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Annex 2.3 - Managing priority pests and diseases

(Approved with conditions, See FC5 Summary, Annex 5)

Document presented for Agenda Item 11:
CRP 3.4 - Roots, Tubers and Bananas

Submitted by:
CIP

THEME 3: Managing priority pests and diseases				
PRODUCT LINE 3.1.1: Detection, surveillance, mapping: cross-cutting				
Next users:	RTB breeding programs and seed programs, policy makers at all levels, particularly quarantine related, collaborating NARES programs and			
End users:	In this case next users are virtually end users as these technologies will be used for decision making, ex ante impact assessment, resource allocation,			
Expected impact:	Better targeting of resources for R&D; better detection tools and pest and disease distribution maps will eventually lead to more effective pest and			
Products	**Milestones**	**Outcomes**	**Target region & key countries**	**Key partners**
3.1.1.1 Development of "centers of excellence" for diagnosis and monitoring (surveillance) of primary pathogens and pests	2011: At least one location each for Africa, LAC and Asia identified ; NARES and other partners form RTB pathogen/pest form surveillance network(s) with key local partners 2012: Centralized laboratories (one per location) equipped with HR and equipment including cost-effective platforms for detecting multiple pathogens (micro array type technologies) 2012: State of-the art diagnostic facility established for high throughput diagnosis for pest and pathogens of RTB crops established within each centralized laboratory 2013: Common pest and pathogen database with at least one primary pest and pathogen/ crop established	Research: Standardized pest/pathogen collections and data in common data bases; More fluid exchange of breeding material across borders; More efficient selection of breeding materials to fit disease pressure where it will be deployed. Development: Better deployment of resistant germplasm; better prediction of change due to climate and pest/pathogen population dynamics; accurate diagonosis of pests and diseases leads to greater efficiency in targeting and use of pest/disease management strategies by extension services and producers.	Global	CIP (lead), CIAT, Bioversity IITA, Arrhus Uni., SCRI
	2011: Core collection for each primary pest and pathogen (from 3.1.1.1) consolidated; Collection plan for at least 3 countries per region developed; for nematodes at least one country in Eastern, Southern, and Western Africa 2012: At least 50 samples collected per core collection in each collection location; data entered in databases 2012: Strategy developed for cross center mapping with GIS (HR and physical resources identified) 2013: Capacity to develop local, regional and global maps of pest occurrence using GIS developed 2014: Maps of pest/pathogen distribution using GIS; all core collections mapped on local regional global scales.	Research: SMS disease surveillance networks established, platform for rapid diagnosis of pests and pathogens available to ARI and NARS partners. National and regional linkages and databases established by NARS and Ministries of Agriculture. Targeted spatial disease surveillance performed. Distribution and spread of key diseases and pests recorded using data from routine spatial disease surveillance. Approaches to harmonize legislation on detection methods for safe, legal GR movement implemented by NARS	Global	FAO, Garmeen,Source Traee, IITA, IAPSC, CIP, FAO, Aarhus Uni, SCRI, Bioversity

3.1.1.3 Risk of crop loss due to pathogen/pest assessed in context of global change	2012: Models for risk of effect of CC on at least one pest or pathogen per crop developed 2013: Maps at local, regional and global scale of risk produced for major pests/pathogens of RTB 2013: A common GIS-based platform (interface) for mapping risk allowing access to non GIS experts	Research: GIS data for disease and pest spread interpolated with other GPS linked data sets to identify contributing factors. Risk of disease spread determined leading to targeted interventions to prevent introductions, establishment and spread. Confirm factors responsible for pest and disease spread and efficacy for control interventions through routin spatial surveys. Development: Policy makers and researchers access web based services to explore risks and changes in pathogen/pest patterns under CC scenarios.	Global	FAO, Garmeen,Source Traee, IITA, IAPSC, CIP, CIAT, Bioversity
3.1.1.4 Web-enabeld pest and pathogen diagnostic platform for RTB crops	2011: On-line pest and pathogen repository established. 2013: Digital diagnostics platform established and operationalized.	Research: Increased awareness and capability to diagonse RTB pests and pathogens. Development outcome: accurate diagonosis of pests and diseases leads to greater efficiency in targeting and use of pest/disease management strategies by extension services and producers.	Global	IITA, Bioversity, FAO, CIP
3.1.1.? Appropriate materials developed for training of NARES researchers in pathogen, collection, maintenance and use of markers	2011: Key capacities for management of key RTB diseases and pests and improved research capacity for NARS researchers in at least 3 countries per region identified 2012: CS materials developed from identified capacities that can be used in organized researcher training process 2013: CS materials validated in training sessions - one per region involving NARS of at least 3 countries	Research: More standardized and improved research done by NARES partners ; more collaboration among NARS working on RTB Development: Improved management of diseases and pests resulting from better support from NARES	Global	CIP, CIAT, Bioversity IITA, Arrhus Uni.
R&A19D PRODUCT LINE 3.1.2: Ecology, biology, and epidemiology of pests and diseases: cross-cutting				
Next users:	RTB breeding programs and seed programs, collaborating NARES programs and Megaprograms 1,4,5 and 7			
End users:	RTB dependent populations with low productivity, susceptible to climate change and at risk of disease and pest attack			
Expected impact:	Improved knowledge and tools will lead to better disease management and therefore reduced crop loss, diminished risk of pesticide poisoning,			
Products	**Milestones**	**Outcomes**	**Target region & key countries**	**Key partners**

3.1.2.1 Enhanced understanding of the ecology and epidemiology of common pests/pathogens affecting quality of planting material	2011: Plan for cross-crop epidemiological study of major RTB "seed" born pathogens developed 2013: Field studies completed for modeling "seed" quality degradation in RTB 2014: Effect of interventions (eg. roguing) modeled for RTB; predictive model of disease management interventions 2015: Field trials implemented to validate tools and identify most effective approaches for managing quality of planting material	Research: Capacity to model degradation of planting material in RTB and compare effects of different interventions (roguing, positive selection, flush out). Hypothesis for evaluation in field trials. Development: Farmers (on-farm seed) and seed specialists can use best approaches to maintain or improve quality of planting material.	global	CIP, CIAT, Bioversity IITA, Arrhus Uni.
3.1.2.2 Epidemiological information used to improve standardized procedures resistance phenotyping (i.e., methodologies for resistance evaluation)	2011: Key capacities and needs related to resistance phenotyping identified with at least 3 NARS per region involved in selection of resistant varieties 2012: tools developed for inputing standardized data in to common data base structures for better data quality, standardization and storage in common data bases 2013: Tools validated in training sessions with NARS from at least 3 countries per region.	Research: More standardized and improved research done by NARES partners particularly for selection of resistant cultivars; greater efficiency in selection of resistance Development: Improved management of diseases and pests resulting from better support from NARES; farmers have greater access to resistant cultivars due to improved and more efficient selection processes	global	CIP, CIAT, Bioversity IITA,
3.1.2.3 Role of plant health in disease suppression better understood and utilized	2011: plant/root health model systems identified for at least one case study per RTB 2012: field experiments (one per region) for quantifying effects of plant/root health on disease severity implemented 2014: action research with at least 3 farmers per region to test concept that overall plant health is important for controlling key diseases and pests	Research: Research partners become aware of importance of holistic approach to solving specific disease and pest problems Development: Improved management of diseases and pests resulting from better general crop husbandry	global	Bioversity, CIP, CIAT and local NARS
3.1.2.4. Knowldege on ecology and biology of pestiferous nematodes attacking RTB crops.	2014: Improved information on distribution and impact of Pratylenchus spp. available.	Research outcome: CG Centers and NARS breeders use knowledge in dveloping nematode resistant/tolerant RTB crops, and enhanced capacity ability to conduct research on nematodes	Sub-saharan Africa and other regions where RTB crops are prominent	IITA, CIAT, Bioversity, NARS, and Universities
Develop tool for assisting scientists and farmers in the identification of major pests/diseases	2015 Global image bank for Musa pest and disease identification through image recognition developed 2016 Cellphone application for Musa pest and disease identification through image recognition tested	Research outcome: Researchers use global image bank for improved pest and disease ID; communicate results via cell phone Development outcome: Farmers use cell phone information to make more informed decisions about pest and disease management	Initiated in SSA; later implemented in LAC and Asia - link to global plant clinic	Global Plant Clinic (CABI), Bioversity, CIP, CIAT, IITA
R&D PRODUCT LINE 3.1.3: Ecology and management of beneficial organisms: cross-cutting +A29				

