Contracting Authority: The Secretariat of the African, Caribbean and Pacific (ACP) Group of States

ACP-EU Co-operation Programme in Science and Technology (S&T II)

Grant Application Form

Intra-ACP envelope of the 10th European Development
& Budget Line 2011 21.06.02
Reference: EuropeAid/133437/D/ACT/ACPTPS

Deadline for submission of concept notes and applications 7 February 2013

Title of the action:	**Strengthening capacities and informing policies for developing value chains of neglected and underutilized crops in Africa**
[Number and title of lot]	LOT 1 – EDF
Location(s) of the action:	Location of action: Benin, Kenya, Zimbabwe. Benefits from the action will also reach stakeholders from West, Eastern and Southern Africa sub-regions.
Name of the applicant	International Plant Genetic Resources Institute (Bioversity International)
Nationality of the applicant[1]	Italy

[1] For organisations, the statutes must make it possible to ascertain that the organisation was set up by an act governed by the national law of the country concerned. In this respect, any legal entity whose statutes have been established in another country cannot be considered an eligible local organisation. In this respect, see also footnotes of the Guidelines of the call.

Dossier No	

(for official use only)

EuropeAid ID[2]	**IT-2009-CGH-0502075750**
Ongoing contract/Legal Entity File Lumber (if available)[3]	**6000183607**
Legal status[4]	International Organisation
Partner 1[5]	1. African Network for Agriculture, Agroforestry and Natural Resources Education (ANAFE), Kenya. Date of establishment: 21 June 2007. Legal status: Not-for-profit organization.
Partner 2	2. International Foundation for Science, Sweden. Date of registration: 28/11/2002 (though founded in 1974). Legal status: *Insamlingsstiftelse* (Foundation)
Partner 3	3. Laboratory of Agricultural Biodiversity and Tropical Plant Breeding (LAAPT), Benin. Date of establishment: 4 October 2010. Legal status: Governmental institution (University)
Partner 4	4. University of Nairobi, Kenya. Date of establishment 1970. Legal status: University
Partner 5	5. Africa University EuropeAid ID ZW-2009-BHM-2901963616 Nationality: Zimbabwe Date of establishment 1992. Legal status: Private, not-for-profit

Applicant's contact details for the purpose of this action	
Postal address:	Via dei Tre Denari, 472/a 00057 Maccarese, RM, Italy
Telephone number: (fixed and mobile) Country code + city code + number	+ 39 06 61181
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Contact person for this action:	Per Rudebjer
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Address:	As above
Website of the Organisation:	www.bioversityinternational.org

[2] To be inserted if the organisation is registered in PADOR. This number is allocated to an organisation which registers its data in PADOR. For more information and to register, please visit http://ec.europa.eu/europeaid/onlineservices/pador.

[3] If an applicant has already signed a contract with the European Commission and/or has been informed of the Legal Entity File number. If neither of this apply, indicate "N/A".

[4] E.g. non profit making, governmental body, international organisation.

[5] Add as many rows as partners.

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PART A. CONCEPT NOTE

1.1. SUMMARY OF THE ACTION

Please complete the table below which should not exceed 1 page.

