefit from Training: Benin
Thesis Title/Research Area: Effect of aggregation pheromones of *Clavigralla tomentosicollis* on its egg parasitoid *Gryon fulviventre*
Start Date: 2013
Projected Completion Date: 2014
Training status (Active, completed, pending, discontinued or delayed): Active
Type of Innovations Lab Support (full, partial or indirect) for training activity: partial

First and Other Given Names: Cossi Roland Maximilien
Last Name: Belogoun
Citizenship: Benin

Gender: Male
Training Institution: IITA
Supervising CRSP PI: Tamò
Degree Program for training: MSc in Entomology
Program Areas or Discipline: Entomology
If enrolled at a US university, will Trainee be a “Participant Trainee” as defined by USAID?
Host Country Institution to Benefit from Training: Benin
Thesis Title/Research Area: Biology and competitiveness of *Phanerotoma syleptae*, a novel parasitoid of the pod borer *Maruca vitrata*
Start Date: 2013
Projected Completion Date: 2014
Training status (Active, completed, pending, discontinued or delayed): Completed
Type of Innovations Lab Support (full, partial or indirect) for training activity: partial

First and Other Given Names: Maryse
Last Name: Tossou
Citizenship: Benin
Gender: Female
Training Institution: IITA
Supervising CRSP PI: Tamò
Degree Program for training: BSc
Program Areas or Discipline: Entomopathology
If enrolled at a US university, will Trainee be a “Participant Trainee” as defined by USAID?
Host Country Institution to Benefit from Training: Benin
Thesis Title/Research Area: Comparing spent grain and milled rice as substrate for mass production of *Beauveria bassiana*
Start Date: 2014
Projected Completion Date: 2014
Training status (Active, completed, pending, discontinued or delayed): Completed
Type of Innovations Lab Support (full, partial or indirect) for training activity: partial

First and Other Given Names: Maimouna
Last Name: Abdourahamane
Citizenship: Niger
Gender: Female
Training Institution: INRAN
Supervising CRSP PI: Ibrahim Baoua
Degree Program for training: PhD in Entomology
Program Areas or Discipline: Entomology
If enrolled at a US university, will Trainee be a “Participant Trainee” as defined by USAID?
Host Country Institution to Benefit from Training: Niger
Thesis Title/Research Area: Study of the incidence of *Clavigralla tomentosicolis* on cowpea yield, promoting a biopesticide (neem extract and Mavi viral suspension) for the effective control against the pest in the regions of Maradi and Zinder
Start Date: 2014

Projected Completion Date: 2017
Training status (Active, completed, pending, discontinued or delayed): Active
Type of Innovations Lab Support (full, partial or indirect) for training activity: partial

First and Other Given Names: Ousseina
Last Name: Abdoulaye
Citizenship: Niger
Gender: Female
Training Institution: INRAN
Supervising CRSP PI: Ibrahim Baoua
Degree Program for training: PhD in Entomology
Program Areas or Discipline: Entomology
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID?
Host Country Institution to Benefit from Training: Niger
Thesis Title/Research Area: Study of the incidence of pod borer (*Maruca vitrata*) on cowpea yield, promoting a biopesticide (neem extract and Mavi viral suspension) for the effective control against the pest in the regions of Maradi and Zinder
Start Date: 2014
Projected Completion Date: 2017
Training status (Active, completed, pending, discontinued or delayed): Active
Type of Innovations Lab Support (full, partial or indirect) for training activity: partial

First and Other Given Names: Abdou
Last Name: Harouna
Citizenship: Niger
Gender: Male
Training Institution: INRAN
Supervising CRSP PI: Ibrahim Baoua/Amadou
Degree Program for training: Msc in Entomology
Program Areas or Discipline: Entomology
If enrolled at a US university, will Trainee be a "Participant Trainee" as defined by USAID?
Host Country Institution to Benefit from Training: Niger
Thesis Title/Research Area: Effect of biopesticide neem seeds extract for the control cowpea pods pest (*Maruca vitrata)*
Start Date: 2011
Projected Completion Date: 2014
Training status (Active, completed, pending, discontinued or delayed): Active
Type of Innovations Lab Support (full, partial or indirect) for training activity: partial

First name: Fuseini
Last name: Abdulai
Citizenship: Ghanaian
Gender: Male
Discipline: Entomology

Host Country Institution to benefit from Training: Ghana
Supervising Legume Innovation Lab PI: Asante and Braimah through the University for Development Studies, Tamale, Ghana
Start Date of Degree Program: September 2014
Program completion Date: July 2015
Training Status During Fiscal – Year 2014: Undergraduate
Type of Legume Innovation Lab Support: Partial