Next users:	Collaborating NARES programs involved in disease and insect management; collaborating IARCs. This product line can also lead to products used by			
End users:	RTB dependent populations with low productivity, with problems of plant nutrient deficiency and/or pests and diseases			
Expected impact:	Use of beneficial organisms can lead to improved productivity and reduced risk of pest and disease losses, and reduced pesticide dependency - thus			
Products	**Milestones**	**Outcomes**	**Target region & key countries**	**Key partners**
3.1.3.1 Inventory, collection, characterization and documentation of beneficial organisms	2011: compilation of CG RTB collections of beneficial organisms and storage and characterization methods; compilation of methods for detecting, characterizing and managing microbial organisms associated with vegetative planting material by CG centers and advanced partners; 2012: Feasiblity of using a Microbial commons approach for soil borne organisms evaluated and alternative approaches developed 2013: RTB common strategy proposed and incorporate into workplans and funding proposals.	Research outcome: scientists have ready access to wider range of microbes with an increasing base of information on characteristics and use; Development outcome: development projects and private and public suppliers of planting material use microbially enhanced planting material and other beneficials	Global	Bioversity (lead), IITA, CIP, CIAT, NARS, Technical University of Graz, Bonn, Wageningen, Mycothek
3.1.3.2 Knowledge on the biological dynamics, and related factors that affect biological activities of beneficial organisms in the host environment	2011: review of advances in study of microbial communities (soil, root, stem, leaf) and aboveground food webs and agreement on approaches to cross crop characterization; 2012: protocols tested within the framework of existing grants to look at biological control and growth stimulation 2013: RTB common strategy proposed and incorporate into workplans and funding proposals.	Research outcome: the role of beneficials in RTB health and productivity better understood by scientists; Development outcome: farmers use management practices which take advantage of beneficials, including microbial communities, for improved RTB health and productivity	Global	Bioversity (lead), IITA, CIP, CIAT, NARS, Technical University of Graz, ARIs
3.1.3.3 - Evaluation of potential for Shared beneficials for common pests/diseases of RTB	2011: compilation of CG RTB experience on the use of beneficials to manage above and below ground pathogens and insect pests and identification of potential for sharing beneficials; 2012: development of design to test effective use of proposed shared beneficials for RTB 2013: RTB common strategy proposed and incorporate into workplans and funding proposals.	Research outcome: the role of beneficials in RTB health and productivity better understood by scientists; Development outcome: farmers use management practices which take advantage of beneficials, including microbial communities, for improved RTB health and productivity	Global	CIP (lead), Bioversity , IITA, CIAT, NARS, ARIs

3.1.3.4 Formulation methods and delivery system for effective utilization of beneficial organisms	2011: compilation of experiences in the production of commercial-scale formulation products of biological control (beneficial organisms) among CG RTB centers and partners; 2012. identification of countries and partners for application of commercial scale use of biological control products in intensification; 2013: new proposals developed for expanded work on formulation and delivery systems.	Research outcome: public and private labs produce microbially enhanced planting material and other beneficials targeted to pests and diseases of RTB; Development outcome: farmers grow healthier, more productive RTB	Global	IITA (lead), CIAT, Bioversity, CIP, ARIs
R&D PRODUCT LINE 3.1.4: Specific management strategies: cross-cutting				
Next users:	RTB breeding programs and seed programs, collaborating NARES programs and Megaprograms 1,4,5 and 7			
End users:	Most specific management strategies products should have direct application for RTB producers and potentially others in the production chain			
Expected impact:	Use of specific management strategies can lead to improved productivity and reduced risk of pest and disease losses, and reduced pesticide			
Products	**Milestones**	**Outcomes**	**Target region & key countries**	**Key partners**
3.1.4.1 Appropriate materials developed for training of farmers in management of important RTB pests and diseases	2011: Key capacities for farmers to improve management of major RTB diseases and pests identified 2012: CS Materials developed from identified capacities 2013: CS Materials validated in training sessions involving at least 300 farmers per region 2014: Plan for scaling up of farmer CS developed with local partners to reach at least 1000 farmers per region 2015: At least 1000 farmers per region participate in CS activities	Research: More standardized and improved farmer CS process developed that could later be scaled up or used with different crops. Development: Improved management of diseases and pests resulting from farmers with better pest and disease management capacity	GLOBAL	CIP (lead), FAO, Bioversity, CIAT, IITA
3.1.4.2 Use of cultivar diversity to manage pests and diseases (related strategies of selection, adoption by farmers, reaching end users..)	2011 At least two systems for meta-analysis of role of host diversity in plant disease management chosen: e.g., potato late blight and black sigatoka 2012 At least one field trial per system developed in key areas where model diseases are severe and interested partners participate 2013 Models developed to compare role of host diversity in disease suppression compared for commonality of processes across crops.	Research: CG and NARS researchers have evidence for control (or lack thereof) of foliar diseases using host diversity. Development: Farmers gain access to validated strategies of controlling major foliar diseases with host diversity	Global	CIP (lead), FAO, Bioversity, CIAT, IITA

3.1.4.3. Appropriate methods for introducing and scaling up integrated pest and disease management programs generated, adapted or validated	2011: Inventory of training and implementation methods used by CG and non-CG centers available. 2012: Definition of "best-practice" cases related to IPM/IDM implementation for specific monitoring and learning.	Research: NARS adopt best practices of IPM from inventory Development: Farmers implement best practices on farm for better pest and disease management	Global	CIP (lead), FAO, Bioversity, CIAT, IITA

THEME 3: Managing priority pests and diseases				
PRODUCT LINE 3.2.1: Detection, surveillance, mapping: bananas				
Next users:	Researchers of NARS; policy makers and quarantine officers; IPM programme of NARS; private laboratories and seed companies			
End users:	The next users may also be the end users; but the ultimate end users are farmers and farmer organizations who will use improved products in managing			
Expected impact:	Effective management of important banana diseases in areas where they are now causing epidemics; non-spread to areas where the disease is not yet			
Products	**Milestones**	**Outcomes**	**Target region and key countries**	**Key partners**
3.2.1.1. Development of diagnostic tools for rapid and accurate detection of major banana pathogens in lab and field, including capacity building for their appropriate use in quarantine and seed systems	2011: Rapid diagnostic tool for Foc race identification piloted in 2 countries 2012: Rapid diagnostic tool for Foc race identification used by quarantine officers in 2 countries; PCR, qPCR and NEAR assay to certify seed free from bacterial and other pathogens 2013: BXW rapid detection tool piloted; key factors in use of reliable low-cost BBTV detection tools in local clean seed programs identified Need to insert the molecular tools with target dates for the milestone(s)	Research: Researchers have better tools available to carry out pathogen identification and mapping; Identification of high-risk pathogens streamlined and decentralised, relaxing reliance on hyper-specialised experts Development: Improved efficiency of prevention of pathogen spread	Global	Bioversity, CIAT, IITA, ARS, NARS, Regional Musa networks, ProMusa, MADR, FONTAGRO, IICA
3.2.1.2. Development of global banana pathogen distribution database with direct links to appropriate national partners	2011: Database for storing banana pathogen distribution data developed, BBTV surveyed in West and Central Africa 2012: Data on distribution of Foc races in Asia entered into global database; Data on distribution of BXW in East Africa entered into global database; BBTV surveyed in West and Central Africa 2013: Data on distribution of Foc races in LAC and Africa entered into global database; Data on distribution of BBTV in Asia and Africa entered into database 2014: Distribution maps of major banana pathogens developed (including historical data to monitor spread); Distribution and status of invasive banana pathogens in LAC monitored	Research outcome: CG Centers, NARS, quarantine authorities use information on spread of pathogens for targeting preventive and management strategies. Development outcome: Reduced risk for farmers of spread of new diseases.	Global	Bioversity, CIAT, IITA,ARS, NARS, Regional Musa networks, ProMusa, MADR, FONTAGRO, IICA, CARBAP, IAPSC