Title of the action:	**Strengthening capacities and informing policies for developing value chains of neglected and underutilized crops in Africa**
Lot:	X **Lot 1** **Lot 2**
Location(s) of the action:	Location of action: Benin, Kenya, Zimbabwe. Stakeholders from the West, Eastern and Southern Africa sub-regions will also benefit from the action.
Total duration of the action	36 months
Amount of requested EU contribution	*<EUR / currency of the Contracting Authority >*
Objectives of the action	***Overall objectives:*** 1. Enhanced value chains of neglected and underutilized species (NUS) in Africa contributing to improved food and nutritional security, income of smallholder farmers and entrepreneurs and mitigation of, and adaptation to climatic, agronomic and economic risks. ***Specific objectives***: 1. Strengthened national and regional capacities for research, development, education on NUS value chain, and for communication of results to society; 2. National and regional policy actors, research and education institutions in West Africa, East Africa and Southern Africa informed on the role and benefits of deploying NUS into strategies and programmes for agriculture, nutrition and adaptation to climate change.
Target group(s)	Scientists; Value chain stakeholders, processors, private sector actors and farmers' organizations; Senior higher education staff; policy makers
Final beneficiaries	Small-scale farmers, processors, traders and entrepreneurs; consumers.
Estimated results	1. National action plans for value chain upgrading of bambara groundnut and amaranth in Benin, Kenya and Zimbabwe prepared, and best practices and lessons validated with national and regional policy actors; 2. Strategies and tools for integrating NUS into higher agricultural education curricula agreed with universities and technical colleges, and shared through African educational networks; 3. Enhanced capacity in three African sub-regions to conceptualize and design inter-disciplinary research projects on NUS value chains, and to effectively communicate results to relevant stakeholders; 4. Strategies, tools and methods for strengthening NUS research, education and policy communicated to stakeholders.
Main activities	1. National stakeholder workshops in Benin, Kenya and Zimbabwe to build consensus around issues and develop national action plans for improvement of NUS research, development and education. 2. Sub-regional multi-stakeholder platforms to agree on strategy for NUS value chain upgrading. 3. Regional policy dialogue on NUS value chain enhancement strategies 4. Capacity building of researchers and stakeholder on designing action research on NUS value chains, and on scientific communication 5. Curriculum design and popularization on NUS value chain for Universities and Agricultural colleges.

1.2. RELEVANCE OF THE ACTION (MAX 3 PAGES)

1.2.1. Relevance to the objectives/sectors/themes/specific priorities of the call for proposals

The proposed Action focuses on the capacity of ACP countries in three African sub-regions – West, Eastern and Southern Africa – to more effectively deploy underutilized crops and fruits for food security, income generation and resilience to agronomic, economic and climatic shocks. Emphasis will be on bambara groundnut (*Vigna subterrana*) and the African leafy vegetable (ALV) amaranth (*Amaranthus* spp*)*, serving as model crops for broader, regional capacity development, strategy revisions and policy advocacy.

The Applicant, Bioversity International, and its research and development (R&D) and partners have, in the past 10 years, refined a multi-disciplinary methodology for developing value chains of neglected and underutilized (NUS) crops from farms to markers. In e.g. Kenya, a very successful project brought ALVs to the upscale supermarkets in Nairobi[6], benefiting consumers and value chain actors alike; this method needs to be replicated and applied to other crops and in other countries. The proposed Action will develop value chain upgrading strategies for bambara and amaranth, two species chosen because they are widely grown in Africa and considered priority crops for commercialization. This Action will be evaluate them in three focus countries located in the three African sub-regions, and scale out best practices to contribute, in the longer term, to increasing production, marketing and consumption of a broader range of NUS crops. Upgrading value chains leads to increased income, especially of female farmers and entrepreneurs who often predominate in production, harvesting, processing and retail of NUS. The Action is also relevant for food security due to the nutritional properties of NUS, and resilience of many such crops to stress including climate change.

The Action will be implemented by a partnership of two European (the Applicant and the International Foundation for Science (IFS) and four African partners. In Africa, three higher education institutions in Benin, Kenya and Zimbabwe will lead national level activities, drawing on their experience in linking research with farmers, private sector players and policy. They will also serve as sub-regional hubs for training and scaling up of lessons learned. The African Network for Agriculture, Agroforestry and Natural Resources Education (ANAFE), a network of more than 130 higher education institutions, will ensure an effective two-way channel to ensure a broad African perspective in the project, as well as to share project experience at the African regional level. By emphasizing a value chain approach, the Action will link science with the private sector. To this end ExcelHort, a private business development organization based in Uganda, and the Global Horticulture Initiative, Italy will be Associates to the Action. The regional organization the West and Central African council for Agricultural Research and Development (CORAF/WECARD) is also an Associate, contributing to knowledge sharing in its region.

The Action is particularly focused towards addressing Results 2 of the call: the capacity of scientists to develop NUS value chains via stakeholder consultation will be strengthened, as will their capabilities to conceptualize, plan, facilitate relevant research, and communicate results. In particular, the project will address the need to link science and the private sector in value chain R&D.