First name: Mariam
Last name: Derra
Citizenship: Burkina Faso
Gender: Female
Discipline: Entomology
Host Country Institution to benefit from Training: INERA
Supervising Legume Innovation Lab PI: Dabire
Start Date of Degree Program: September 2014
Program completion Date: TBD
Training Status During Fiscal – Year 2014: Graduate student
Type of Legume Innovation Lab Support: Partial

First name: Edouard
Last name: Drabo
Citizenship: Burkina Faso
Gender: Male
Discipline: Entomology
Host Country Institution to benefit from Training: INERA
Supervising Legume Innovation Lab PI: Dabire
Start Date of Degree Program: September 2014
Program completion Date: TBD
Training Status During Fiscal – Year 2014: Graduate student
Type of Legume Innovation Lab Support: Partial

First Name: Dorcas
Last Name: Dushie
Citizenship: Ghanaian
Gender: Female
Training Institution: KNUST and CRI
Degree Programme: BSc. (Hons) Agric. Degree (Seasonal distribution of cowpea pests in the forest region of Ghana)
Start Date: Oct. 2014
Completion Date: July, 2015
Type Innovations Lab. Support: Partial/indirect

First Name: Joseph
Last Name: Anyem Darkwah
Gender: Male
Citizenship: Ghanaian
Training Institution: KNUST and CRI
Degree Programme: BSc. (Hons) Agric. Degree (Assessment of botanical extracts/biopesticides for management of cowpea pests)
Start Date: Oct. 2014
Completion Date: July, 2015
Type Innovations Lab. Support: Partial/indirect

Short-term Training:

Type of training: FFF
Description of training activity: These will be training of NGOs and outside groups and then these materials will be used in FFF, where INERA and INRAN will work with them closely throughout the FFF sessions
Location: Niger and Burkina Faso
Duration: Several months
When will it occur? Fall of 2013
Participants/Beneficiaries of Training Activity: We expect direct impact on NGOs and other groups that can use these in their educational programs. We expect benefits to cowpea farmers to also result.
Anticipated numbers of Beneficiaries (male and female): We expect 220 (equally split between males and females) to benefit
PI/Collaborator responsible for this training activity: Dabire and Baoua/Amadou
List other funding sources that will be sought (if any): N/A
Training justification: We have already observed that training outside groups in our educational content has significant potential for scaling of our technologies and approaches that have been developed. This will both be a training system and a testing of scaling.

Type of training: ICT training sessions (online and minimally one in country)
Description of training activity: Minimally once in a year in Benin (or Burkina Faso) and several online when and where opportunity permits with collaborating organizations
Location: One in Benin and others virtually or during other training opportunities/trips
Duration: Several hour to one day sessions – followed by week long collaborative efforts for new content
When will it occur? To be determined, but this will occur during other trips for other

activities.
Participants/Beneficiaries of Training Activity: We expect direct impact on NGOs and other groups that can use these in their educational programs. We expect benefits to cowpea farmers to also result. We will also involve senior scientists and technicians in these training sessions.
Anticipated numbers of Beneficiaries (male and female). In FY15 we will have trained 200 individuals from NGOs/government agencies/private sector firms and we expect these groups (and out online systems) to impact >5000 people to our materials. We also expect "spill-over" of SAWBO animations into other countries and projects/regions. For example, SAWBO animations have been used by IIAM in Mozambique for hour-long training sessions (Pittendrigh and Bello in attendance with 100+ farmers)
PI/Collaborator responsible for this training activity: Pittendrigh, Tamo, Dabire, Ibrahim/Amadou, Bello-Bravo
List other funding sources that will be sought (if any): ADM Institute for the Prevention of Postharvest Loss and the Chancellor's office
Training justification: We have already observed that training outside groups in our educational content has significant potential for scaling of our technologies and approaches that have been developed.

Type of training: Technician cross-training
Description of training activity: Technicians will be cross-trained across IITA and the NARS programs
Location: Niger, Burkina Faso, Ghana, and Benin
Duration: 1-day to multiple weeks
When will it occur? Throughout FY14
Participants/Beneficiaries of Training Activity: minimally 6 technicians and/or students
Anticipated numbers of Beneficiaries (male and female): We expect the NARS programs to benefit and increase their ability to have impact with biocontrol agents and biopesticides
PI/Collaborator responsible for this training activity: Tamo, Baoua/ Amadou, Dabire, Braimah, and Asante
List other funding sources that will be sought (if any): N/A
Training justification: We have found this a highly cost-effective way to exchange the technologies between institutions.

Equipment (costing >$5,000)**: N/A**
Specific Type of Equipment to be purchased
Justification for equipment to achieve workplan objectives
Institution to benefit from equipment
Institution to purchase equipment

Amount budgeted for equipment item