3.2.1.3. Establishment of Musa-associated pathogens collection based on agreements with NARIs	2011: Establishment of international Musa Foc collection at Mycotheque initated with samples from Asia 2013: International Foc collection expanded with samples from Africa and LAC 2015: International collection expanded to include other Musa-associated organisms (following the example of the potato-associated organisms collection hosted at Mycotheque)	Research outcome: Scientists use collection of well-characterised reference isolates of major banana pathogens for more rapid and complete research results; Development outcome: Pest and disease management strategies available with clearly targeting of organism	Global	Bioversity, IITA, CIAT, Mycotheque, regional Musa networks, ProMusa
3.2.1.4. Ex ante risk assessment of major banana diseases in important production areas in coordination with national and regional stakeholders	2011: Risk assessment for BXW in key banana-producing areas in Africa where BXW has not yet been found 2012: Risk assessment for Foc TR4 in key banana-producing areas in Asia where Foc TR4 has not yet been found 2013: Risk assessment for BBTV in LAC, in key-producing areas in Asia and Africa where BBTV has not yet been found; Modelling of effect of climate on spread of major banana pathogens	Researh outcome: Research and quarantine approaches based on more clear understanding of risk with More efficient targeting of research priorities and investments and policy formulation; Development outcome: Farmers provided with most appropriate and efficient public sector action on pest and disease management	Global	Bioversity, CIAT, IITA, regional Musa networks, ProMusa, ARS, NARS
PRODUCT LINE 3.2.2: Ecology, biology, and epidemiology of pests and diseases: bananas +A18				
Next users:	Researchers of NARS; IPM programme of NARS; IPM professionals and extension workers;			
End users:	The next users may also be the end users; but the ultimate end users are farmers and farmer organizations who will use more effective disease			
Expected impact:	Increased efficiency in developing/ packaging effective pest and disease management tactics/ approaches which will eventually result into reduced			
Products	**Milestones**	**Outcomes**	**Target region and key countries**	**Key partners**
3.2.2.1. Enhanced understanding of the ecology and epidemiology of Foc with appropriate documentation and training for effective employment by NARIs	2013: Increased understanding of the dynamics of Foc disease development in regards to host-pathogen-environment-soil organisms interaction; Model of epidemic development as aid in disease management and risk assessment 2014: Clear knowledge of virulence/pathogenicity of Foc races in relation to banana cultivars; Understanding of mechanism of Foc suppressive/conducive soils; Understanding the co-evolution of banana and Foc races	Improved disease management strategies, thus reducing damage and increasing productivity	Asia, Africa and Latin America	Bioversity, ACIAR, DEEDI, GMU,GDAAS BAPNET (MUSALAC,BARNESA)

3.2.2.2. Enhanced understanding of the ecology and epidemiology of BBTD, virus and vector, with appropriate documentation and training for effective employment by NARIs	2011: Methods for studying re-infection rates tested; Diversity host association of Pentalonia nigronervosa and P. caladii determined 2012: Methods for studying minimum area and duration of eradication prior to clean replanting tested 2013: Method for screening of Musa germplasm for host reaction to BBTV developed; Studies to develop model for banana aphid spread and degree of BBTV infection planned and initiated; capacity of P. caladii to transmit BBTV determined; Factors affecting population development and dispersal of banana aphid and spread of local spread of BBTV determined. 2015: Model of epidemic development as aid in disease management and risk assessment	Research outcome: Research use knowledge on aphid identification and dynamics to develop aphid and BBTD management strategies. Development outcome: banana production enhanced due to development of effective options to control BBTD.	Asia, Africa and Latin America	IITA, Bioversity, BARNESA, BAPNET, NARS, Agri-Food Canada, WSU (USA), Queensland Department of Primary Industry
3.2.2.3. Enhanced understanding of the ecology and epidemiology of bacterial wilts with appropriate documentation and training for effective employment by NARIs	2012: Pilot zones established to study ecology of co-occurrence of bacterial and fungal wilts in Asia, Africa and Latin America 2013: Understanding of disease and management factors in resurgence of BXW identified in East Africa; Increased understanding of the dynamics of disease development caused by bacterial wilt pathogens; Model of epidemic development as aid in disease management and risk assessment 2014: Clear knowledge of pathogen-host-interactions in relation to cultivars and agroecosystem variables	Improved disease management strategies, thus reducing damage and increasing productivity	Asia, Africa and Latin America	Bioversity, NARs, ARIs, BAPNET, MUSALAC, BARNESA
PRODUCT LINE 3.2.3: Ecology and management of beneficial organisms: bananas				
Next users:	RTB breeding programs and seed programs, collaborating NARES programs and Megaprograms 1			
End users:	RTB dependent populations with low productivity, with problems of plant nutrient deficiency and/or pests and diseases			
Expected impact:	Use of beneficial organisms improves productivity, reduces risk of pest and disease losses and reduces pesticide dependency - thus leading to more			
Products	**Milestones**	**Outcomes**	**Target region and key countries**	**Key partners**

3.2.3.1. Inventory, collection, characterization and documentation of beneficial organisms in conjunction with NARIs	2012: Collection of endophytic microorganisms of banana available in Bioversity LAC as Global Public Good through procedures which serve as model for other collections; Trichoderma spp, mycorrhizae, beneficial antagonistic fungal and bacterial bank mantained and enriched with novel isolates; 2013: Banana-associated beneficial organisms added to international repository at Mycotheque (see 3.2.1.3)	Research outcome: scientists have ready access to wider range of microbes with an increasing base of information on characteristics and use; Development outcome: development projects and private and public suppliers of planting material use microbially enhanced planting material	global	Bioversity, IITA, CIAT, Mycotheque
3.2.3.3. Knowledge on the biological dynamics and related factors that affect biological activities of beneficial organisms in the host environment	2011: Entomopathogenic nematodes attacking soil-dwelling RTB pests identified and their pathogenicity tested in screenhouse conditions. 2012: methods piloted to document microbial communities of planting material and different management practices in East African bananas; field efficacy of at least one entomopathogenic nematode species determined; 2013 feasibility of use of endophytes for Foc control explored; delivery formulation developed and efficacy in multilocation trials determined.	Research outcome: the role of microbes in banana health and productivity better understood by scientists; Development outcome: farmers use management practices which take advantage of microbial communities for improved banana health and productivity	Latin America, East Africa	Bioversity, IITA, CIAT, Graz University of Technology, DEEDI/Queensland, Australia, University Bonn
3.2.3.4. Formulation methods and delivery system for effective utilization of beneficial organisms	2011: At least 1 commercial tissue culture producer has capacity, through training and provision of advice on equipment to produce endophyte-enhanced tissue culture. 2012: Field trials in Burundi, Kenya and Uganda conducted to establish performance of Fusarium oxysporum-enhanced banana. 2013: Strategies validated for field-scale use of endophytic micro-organisms for nematode management in Musa production in Latin America	Research outcome: public and private labs produce microbially enhanced planting material; Development outcome: farmers grow healthier, more productive bananas	Latin America, East Africa (Burundi, Kenya, Uganda)	Bioversity, IITA, Corbana, NARs of Burundi, Kenya, Uganda