The Action will contribute to Result 1 by contributing to the mainstreaming of NUS R&D into national and sub-regional strategies through National Action Plans and sub-regional consultations, and into higher education curricula through curriculum workshops and publications.

It will also contribute to Result 3 by scaling out recommendations and informing policy actors in Africa by linking with key African agricultural organizations such as African Forum for Agricultural Advisory Services (AFAAS), the Association for strengthening Agricultural Research in Eastern and Central Africa (ASARECA), CORAF/WECARD and the Forum for Agriculture Research in Africa (FARA).

1.2.2. Relevance to the particular needs and constraints of the target country/countries, region(s) and/or relevant sectors (including synergy with other EU initiatives and avoidance of duplication)

Africa hosts thousands of edible plants, but only a small number dominate the formal agriculture sector. While maize, wheat, rice and banana continue to provide the bulk of the global food energy, a more sustainable agricultural model is needed, that produces more from less by conserving and using resources, reducing negative impacts on the environment, and enhancing natural capital and the flow of

[6] Irungu, C, Mburu J, Maundu P, Grum M, Hoeschle-Zeledon I. 2008. Marketing of African leafy vegetables in Nairobi and its implications for on-farm conservation of biodiversity. ISHS Acta Horticulturae 752:197-203. International Society for Horticultural Science, Leuven, Belgium

ecosystem services[7]. To this end, there is a growing international recognition of the role nutritious neglected and underutilized crops (NUS) actually play in the livelihood and resilience systems of smallholder farmers in African countries. Many NUS are well suited to marginal environments and as such are of strategic importance in adaptation to climate change. The Food and Agriculture Organization of the United Nations (FAO) and the European Plant Science Organization (EPSO), at a 2012 workshop in Rome[8], identified underutilized fruits and vegetable crops as one of three priority areas for European and African scientific collaboration. And, at a meeting in Cordoba, Spain in 2012, the Director General of FAO stressed that neglected and underutilized species "play a crucial role in the fight against hunger and are a key resource for agriculture and rural development," and called for increased research on NUS crops. He noted that "While some research is taking place, the results do not always reach smallholders". Many NUS could offer better opportunities, provided supply capacities are linked to markets.

Commercializing NUS requires a holistic value chain approach, supportive policies and receptive, informed markets. It requires research capacity oriented towards putting results into use. The EU-ACP Science & Technology Programme is currently supporting a project, terminating in 2013, on building human and institutional capacity for the conservation and use of neglected and underutilized species of crops in West, and East Africa[9], The project is coordinated by the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM), and implemented in partnership with six African and two European organisations (five on which now collaborate on this proposed follow-up Action). The project has trained 160 scientists in ten African countries on research proposal preparation, science communication, experimental design and data analysis, health & nutrition and introductions to value chain analysis, all focusing on priority NUS identified via stakeholder consultation in East and West Africa. These project experiences resulted in the following strong recommendations:

1. A surprisingly large number of young scientists in Africa already work on, or are interested in R&D on NUS. More than 1500 scientists applied for the seven training courses, but only about 12% could be accepted leaving a very large unsatisfied demand for capacity building and research support in NUS.

2. A sub-regional approach to R&D and capacity strengthening for NUS is effective. Two stakeholder workshops identified priority NUS for each sub-region and capacity building issues were identified. The approach helped create knowledge sharing and networks of scientists working on the same crops.

3. Most young scientists are not familiar with multi-disciplinary value chain development research, or food systems approaches. Scientists tend to specialize in a small niche of the value chain of NUS. Research on any one NUS crop is highly fragmented. Very few trainees had a holistic, systems-oriented approach to value chain research and did not work across disciplines or with the private sector.

4. Courses in proposal writing and scientific writing makes positively influences the quality of research design. Proposal quality and manuscripts can be substantially improved during a 5-day training course. Writing skills for proposals – and science communication in general - are underestimated needs.

5. Skills in research design and data management need strengthening. Many concept notes and proposals have weak project logic and confused hypotheses, objectives and activities. Often, the problem analysis is the result of a superficial desk exercise. Researchers need to communicate with stakeholders more as part of the research design process. A second issue is the literature review which is often of poor quality but can be improved by becoming aware of access to free electronic databases.