3.2.3.4. Natural enemies of banana aphids identified and used in aphid control	2011: Expoloration for banana aphid natural enemies in India and other countries completed and the parasitoid Endaphis fugitiva cultured and tested agains banana aphid populations in Central Africa. 2012: Identified banana aphid natural enemies from foreign exploration cultured and their biotic potential against banana aphid determined. 2013: Experimental field releases of Endaphis fugitiva in at least one country conducted and efficacy studies on other identified natural enemies completed.	Research outcome: Researchers, NARS and extension services have biological tools for controlling banana aphid populations as an option in BBTD management. Development outcome: Banana/plantain farmers realize enhanced banana/plantain productivity through lower BBTD incidence and severity.	Cameroon	IITA, University of Hawaii (USA), NARS in Asia, Academy of Sciences, Cszek Republic
PRODUCT LINE 3.2.4: Specific management strategies				
Next users:	Universities, researches, techinician and extension, farmers,			
End users:	farmers, productive sector, banana value chain, programs nationales and internationales			
Expected impact:	economy in production by reducing pesticide use, increase in area planted, environmental pollution reduction, better product quality and increased			
Products	**Milestones**	**Outcomes**	**Target region and key countries**	**Key partners**
3.2.4.1. new strategies for soil management and nutrition to improve the health and competitiveness of the banana crop and reduce pesticide use	2012: study of mechanisms and factors in effectiveness of banana rachis leachate, mycorrhizal fungi for pest and disease control; 2013: soil quality measurements, relation of pest management and economic and environmental performance of alternative practices developed; Integration of nematicidal or nematistatic crops and intercrops for plantain systems	Research outcome: researchers and extension build on knowledge of alternatives for management of crop-related biodiversity to improve research and extension programs to reduce crop losses and increase productivity; Development outcome: farmers access alternative management techniques to reduce crop losses and increase productivity	Latin America - Colombia, Guadeloupe, French Guiana	CIAT, Corpoica, Fedeplatano, IRD/UNAL, INRA, UR, APC, URAPC, CIRAD, UPR26, UAG, EA, DYNECAR, UMR113, RPB, QUALITROP, IITA, INERA, Bioversity
3.2.4.4. Management tactics for Foc based on improved understanding of epidemiology and ecology	2012: On-farm Fusarium wilt management strategies for small holders in Asia developed	Research outcome: Improved understanding of disease provides basis for more effective management research management, thus reducing damage and increasing productivity	Global	Bioversity CfL-Asia, BAPNET, ACIAR, Lapanday Fruits Co, BPI, ITFRI, GDAAS
3.2.4.6. Management tactics for bacterial wilts (BXW, moko) based on improved understanding of epidemiology and ecology	2011: pathogen diversity established; 2012: epidemiological model and management strategies for moko; 2013: Strategies to limit BXW spread, resurgence and damage in East and Southern Africa developed and promoted	Research outcome: Improved understanding of disease provides basis for more effective management research management, thus reducing damage and increasing productivity	East and Central Africa, Amazon, Colombia	NARO, KARI, ARDI Tanzania, ISAR, INERA, MAKERERE UNIVERSITY, CIAT, BIOVERSITY, FONTAGRO, MADR, IICA

3.2.4.8 Integrated management of banana bunchy top disease (BBTD)	2012: Role of phytosanitation and biological control of aphid vectors in limiting BBTV infections and crop losses determined in at least one countries. 2013: Integrated management of BBTV widely tested in at least three countries in Central Africa.	Research outcome: Effective integrated management package for BBTV management available. Development outcome: extension services and farmers practice integrated management of BBTV, improve banana/plantain productivity and reduce disease spread.	Central Africa, including Cameroon, Malawi and DR Congo, Asia, Pacific	IITA, Bioversity, CARBAP, BPI, ITFRI, Queensland DPI, INERA, NIHORT, UNIKIS, UNIKIN, ISABU, IRAZ, IZAR, IRAD, INERA, MARI

THEME 3: Managing priority pests and diseases				
PRODUCT LINE 3.3.1: Detection, surveillance, mapping: cassava				
Next users:	NARES and ARI R&D programs on root and tuber crops, Megaprogram 1.2, and global/regional R&D agencies like FAO			
End users:	RTB dependent populations in the tropics and sub-tropics			
Expected impact:	Higher and more stable productivity, and better quality of diverse products leading to improvements in levels and stability of income and food security			
Products	**Milestones**	**Outcomes**	**Target region and key countries**	**Lead institution and key partners**
3.3.1.1 Global cassava pest and disease distribution database and profiles.	2011: Partners in key countries identified for data gathering and collating. 2012: Data on pest and disease location sites standardized and entered into a centralized database. 2013: Potential risk of establishment determined via niche models.	Research outcomes: (1) Quarantine programs aware of risk of establishment for key cassava pests and diseases. (2) Breeders better able to target the development of pest and disease resistant cultivars. Development outcomes: (1) Reduced reliance on agrochemicals. (2) Shorter reaction times to pest and disease invasions and range expansions in response to climate change.	Global	CIAT, MADR,
3.3.1.2 Molecular diagnostics for rapid and accurate identification of high risk pests and diseases.	2012: PCR-based protocols to identify cassava whiteflies, mealybugs and diseases (i.e Phytoplasmas) developed.	Research outcomes: (1) Identification of high risk pests and pathogens streamlined and decentralized, reducing reliance on specialized taxonomists. (2) More precise understanding of prevalence of high-risk pests and diseases. Development outcomes: (1) More efficent quarantine protocols and procedures to allow safer and more dynamic exchange of germplasm. (2) Better understanding of pests and diseases leads to more sensible policies by agricultural authorities.	Global	CIAT, MADR,
PRODUCT LINE 3.3.2: Ecology, biology, and epidemiology of pests and diseases: cassava +A18				
Next users:	NARES and ARI R&D programs on root and tuber crops, Megaprogram 1.2, and global/regional R&D agencies like FAO			
End users:	RTB dependent populations in the tropics and sub-tropics			
Expected impact:	Higher and more stable productivity, and better quality of diverse products leading to improvements in levels and stability of income and food security			
Products	**Milestones**	**Outcomes**	**Target region and key countries**	**Lead institution and key partners**

3.3.2.1. Knowledge generated to enable the development of transgenic cassava plants that prvent the transmission of cassava ivruses by their whitefly vectors.	2011: Basic components of CBSV transmission characterized (acquisition access period, latent period, inoculation access period, retention time). 2012: Transmission pathways within Bemisia tabaci determined for both cassava mosaic geminiviruses and cassava brown streak viruses. 2013: Virus receptor sites identified in B. tabaci that facilitate persistent or non-persistent transmission processes. 2014: Strategies identified to prevent virus binding within the vector, blocking virus transmission.	Centers and research partners are equipped with the knowledge to develop whitefly control strategies based on transmission interference using transgenic plants.	Tanzania and Kenya, Universities in Australia and USA	IITA
3.3.2.2. New knowledge on Bemisia tabaci - a major pest and virus vector in root crops	2011: Biological and genetic characteristics of 'super-abundant' whiteflies on cassava determined. Characteristics of cassava whiteflies compared with those on sweet potato, other crops and wild hosts.2012: Molecular diagnostics developed to distinguish between biologically distinct populations of whiteflies.2013: Whitefly diagnostics of survey-collected populations used to map the distribution of 'super-abundant' whiteflies and forecast patterns of future spread.2014: Models developed combining virus, crop and vector components to forecast patterns of whitefly population development and future spread of virus pandemics through East and Central Africa.	Center and NARS researchers will be using new knowledge and diagnostic tools to effectively monitor whitefly outbreaks and target control interventions. Models will guide policy makers on higher level crop and disease management strategies.	SSA	IITA, NARS in SSA
3.3.2.3 New Knowledge on African root and tuber scale	2011: molecular markers for identification of cryptic scale species identified. 2012: accurate identification of scale species incorporated into research to develop scale-resistant cassava; 2013: biology of the scale species on wild and cultivated host plants elucidated.	Research outcome: accurate tools for scale identification developed and used by IITA and partners in developing management startegies for the scale; Development outcome: enhanced cassava productivity due development of scale-resistant cassava and better targeting of scale management options.		IITA, INERA (DR Congo), IRAD (Cameroon), University of Massechussetts (USA)
3.3.2.4 Potential and role of spiralling whitefly (SWF) in cassava brown streak (CBSV) transmission	2011: Transmission efficiency and conditions affecting SPW transmission of CBSV determined. 2012: Role of SWF in CBSV epidemiology determined.	Research outcome: Virologists and entomologists consider SWF in management of CBSV. Development outcome: greater awareness by extension services and farmers of the role of SWF in cassava production	Eastern and Southern Africa	IITA, NARS in Tanzania, Kenya, Uganda, Malawi
PRODUCT LINE 3.3.3:Ecology and management of beneficial organisms: cassava+A26				
Next users:	NARES and ARI R&D programs on root and tuber crops, Megaprogram 1.2, and global/regional R&D agencies like FAO			

End users:	RTB dependent populations in the tropics and sub-tropics			
Expected impact:	Higher and more stable productivity, and better quality of diverse products leading to improvements in levels and stability of income and food security			
Products	**Milestones**	**Outcomes**	**Target region and key countries**	**Lead institution and key partners**
3.3.3.1 Collection of beneficial microbials for cassava production	2010-13: Entomopathogen and phytopathogen antagonist collection banks (300+ isolates) maintained and enriched with new isolates. 2012: Collection of beneficial endophytes established, at least 10 promising isolates identified 2013: Endophyte-mediated plant resistance to whiteflies evaluated.	Research outcomes: (1) Private and NARS biocontrol operations have access to key microbials to mass produce promising biopesticides and inoculants. Development outcomes: (1) Farmers provided with more alternatives for ecologically-based crop protection.	Global	CIAT
3.3.3.2 Natural enemies of Bemisa whiteflies identified and characterized.	2011: Local natural enemies (parasitoids, predators, pathogens) assoicated with Bemisia whiteflies identified and their distributions and dynamics determined; and exotic and promissing parasitoids identified, introduced, and tested on at least two geographic populations/biotypes of Bemisia whiteflies. 2012: Interactions between local and exotic parasitoids of Bemisia whiteflies determined and potential of negative or complementary effects identified; 2013 Maintenance of colonies of at least three Bemisia whitefly parasitoids continued and promising species mass reared for use in field releases	Research outcome: Researchers and NARS use effective parasitoids to promote biological control of Bemisia whiteflies. Development outcome: biological control agents reduce whitefly populations and enhance cassava productivity.	Cameroon, Tanzania, Uganda, Malawi	IITA, University of Tel Aviv (Isarel), Chinese Academy of Agricultural Sciences, IRAD (Cameroon), NBCP (Tanzania)
PRODUCT LINE 3.3.4: Specific management strategies				
Next users:	NARES and ARI R&D programs on root and tuber crops, Megaprogram 1.2, and global/regional R&D agencies like FAO			
End users:	RTB dependent populations in the tropics and sub-tropics			
Expected impact:	Higher and more stable productivity, and better quality of diverse products leading to improvements in levels and stability of income and food security			
Products	**Milestones**	**Outcomes**	**Target region and key countries**	**Lead institution and key partners**

3.3.4.1. Integrated management of cassva frogskin disease	2012: Causal agent and vectors associated with frogskin disease identified. 2012: Response to frogskin disease evaluated in at least 10% of cassava germplasm. 2012: Adequate diagnostic tools for cassava frogskin disease developed. 2013: Frogskin disease management strategy and epidemiological model developed. 2013: Integrated crop management recommendations related to frogskin disease and vector in LAC. 2014: LAC network for cassava health assessment and response to climate change	Research outomes: (1) Research community gain access to accurate and timely frogskin diagnosis as a monitoring and management tool. Development outcomes: (2) Farmers better able to prevent the spread of and/or manage frogskin disease.	Latin America	CIAT, MADR,
3.3.4.2 Integration of biological control and host plant resistance in the management of Bemisia tabaci – vector of CMD and CBSV in cassava.	2012: Experimental field releases of exotic parasitoids evaluated in at least two countries. 2013: mass rearing method and wide scale releases of promising parasitoids of Bemisia whiteflies conducted in at least two countries; pilot studies on relative role of cassava resistance and biological control of Bemisia whiteflies initiated.	Research outcome: Effective natural enemies of Bemisia whiteflies available for their control and promoted by researchers, NARS and other stakeholders. Development outcome: reduced damage to cassava and higher crop productivity and farm income from the biological control of Bemisia whiteflies.	Eastern and Central Africa	IITA, University of Tel Aviv (Isarel), USDA-ARS, CIAT
3.3.4.3 Biological control of spiralling whitefly with parasitoids.	2011: At least one effective parasitoid of SWF established in at least one country in eastern Africa, and its seasonal dynamics and impact on SWF populations determined on cassava and at least on other host plant. 2012: parasitoids introduced in at least two additional countries and spread and persisence of introduced parasitoids determined and georeferenced maps of its distribution produced. 2013: impact of biological control on SWF determined in at least two countries in eastern Africa.	Research outcome: NARS partners rely on biological control in the management of SWF. Development outcome: Parasitoids persist in areas of introduction and provide effective control of SWF leading to higher crop productivity.	Eastern and Southern Africa	IITA, NARS in Tanzania, Kenya, Uganda, Malawi

THEME 3: Managing priority pests and diseases				
PRODUCT LINE 3.4.1: Detection, surveillance, mapping: potato				
Next users:	RTB breeding programs and seed programs, collaborating NARES programs and Megaprograms 1,4,5 and 7			
End users:	In this case next users are virtually end users as these technologies will be used for decision making, ex ante impact assessment, resource allocation,			
Expected impact:	Better targeting of resources for R&D; better detection tools and pest and disease distribution maps will eventually lead to more effective pest and			
Products	**Milestones**	**Outcomes**	**Target region and key countries**	**Lead institution and key partners**
3.4.1.1 Development of detection (diagnostic) tools; establishment of pathogen detection and monitoring (surveilance) laboratories	2011: Networks formed for Africa, LA and Asia involving at least 3 NARES per region for surveillance of P. infestans populations 2012: Centralized laboratories (see cross cutting product 3.1.1.1) equipped with equipment and HR needed for Pi collection and monitoring. 2012: Core collections of at least 200 Pi isolates per region established in each laboratory.	Research: NARES working on pathogen surveillance of P. infestans use standardized approaches and work with regional/global focus; Development: farmers have improved access to varieties with durable resistance and better management approaches based on knowledge of fungicide resistance in pathogen populations	sub-Saharan Africa, Andean region, South and South East Asia	CIP, interested NARES in each region; AVRDC, FERA
3.4.1.2 Surveillance of pest/disease abundance/severity and distribution.	2011 Key laboratories in each regional group using Phytophthora.exe to log pathogen data in global data base for at least 100 isolates per region 2013: Surveys on insect pests in major potato highland cropping systems performed; data logged in common data base	Research: breeders have detailed knowledge of pathogen dynamics for targeted selection; extension agents have knowledge of pesticide resistance in populations of Pi Development: farmers have improved access to varieties with durable resistance and better management approaches based on knowledge of fungicide resistance in pathogen populations. Research: A better understanding of pest distribution and severity allows for a better targeting and planning of IPM. Development: NARES and farmers have information on the severity of pests and emerging pest problems and can be supported in implementing an IPM program.	sub-Saharan Africa, Andean region, South and South East Asia	CIP, interested NARES in each region; Arrhus University, Denmark, AVRDC, SCRI, FERA