6. Rapid surveys during several training courses found that the term 'Outcome' is not well understood. While the international agriculture R&D community emphasizes greater use of science-based knowledge to contribute to outcomes and impacts – important in designing e.g. logframes – such terms are not well understood. There is poor understanding among young scientists of how scientific knowledge should be used for innovation—the 'theory of change', of which research is only one component.

7. NUS scientists have limited contacts with the private sector during conceptualization and execution of research. This also limits commercialization of research results. Early specialization by graduates going into science or commerce (among others), means these two niches of agricultural value chains are not well connected, restricting the potential for operationalizing research results on NUS crops.

8. The role of NUS and agricultural diversification in adaptation to climate change is broadly recognized. Many young scientists are interested in using diversity as a tool for climate change adaptation.

9. There is a need to strengthen agricultural higher education curricula regarding NUS. Many skills listed above need a foundation in higher education. This requires review of curricula, as well as a shift from rote to experiential learning, multi-disciplinary perspectives and more interaction with stakeholders.

[7] Collette L, Hodgkin T, Kassam A, Kenmore P, Lipper L, Nolte C, Stamoulis K, Steduto P. 2011. Save and grow. Food and Agriculture Organization of the United Nations. Rome, Italy.
[8] http://www.epsoweb.org/sustainable-crop-production-fao-epso-rome-it-june-2012
[9] EU-ACP (S&T) Action, FED/2009/217072

10. There is a need for policies supportive of multi-disciplinary science research on the value chain approach, to encourage research on and commercialization of NUS. This includes support for collaboration among sectors and capacity to work in multi-disciplinary research teams.

The current proposed Action will expand the individual scientific capacity developed in the earlier EU-ACP project, and will go deeper by linking NUS scientists with value chain actors, in particular the private sectors. The experience of the regional African partner, ANAFE, in linking universities, research and business in agricultural Innovations will be of great contribution in this process. Secondly, we will expand geographically by including in the training opportunities over 10 other countries from West, East and Southern Africa. Thirdly, we will address the need for scaling out lessons, policy recommendations and capacity building approaches in the three African sub-regions through training, curriculum development and policy dialogue, in liaison with African partner networks.

African countries' rapidly growing economies provide entrepreneurial opportunities at an unprecedented scale. Value chain development is a business-orientated approach characterized by chain linkages from the supply of specific inputs to primary production, processing, and marketing to consumers. What we want value chain development to do is therefore to increase business opportunities, but, in doing so, also to help smallholder farmers 'move up a level' for increased income generation, e.g. through increased quality production and productivity, through vertical integration or through cooperative formation. An important group of beneficiaries of value chain upgrading of these crops would be women who are often the main actors in value chain activities such as production, harvesting, processing and retailing.

1.2.3. Describe and define the target groups and final beneficiaries, their needs and constraints and how the action will address these needs

Scientists: The previous EU-ACP S&T project demonstrated the huge interest shown by young scientists in NUS. But, their research is fragmented and often narrow, lacking a holistic perspective. Their experience in working in multi-disciplinary value chain research of NUS is limited. This Action will bring scientists and key value chain actors together for more relevant and more applicable R&D.

University lecturers and education leaders: The issues relating to NUS are, by and large, ignored in higher agricultural education programmes in Africa[10]. Further sensitization of educators on integrating NUS into curricula is required, and a range of institutional and capacity constraints need to be addressed. The Action will invite stakeholders to participate in a workshop with the aim of making recommendations for integrating NUS and value chain tools into curricula.

Policy actors: By and large, agricultural policy actors are rooted in a high-input agricultural paradigm that works on a narrow range of crops. As the international agenda increasingly emphasizes sustainable agriculture and points at the role of agricultural diversification as one of the key elements to achieving this, there is a significant need to sensitize policy actors. This Action will do this at national, sub-regional and regional levels, through consultations, communication and publications.