3.4.1.3 Risk of crop loss due to pests/pathogens mapped and assessed in the context of global change	2012: Maps at local, regional and global scale of P. infestans populations developed from common data base and made available 2013: Maps of risk of change in late blight intensity due to climate change developed and made available 2011: Risk of establishment and changes in the distribution of three potato tuber moth species mapped in response to climate change forecasted through spatial phenology modeling. 2012: Risk of establishment and changes in the distribution of two leafminer fly species in response to climate change forecasted through spatial phenology modeling. 2013: Risk of establishment and changes in the distribution of two Andean potato weevil species mapped in response to climate change forecasted through spatial phenology modeling.	Research: Decision makers who need information for resource allocation consult maps for major potato diseases and pests. NARES use information to develop adaptation strategies for pest management due to climate change. Development: Farmers are better prepared for emerging pest problems, have access to better allocated resources, better targeted varieties, and information on IPM strategies.	Global, regional (LAC)	CIP, interested NARES in each region; Arrhus University, Denmark, AVRDC, SCRI, FERA
3.4.1.4 Appropriate materials developed for training of NARES researchers in important pest and disease issues	2011: Learning materials available in target areas for management of primary potato pests and diseases 2012: Methodology available for capacity building of NARES partners in target areas 2013: At least one capacity building experience per year in two locations per region per year	Research: NARES change research approaches after training using more effective and standardized approaches and standard data bases; Development: Farmers eventually employ new approaches or technologies (eg varieties) coming from improved research support	Global	CIP, CIAT, IITA, Bioversity, MP 1,
PRODUCT LINE 3.4.2: Ecology, biology, and epidemiology of pests and diseases: potato				
Next users:	RTB breeding programs, collaborating NARES programs and IARCS; Megaprograms 1,4,5 and 7			
End users:	RTB dependent populations with low productivity, susceptible to climate change and at risk of disease and pest attack should have access to better			
Expected impact:	Improved knowledge and tools will lead to better disease management and therefore reduced crop loss, diminished risk of pesticide poisoning,			
Products	**Milestones**	**Outcomes**	**Target region and key countries**	**Lead institution and key partners**
3.1.2.1 Enhanced understanding of the ecology and epidemiology of P infestans	2012: Dynamics of sporulation, dispersal and deposition of P infestans in highland tropics described in at least two locations and quantified for simulation model; 2013: Dynamics of fungicide efficacy and persistence for P infestans under tropical conditions described and validated via disease simulation	Research outcome: Researchers in NARS and AIRCs have more accurate disease simulation tool for scenario testing. Development: More efficient development of disease management strategies and more efficient selection of resistance eventually lead to use of these outputs by farmers.	Initially highland tropics; eventually globally	NARS in target areas;

3.1.2.2 Standardized procedures developed for resistance phenotyping (i.e., methodologies for resistance evaluation)	2012: Data input templates and common database available to NARS in at least 3 countries per major region; 2012: Quantitative scale for resistance to P infestans readily available to all NARS; 2013: Quantitative relationship between host resistance and fungicide need established in at least 3 target areas	Research: NARS use harmonized techniques evaluating resistance to P infestans and eventually other pests and pathogens. Development: More efficient selection of resistant cultivars will lead to greater use by farmers.	Global	NARS in target areas;
3.4.2.3 Molecular tools for pest identification.	2011: Molecular tools for identifying leafminer fly species established.	Research: NARS use molecular tools for species identification. Development: Farmers use appropriate management tactics based on correct identification of the pest.	South America (Peru), SSA (Kenya)	CIP, University of Innsbruck, icipe
PRODUCT LINE 3.4.3: Ecology and management of beneficial organisms: potato				
Next users:	Collaborating NARES programs involved in disease and insect management; collaborating IARCs. This product line can also lead to products used by			
End users:	RTB dependent populations with low productivity, with problems of plant nutrient deficiency and/or pests and diseases			
Expected impact:	Use of beneficial organisms can lead to improved productivity and reduced risk of pest and disease losses, and reduced pesticide dependency - thus			
Products	**Milestones**	**Outcomes**	**Target region and key countries**	**Lead institution and key partners**
1.4.3.1 Inventory, collection, characterization and documentation of beneficial organisms of key potato pests	2011: Entomopathogenic pathogens (baculoviruses, nematodes and fungi) of key pests collected and chararcterized. 2012: Abundance and diversity of beneficial insects in major potato based cropping systems determined.	Research: NARES and the private sector have information about potential microorganisms that can be used as biopesticides and key information on beneficial insects that could be promoted through adequate cropping systems and IPM programs. Development: Farmers pest management considers natural control through beneficial insects and the use of biopesticides and hence profits from reduced use of pesticides.	Global, potato highlands	CIP, interested NARS, University, ARI, private sector
1.4.3.2 Pathogenicity and potential use of entomopathogens for key potato pests as biopesticides	2012: Pathogenicity of entomopathogens tested in lab bioassays. 2013: Effectivity of entomopathogens in field trials validated. 2014: Mass production system of potential entomopathogens developed and optimised	Research: NARES and the private sector have information to use potential microorganisms as biopesticide. Development: Biopesticides are available as public goods, produced by NARES and the private sector and used by farmers in potato pest management.	Global, potato highlands	CIP, interested NARS, icipe, ARI, Universities, private sector
1.4.3.3 Formulation and delivery systems for effective utilization of beneficial organisms	2014: Formulation and delivery systems for biopesticides developed and optimized.	see 1.4.3.2	Global, potato highlands	CIP, interested NARS, icipe, ARI, Universities, private sector

1.4.3.4 Classical biological control of invasive potato pests	2011: Temperature-dependent potential efficacy of three parasitoids of the potato tuber moth assessed through two-species-interaction phenology modeling. 2012: Temperature-dependent potential efficacy of three parasitoids of the leafminer fly assessed through two-species-interaction phenology models. 2013: Parasitoids introduced and mass-reared in target countries by NARS. 2014: Parasitoids released and naturalized.	Research: NARS and IARC use information to better target invasive potato pests through classical biological control. Development: Potato farmers have reduced pest problems through an efficient release and naturalization of biocontrol agents (parasitoids).	Global	CIP, interested NARS, icipe
1.4.3.5 Molecular tools for beneficial organisms identification.	2012: Molecular tools developed for identifying/detecting potato tuber moth and leafminer fly associated principal parasitoids used in classical biocontrol programs.	Research: NARS and CIP use molecular tools to monitor naturalization of parasitoids. Development: Farmers profit from an improved monitoring system to evaluate efficiency of the biocontrol program.	Global	CIP, interested NARS, icipe, University of Innsbruck
PRODUCT LINE 3.4.4: Specific management strategies: potato				
Next users:	Collaborating NARES programs involved in disease and insect management; collaborating IARCs. This product line can also lead to products used by			
End users:	Most specific management strategies products should have direct application for RTB producers and potentially others in the production chain			
Expected impact:	Use of specific management strategies can lead to improved productivity and reduced risk of pest and disease losses, and reduced pesticide			
Products	**Milestones**	**Outcomes**	**Target region and key countries**	**Lead institution and key partners**
3.1. 4.1 Specific tactics for the control of potato late blight are available	2012: Efficacy of phosphonate for management of potato late blight tested in field trials in Africa, LA and Asia.	Research: Participating NARES incorporate phosphonate in their LB management research and extension programs; Development: Farmers utilize phosphonate for LB control	Global	CIP, interested NARES
3.1.4.2 Development of IPM strategies.	2011: IPM strategies for potato highland production systems in LAC (Peru) developed and documented. 2012: IPM strategies for potato highland production systems in Hindu-Kush-Himalaya region (Nepal, Bhutan) developed and documented. 2013: IPM strategies for potato highland production systems in SSA (Kenya, Uganda, Rwanda) developed and documented.	Research: NARES incorporate potato IPM strategies in their national plant protection program. Development: Farmers use potato IPM strategies to reduce losses or pesticide use	South East Asia, SSA, Latin America	CIP, interested NARES

3.1.4.3 Biorationals for the management of potato pests	2011: Plastic barriers for Andean potato weevil management commercial available. 2012: Attract-and-kill for the management of the potato tuber moth complex (two species) registered and commercialised.	Research: NARES have available and propagate effective IPM technologies for the control of main potato pests. Development: Farmers use effective IPM tools to reduce losses from pests thereby reducing effectively pesticide use.	South East Asia, SSA, Latin America	ICIP, interested NARES, private sector
3.1.4.4 Training of national programs in ecological pest management and appropriate materials developed for farmers training in management of important potato pests and diseases.	2011: Primary farmer training agencies identified and trained in ecological pest management in target areas. 2011: Capacity building materials available and put in context of farmer situation in target areas	Research: Local farmer training agencies are trained and use capacity building materials. Development: Farmers change pest and disease management approaches and adopt IPM as a result of training.	Global	FAO, local training implementors