Final beneficiaries: Smallholder farmers, processors, traders, entrepreneurs, consumers and scientists, currently lacking adequate support for NUS development, will benefit from more effective participation in value chains. The Action will contribute to developing capacity and supportive policies for value chain upgrading, leading to farmers', processors' and traders' gainful participation in value chains.

1.2.4. Particular added-value elements

- Upgrading value chains through analysis and research will provide opportunities for increasing income for stakeholders, including smallholders, by increased production, greater coordination and cooperation, and through vertical integration of steps along the value chain.
- Linking scientists to stakeholders will provide them with a broadened value chain-focused perspective which ensures greater relevance of their research projects. Through science communication strategies, such experience will be scaled out to the three African sub-regions.
- Training of scientists in, e.g. research conceptualisation, project proposal writing, science communication and developing value chains will qualify them as trainers of trainers.
- Empowering women – dominant actors at critical points in many value chains: enhanced negotiating power leading to increased income will help ensure adequate family nutrition.

[10] Rudebjer P, Chakeredza S, Njoroge K, van Schagen B, Kamau H, Baena M. 2011. Teaching agrobiodiversity for food and agriculture: a curriculum guide for higher education. Bioversity International, Rome

1.3. DESCRIPTION OF THE ACTION (MAX 1 PAGE)

The Action has two specific objectives: 1. Strengthened national and regional capacities for research, development, education on NUS value chain, and for communication of results to society; 2. National and regional policy actors, research and education institutions in West Africa, East Africa and Southern Africa informed on the role and benefits of deploying NUS into strategies and programmes for agriculture, nutrition and adaptation to climate change.

The two European and four African partners have jointly designed a project that focuses on creating innovation platforms of stakeholders to generate actions plans for value chain upgrading, and training scientists for facilitating such processes. The Action will compare the effectiveness of value chains for the same crops in different sub-regions, leading to broader recommendations for upgrading value chains, identification of research issues, education and policy issues aimed at supporting NUS commercialisation. The Action has four main expected results:

Result 1. National action plans for value chain upgrading of bambara groundnut and amaranth in Benin, Kenya and Zimbabwe prepared, and best practices and lessons validated with national and regional policy actors.

- An inception workshop will be held in Kenya in month 2, during which a detailed project implementation plan will be developed.
- A national study on NUS in Zimbabwe will be conducted by Africa University during months 3-4, and presented at a national stakeholder workshop, to document the current status of NUS R&D and capacity. (Similar studies were done in Benin and Kenya in 2010).
- The national partners will organize national innovation platform workshop on bambara groundnut and amaranth value chains, resulting in value chain upgrading strategies and an identification of constraints that need to be addressed through research, capacity building and policy support.
- National Action Plans on bambara groundnut and amaranth value chain upgrading will be prepared at the end of Year 1 for each of three countries.
- In early Year 2 the national partners, supported by other partners and Associates will organize sub-regional multi-stakeholder workshops on NUS in West, Eastern and Southern Africa.
- Policy briefs will then be developed and disseminated.

Result 2. Strategies and tools for integrating NUS into higher agricultural education curricula agreed with universities and technical colleges, and shared through African educational networks:

- A regional NUS curriculum workshop involving a wide range of stakeholders will be held in early Year 2. The activity will be lead by ANAFE, using a curriculum development methodology successfully used to strengthen agroforestry curricula in Africa.
- A curriculum guide on NUS education will be published at the end of Year 2, outlining options and approaches to integrating NUS value chains in university courses and programmes.
- At least two learning cases on NUS value chain upgrading will be developed in Year 2, for higher education and on-the-job training.

Result 3. Enhanced capacity in three African sub-regions to conceptualize and design inter-disciplinary research projects on NUS value chains, and to effectively communicate results to relevant stakeholders:

- Research conceptualisation and proposal writing training for at least 75 young African scientists researching on NUS, in conjunction with value chain stakeholder consultation to assure relevance. One course will be held in each sub-region, in total three courses, of which one in French for Sahelian West African countries.
- Three training courses on science communication will be held in Year 3, one per sub-region. Capacity in at least 75 young African scientists will be strengthened.

Result 4. Strategies, tools and methods for strengthening NUS research, education and policy communicated to stakeholders:

- A project communication strategy will be developed in Year 1, and implemented jointly by the project partners throughout the duration of the project.
- In year 3, ANAFE will lead the organization of a side-event on NUS at an African international meeting.
- An end-of-project workshop will be held in Kenya in Year 3, back-to-back with the side-event on NUS, to synthesize experiences and lessons learned.

PART B. FULL APPLICATION FORM

To be submitted by all applicants

For economical and ecological reasons, we strongly recommend that you submit your files on paper-based materials (no plastic folder or divider). We also suggest you use double-sided print-outs as much as possible

1 GENERAL INFORMATION

Reference of the Call for Proposals	**EuropeAid/133437/D/ACT/ACPTPS**
Title of the Call for Proposals	**ACP-EU Co-operation Programme in Science and Technology (S&T II)**
Name of the applicant	**International Plant Genetic Resources Institute**
No. of the proposal[11]	*Number/not applicable (open procedures)*
Title of the action	Strengthening capacities and informing policies for developing value chains of neglected and underutilized crops in Africa
Location of the action *-specify country(ies) region(s) that will benefit from the action*	Location of action: Benin, Kenya, Zimbabwe. Benefits from the action will also reach stakeholders from the West, Eastern and Southern Africa sub-regions
[No. of the Lot]	LOT 1- EDF

2 THE ACTION[12]

2.1. BUDGET OF THE ACTION, AMOUNT REQUESTED FROM THE CONTRACTING AUTHORITY AND OTHER EXPECTED SOURCES OF FUNDING

The total budget for the action is: EUR 1,167,987. Amount requested from the Contracting Authority is: EUR 992,789. as specified in Annex B.

Please note that the cost of the action and the contribution requested from the Contracting Authority have to be expressed in EURO.

[11] For restricted procedures only; the proposal number as allocated by the Contracting Authority and notified to the applicant at the time of communicating the outcome of the evaluation of the Concept Note.

[12] The evaluation committee will refer to information already provided in the Concept Note as regards objectives and relevance of the action.

2.2. DESCRIPTION OF THE ACTION

2.2.1. Description (max 14 pages)

Introduction

Agricultural research and development (R&D) in Africa has since colonial times focused on increasing productivity of a limited number of staple crops, in particular maize, wheat and rice, which combined account for 60% of global food energy intake. Scientific research has also put emphasis on commodities such as coffee, tea and tobacco, and a few roots and tubers, banana, legumes and pulses. Officially approved improved varieties of these crops, typically designed to fit high-input agricultural systems, have then been promoted among farmers via the official agriculture extension system. Although science and technology has brought about significant productivity gains in these crops, Africa's level of hunger and malnutrition remains stubbornly high, partly due to the continent's rapid population growth but also partly because the prevailing R&D approach has not served farmers well in agricultural systems in rain-fed, marginal areas. Food production per capita remained flat in the period 1961-2007 and the continent is a net food importer (Rakotoarisoa et al. 2012). The Food and Agriculture Organization of the United Nations (FAO) has projected that Africa's food production needs to double by 2050 to lift the continent out of the hunger trap (FAO 2009). Adding to this challenge is the realization that a more sustainable agricultural model is needed, that produces more from less by conserving resources, reducing negative impacts on the environment, and enhancing natural capital and the flow of ecosystem services (Collette et al. 2011).

The very rich diversity in food crops with which the African continent is endowed has in many ways been ignored by R&D, policies and strategies. But the fact is that for small scale farmers, in particularly those in marginal environments, hundreds of species of indigenous cereals, roots and tubers, legumes and pulses, vegetables, fruits and spices remain a very important part of the livelihood system (Frison et al 2011). In many cases these neglected and underutilized species (NUS) of crops and fruits can be superior to their industrial peers in terms of nutritional value, resilience to pests, diseases and climatic change and variability. Often, these are 'women's crops'—traditionally grown, collected and traded by female farmers and entrepreneurs. Farmers' indigenous knowledge of NUS crops is also part of the cultural and culinary heritage. Due to very rapid agricultural, economic and demographic change this diversity and the related traditional knowledge is being eroded at an alarming rate (FAO 2010). Only recently have R&D initiatives and policy agendas started to recognize the current value and future potential of NUS crops and fruits.