THEME 3: Managing priority pests and diseases				
PRODUCT LINE+A10 3.5.1: Detection, surveillance, and mapping: sweetpotato				
Next users:				
End users:				
Expected impact:				
Products	**Milestones**	**Outcomes**	**Target region and key countries**	**Lead institution and key partners**
3.5.1.1 Development of diagnostic tools for rapid and accurate detection of major sweetpotato viruses in lab and field, including capacity building for their appropriate use in quarantine and seed systems	2011 siRNA deep sequencing technology adapted for nationwide virus surveys and virus indexing 2012 Lateral flow devices for field detection major sweetpotato viruses developed	Researchers have tools to easily identify all sweetpotato infecting viruses at sequence level to survey and monitor occurance an spread of established and emerging viruses Low tech and easy to use diagnostic test available to developing country partners	SSA, South and South-East asia	CIP, FERA, interested NARES
3.5.1.2 Development of global sweetpotato pathogen distribution database with direct links to appropriate national partners	2011: Database for storing sweetpotato pathogen distribution data developed 2011: Survey of sweetpotato virome in Mozambique and Ethiopia concluded 2012: Survey of sweetpotato virome in Angola, Nigeria & Ghana 2012: Data on distribution of sweetpotato viruses in Africa and strains entered into the database 2013: Data on distribution of sweetpotato viruses in Asia entered into the database 2014: Distribution maps of major sweetpotato viruses developed (including historical data to monitor spread)"	Quarantine programs aware of risk of spread and establishment of key sweetpotato pathogens Better deployement of resistant germplasm based on knowledge of pathogen population in regions	Global sweetpotato producing countries	CIP, NARES in SSA,
3.5.1.3 Enhanced understanding of the impact of common symptomless (DNA) viruses in sweetpotato production	2011 Impact of common symptomeless DNA viruses (begomoviruses and pararetroviruses) on sweetpotato yields determined	Scientist have information on which to base intervention strategies.		

3.5.1.4 Development of a global database for the distribution of major sweetpotato insect pests (Cylas spp., etc.) linked to risk maps for future pest distribution due to Climate Change	2011: Data on the distribution of sweetpotato pests collected and entered into the database. 2012: Temperature-dependent development, mortality, and reproduction of major sweetpotato pests studied and phenology models developed. 2013: Risk maps for the potential distribution of major sweetpotato insect pests due to climate change developed and made available.	Research: Decision makers who need information for resource allocation consult maps for major potato diseases and pests. NARES have available information on sweetpotato pest distribution as well as models to predict future risks for pests to plan research and management interventions accordingly. Development: Farmers are better prepared for emerging pest problems, have access to better allocated resources, better targeted varieties, and information on IPM strategies.	SSA (Uganda, Kenya, etc.), South East Asia (India, The Philippines, etc.), Latin America	CIP, Univ. of Hohenheim, interested NARES
PRODUCT LINE 3.5.2: Ecology, biology, and epidemiology of pests and diseases: sweetpotato				
Next users:				
End users:				
Expected impact:				
Products	**Milestones**	**Outcomes**	**Target region and key countries**	**Lead institution and key partners**
3.5.2.1 The sweetpotato weevils and sweetpotato butterfly distribution, population dynamics, incidence and damage in different sweetpotato agro-ecologies understood and documented.	2011: Flight activity, infestation patterns, sources for infestation and behavior of Cylas sp. studied. 2012: Yield gap analysis (tuber yield and quality losses) related to Cylas sp. infestations conducted.	Research: NARES have information about Cylas sp. population dynamics, behavior and yield gaps that will contribute to improved management interventions. Development: Farmers have more effective IPM tools for weevil management.	SSA (Uganda, Kenya) and South East Asia (The Philippines, India)	CIP, interested NARES partners
3.5.2.2 Epidemiology of known and emerging sweetpotato viruses understood and documented	2012: Mode of horizontal transmission (insect vectors) determined for emerging sweetpotato viruses	Information on virus epidemiology available enabling to design of management interventions	Global	CIP, interested NARES partners
PRODUCT LINE 3.5.3: Ecology and management of beneficial organisms: sweetpotato				
Next users:				
End users:				
Expected impact:				
Products	**Milestones**	**Outcomes**	**Target region and key countries**	**Lead institution and key partners**

3.5.3.1 Inventory, collection, characterization and documentation of beneficial organisms of sweetpotato pests	2011: Entomopathogenic nematodes and fungi collected and chararcterized. 2012: Abundance and diversity of beneficial insects in major sweetpotato based cropping systems determined.	Research: NARES and the private sector have information about potential microorganisms that can be used as biopesticides and key information on beneficial insects that could be promoted through adequate cropping systems and IPM programs. Development: Farmers pest management considers natural control through beneficial insects and the use of biopesticides and hence profits from reduced use of pesticides.	SSA (Uganda, Kenya) and South East Asia (The Philippines, India)	CIP, interested NARES partners, University of Kiel
3.5.3.2 Pathogenicity and potential use of entomopathogenic nematodes and fungi as biopesticides	2012: Pathogenicity of entomopathogenic nematodes and fungi tested in lab bioassays. 2013: Effectivity of entomopathogens in field trials validated. 2014: Mass production system of potential entomopathogens developed and optimised.	Research: NARES and the private sector have information to use potential microorganisms as biopesticide. Development: Biopesticides are available as public goods, produced by NARES and the private sector and used by farmers in sweetpotato pest management.	SSA (Uganda, Kenya) and South East Asia (The Philippines, India)	CIP, interested NARES partners, private sector, ARI, Universities
3.5.3.3 Formulation and delivery systems for effective utilization of beneficial organisms	2014: Formulation and delivery systems for biopesticides developed and optimized.	see 1.5.3.2	SSA (Uganda, Kenya) and South East Asia (The Philippines, India)	CIP, interested NARES partners, private sector
PRODUCT LINE 3.5.4: Specific management strategies: sweetpotato				
Next users:				
End users:				
Expected impact:				
Products	**Milestones**	**Outcomes**	**Target region and key countries**	**Lead institution and key partners**
3.5.4.1. Inventory of indigenous sweetpotato pest management strategies and cultural practices.	2011: Database on farmers' indigenous knowledge to control Cylas sp. and other sweetpotato pests developed.	Research: Farmers indigenous knowledge used in developing an efficient IPM program. Developement: Farmers profit from other farmers experience in pest management.	SSA (Uganda, Kenya) and South East Asia (The Philippines, India)	CIP, interested NARES
3.5.4.2 Knowledge on the efficacy of cultural practices and plant characteristics to reduce Cylas sp. infestation.	2012: Efficacy of cultural practices to minimize yield and tuber quality losses by Cylas sp. evaluated. 2012: Plant characteristics of sweetpotato landraces and improved varieties associated with low susceptibility to SPW infestation evaluated. 2013: Best cultural practices and IPM tools to provide Cylas-free planting material from vine nurseries assessed.	Research: NARES and farmers who participate directly in the research process have available cultural and other innovative control methods against Cylas sp., which contribute to reduce the damage levels at least by 30%. Development: Farmers use effectively cultural practices in sweetpotato pest management.	SSA (Uganda, Kenya) and South East Asia (The Philippines, India)	CIP, interested NARES

3.5.4.3 Biorationals for the management of Cylas sp.	2012: Simple methods for attracting and killing weevils in participatory research with farmers tested and developed. 2012: Commercial Bt-products and plant derived extracts for their efficacy to reduce weevil infestation in vine nurseries and in field applications evaluated. 2013: New chemical sex pheromone structures and concentrations in low cost attract-and-kill systems tested.	Research: NARES and the private sector have important information to deliver new plant protection products to farmers to manage Cylas sp. Development: Farmers use effective IPM tools to reduce losses from pests thereby reducing effectively pesticide use.	SSA (Uganda, Kenya) and South East Asia (The Philippines, India)	CIP, interested NARES
3.5.4.4 Knowledge on ecological effects of Bt-sweetpotato	2012: Effects of Bt-toxins against Curculionidae sweetpotato pests evaluated. 2013: Important non-targets in multitrophic studies identified and lower tier studies performed.	NARES and CIP have information about insect diversity and key non-target species and the potential ecological impact of Bt-sweetpotato for supporting decision-making on this line of research. Development:Farmers will not experience negative side-effects from the introduction of GM sweetpotato.	SSA (Uganda, Kenya)	CIP, interested NARES