In spite of their positive traits, the value chains of NUS crops often face problems related to their cultivation, processing or marketing, thus limiting their agronomic and market potential. Seed availability and quality, variability in growth and time to harvest, laborious post-harvest processing, un-developed supply chains, lack of standards for packaging and distribution, and a perception of being 'poor man's crops' are but some of the typical problems constraining the commercialization of NUS crops.

Many of these problems could be addressed if an effective R&D system for such crops were in place that includes: i) scientific capacity to effectively interface and interact with stakeholders along the entire value chain in order to pose relevant research questions and address the typically multi-disciplinary problems facing their value chains; ii) policies that recognise the potential contribution of NUS crops for food security, nutrition and climate change adaptation, and strategies to implement these; iii) capacity of scientists and their organizations to communicate research results effectively to a wide range of stakeholders including the private sector; iv) a higher education system that develops adequate capacity among graduates to recognize the necessity to include the complementary contribution of NUS crops in agricultural development; v) leadership and institutional support to scientists, educators and value chain actors concerned with NUS R&D.

A replicable model for value chain upgrading

Research on NUS crops carried out by Bioversity International and its partners in Latin America, Africa and Asia on (Andean grains – Quinoa and *Capsicum*), Africa (African leafy vegetables) and

Asia (minor millets), has resulted in a comprehensive methodology for value chain improvement. The methodology is multi-disciplinary to cover both agronomic and socio-economic aspects. It involves multiple sectors to address both agricultural, and health and nutrition dimensions. Above all, it is built on the participation of stakeholders, including marginalized communities and women (who often are the lead growers and traders of these minor crops.) The key experiences from four of these projects are summarized here, along with generalized lessons learned for up-scaling of these methods:

Andean grains – Quinoa

Agricultural biodiversity offers poor communities living in harsh environments options to improve their livelihoods, generate incomes, attain food security and enjoy better nutrition and health. The nutritional content of Andean grains, seen in their high quality proteins and rich micronutrient profile, their hardiness, good adaptability to environmental stresses, versatility in use, and rich associated food culture and traditions are among the reasons for their widespread use in the Andes and their appreciation by local civilizations over millennia. In spite of these positive traits, the role of these species as a staple food has dramatically changed in the last four decades due to their poor economic competitiveness with commodity cereal crops, lack of improved varieties or enhanced cultivation practices, drudgery in processing and value addition, disorganized or non-existent market chains and a widespread mistaken perception of their being the "food of the poor". Launched in 2001, this initiative represented the first UN-supported global programme dedicated solely to the use enhancement of these species. This international, participatory, multi-stakeholder and highly multi-disciplinary effort contributed to strengthening the reliance of communities over their traditional resources and knowledge. Interventions were carried out in the following fields:

- Participatory selection of higher yielding varieties, resistant to drought, frost, pests and diseases.
- Reintroduction to farmers' fields of more than 40 varieties of quinoa and canihua which had been lost.
- Strengthening of *ex situ* conservation through gap filling germplasm collections in centres of diversity and characterisation, multiplication and regeneration of hundreds of accessions.
- Documentation and rescuing of local knowledge and institutionalisation of Diversity Fairs to promote exchange of knowledge and genetic material.
- Development of better cultivation practices, low cost technology for threshing and removal of saponin meant to reduce drudgery and increase household consumption of crops for nutrition security.
- Assessment of the nutritional variation of target crops in raw and processed products and awareness raising among urban consumers along with popularisation in restaurant chains.
- Development of national quality standards for the commercialization of target crops, allowing communities to enter into lucrative export markets.
- Capacity building of community members over enhanced practices, value addition, nutrition and marketing, and development of collaborative platforms to scale up experiences and reinforce sustainability of use of target species.