THEME 3: Managing priority pests and diseases

PRODUCT LINE 3.6.1: Detection, surveillance, mapping: yams

Next users:	NARES and ARI root and tuber programs, Megaprogram 1.2, and global/regional R&D agencies like FAO
End users:	RTB dependent populations in the tropics of Africa (especially West Africa), Asia, the Americas and the Pacific islands
Expected impact:	Increased and more stable productivity, and better quality and storage of produce/products leading to improvements in levels and stability of income

Products	Milestones	Outcomes	Target region and key countries	Lead institution and key partners
3.6.1.1 Yam infecting Poty-bandavirus diversity determined and simple diagnostics for yam viruses established.	2011. New knowledge on genetic diversity of economically important yam viruses. 2013. Uniplex and mulplex PCR-based diangostic tools for yam virus indexing developed.	Research outcome: researchers and practitioners used advanced tools in yam plant heath management. Development outcome: Increase in adoption of yam virus indexing tools in seed health certification programs ; increase in production of virus-free planting material and consequent expansion in area sown with clean planting material in West Africa; reduction in incidence of major pests and pathogens; significant gains productivity gain in targeted communities.	West Africa: Nigeria, Benin, Togo, Ghana, Ivory Coast.	IITA NRCRI; INRAB; ITRA; CRI; CNRA; National plant protection agencies e.g. GSID (Ghana), NAQS (Nigeria), DPQC (Benin)
3.6.1.2 Characterize EPRVs and develop diagnostic tests to distinguish EPRVs and yam badnaviruses.	2011. Improved yam germplasm collected and evaluated for EPRVs; 2012: Diagnostic tools for EPRVs developed	Research outcome: researchers and plant heath services use diagnostic tools for distinguishing EPRVs and badnavirus particles in infected cells. Development outcome: diagnostic tools promote improved management of EPRVs in yams.	West Africa, Nigeria, Benin, Togo, Ghana, Ivory Coast	IITA, NRI, CNRA, INRAB CRI, SARI, ITRA, NRCRI, CSRS
3.6.1.3 Molecular genetic diversity of Collectotrichum gloeosporioides in West Africa established	2011. Isolates of C. gloeosporioides (causal agent of anthracnose disease) from West Africa analyzed by MLAS; 2012: Genetic diversity of C. gloeosporioides established.	Research outcome: Researchers use new knowledge on pathogen diversity to identifiy yam clones reistant to a broad range of anthrocnose pathogens. Development outcome: improved management of yam diseases and enhanced yam productivity.	Nigeria, Benin, Ghana	IITA, NRCRI, INRAB, CRI, Universities
3.6.1.4 Preliminary charactrization of yam internal brown spot disease (YBSD)	2011: Surveys for YBSD completed; 2013: YBSD biological properties determined.	Research outcome: Researchers use knowledge of YBSD biology, mode of transmission, etiology to develop diagnostic tools and YBSD distribution maps for appropriate targeting of management interventios. Development outcome: formulation of control measures and their use in controlling YBSD and enhancing yam yield and quality.	Ivory Cost	IITA, INERA, Universities

3.6.1.5 Distribution, species diversity, and importance to storage and trade of tuber insect pests in West Africa determined	2012: Late season surveys on tuber insect pests completed in the intensifying (short fallow) yam systems of Nigeria, Togo, Ghana and Ivory Coast; 2013: Data analyses, mapping and reporting completed and related to previous data from Benin	Research outcome: Researchers use knowledge in developing management measures including setting priorities on specific species to target. Development outcome: More effective and efficient management and increased support from policy makers.	Coastal West Africa (Nigeria, Togo, Ghana and Ivory Coast)	IITA; NRCRI; INRAB; ITRA; CRI; CNRA; National plant protection agencies e.g. GSID (Ghana), NAQS (Nigeria), DPQC (Benin)
PRODUCT LINE 3.6.2: Ecology, biology, and epidemiology of pests and diseases: yams				
Next users:	NARES and ARI root and tuber programs, Megaprogram 1.2, and global/regional R&D agencies like FAO			
End users:	RTB dependent populations in the tropics of Africa (especially West Africa), Asia, the Americas and the Pacific islands			
Expected impact:	Increased and more stable productivity, and better quality and storage of produce/products leading to improvements in levels and stability of income			
Products	**Milestones**	**Outcomes**	**Target region and key countries**	**Lead institution and key partners**
3.6.2.1 Enhanced knowledge of diversity and ecology of Meloidogyne spp. in yam systems	**2014: role of Meloidogyne spp. in yam systems determined**	Research outcome: Breeders use knowledge on diveristy and ecology of Meloidogyne spp. in yam breeding programs; Development outcome: yam losses reduced due to lower nematode infections	West Africa	IITA, NARS in West Africa, UC Davis
PRODUCT LINE 3.6.3: Ecology and management of beneficial organisms: yams				
Next users:	NARES and ARI root and tuber programs, Megaprogram 1.2, and global/regional R&D agencies like FAO			
End users:	RTB dependent populations in the tropics of Africa (especially West Africa), Asia, the Americas and the Pacific islands			
Expected impact:	Increased and more stable productivity, and better quality and storage of produce/products leading to improvements in levels and stability of income			
Products	**Milestones**	**Outcomes**	**Target region and key countries**	**Lead institution and key partners**
3.6.3.1 Diversity of indigenous arbuscular mycorrhyzal fungi (AMF) and their roles in short-fallow, yam-based systems in West Africa determined	2012: Surveys completed in yam growing zones of Nigeria, Togo, Ghana and Ivory Coast; 2013: Data analyses, mapping and reporting completed and related to previous data from Benin	Research outcome: Improved understanding of status of indigenous AMF leads to science-based decisions on their exploitation in improving yam systems; Development outcome: AMF-based products used by farmers for improved yam production.	Coastal West Africa (Nigeria, Togo, Ghana and Ivory Coast)	IITA; NRCRI; INRAB; ITRA; CRI; CNRA; National plant protection agencies
PRODUCT LINE 3.6.4: Specific management strategies: yams				
Next users:	NARES and ARI root and tuber programs, Megaprogram 1.2, and global/regional R&D agencies like FAO			
End users:	RTB dependent populations in the tropics of Africa (especially West Africa), Asia, the Americas and the Pacific islands			
Expected impact:	Increased and more stable productivity, and better quality and storage of produce/products leading to improvements in levels and stability of income			
Products	**Milestones**	**Outcomes**	**Target region and key countries**	**Lead institution and key partners**

3.6.4.1 Appropriate mixture and arrangement of D. alata cultivars for effective management of anthracnose disease determined	2013: Data available on impact on disease severity of various mixtures of cultivars with broad and specific resistance to strains of C. gloeosporioides. 2014: Data available on the interaction of the varietal composition with agronomic factors such as planting date and staking	Research outcome: Better understanding of anthracnose disease dynamics and the contribution of host plant resistance to its contro ; Development outcome: Improved yields and stability of field performance of preferred D. alata cultivars following adoption of recommendations	Coastal West Africa (Nigeria, Togo, Ghana, Benin and Ivory Coast)	IITA, NARS of targeted countries
3.6.4.2 Formulation methods and delivery system for effective utilization of beneficial organisms	2014: Arbuscular mycorrhyzal fungal (AMF) products developed for use on seed yams	Research outcome: Technology of AMF use in seed yam used by Centers and NARS researchers; Development outcome: AMF used by farmers and seed producers as protectant and stimulant for for improved seed yam survival and increase yam production.	West Africa	IITA, NARES of targeted countries
3.6.4.6 Other				