The project, with was funded by the International Fund for Agricultural Development (IFAD) has proven that Andean grains, like many other native crops from the Andes, can offer local populations profitable income opportunities provided that a more holistic and multi-disciplinary approach is though deployed for their promotion. As demand for functional foods and alternative non-food products (such as the industrial use of saponin) from Andean grains rises, more research is also needed for the development of community-based technologies along with capacity building interventions in order to empower farmers to benefit from these emerging opportunities. Greater linkages should be created between biodiversity-rich but economically poor regions of the Andes and tourism companies so as to promote sustainable, community-based eco-tourism initiatives (Jäger et al 2009).

Capsicum – Latin America

The project's goal was to generate higher incomes for poor farmers in developing countries by taking better advantage of the largely untapped genetic diversity of the *Capsicum* crop's center of origin. Focusing on the neglected and underutilized diversity of *Capsicum* peppers in Peru, the project effectively managed to bridge the gap between supply and demand by bringing together and strengthen capacities of different kinds of research, development and commercial institutions in a partnership that provided and integrated the critical components of a strong value chain, linking poor farmers to high-value markets. The project fostered the establishment of multi-disciplinary and multi-stakeholder value chain cooperation through the creation of a permanent platform on *Capsicum* at the national level in Peru and Bolivia. Such a mechanism has allowed research institutes and genebanks, small farmers' associations, development agencies, private companies and local and national government agencies to coordinate their individual research, capacity building and development initiatives on *Capsicum* innovation. Germplasm collections were also carried out in Peru and Bolivia as well as screening of promising material for commercially valuable traits (morphological, taxonomic, sensorial and biochemical characterization). Public-private partnerships for new product development and market introduction were encouraged through the application of Participatory Market chain Approach (PMCA). Although the project focused on a specific geographic region and crop, this case demonstrate approaches and methods to address constraints to effectively harnessing agricultural diversity in Latin America and around the world (Jäger et al, 2010).

African leafy vegetables – Kenya

Bioversity scientists, in partnership with local research and development organizations, realized in the late 90ies the need to develop a strategy for conserving leafy vegetables through use to prevent them from becoming further marginalized and ultimately disappearing. The rationale of Bioversity's intervention was that the enhancement of the use of African Leafy Vegetables (ALV) would create more demand for these nutritious local crops and thereby trigger more production of the resource. ALV were rescued and promoted by collecting, characterizing, promoting and valuing their diversity; analyzing their nutritional composition to determine their dietary potential; documenting the indigenous knowledge on their cultivation and use; identifying promising varieties and constraints to seed availability and supply; and assessing their acceptance by consumers. These actions increased the demand, volume and number of ALV species grown by local farmers and available in local supermarkets. An impact assessment study of the project showed that over 60% of project participants in one site reported that their net monthly income from vegetables increased considerably due to the work on ALV, and sales at supermarkets in Nairobi for these products rocketed (Gotor, Irungu 2010).

Minor millets India

Plant genetic resources of minor millets are well suited to enhance resilience of local production systems and strengthen food and nutrition security, particularly among the rural poor. In India, the largest grower of minor millets in the world, the cultivation of these small-seeded millets has declined steadily over the past few decades due to their lower economic competitiveness with major commodity cereals. Finger millet, *kodo* millet, foxtail millet, little millet, proso millet and barnyard millet, have a wide genetic adaptation and are able to grow successfully in diverse soils, varying rainfall regimes, diverse photoperiods and in marginal, arid and mountainous terrains where major cereals have low success. They have the potential to thrive with low inputs and can withstand severe climatic stresses, thus being the best candidates to replace commodities like wheat and rice in areas where such crops may gradually become less competitive due to climate change. These qualities are combined with excellent nutritional values.

The project applied a range of methods that, combined, had positive effect on production, income and labour requirements. Skill development of rural and tribal women in developing value added millet products, maintaining acceptable hygiene standards, packaging, labelling and marketing and development of appropriate technologies were all important components of the work. Strategic and

rule-based alliances with agencies and organizations having experience in marketing, processing and product development were facilitated. The project learnt that greater public awareness about the nutritional and other benefits from cultivation of these crops could be raised through awareness campaigns, exhibitions, farmers' fairs, radio and TV programmes, workshops, conferences, symposia, publications, etc. by the research institutions, State Agricultural Universities and the agriculture development departments. Urgent attention needs to be given for promoting policies, laws and regulations that ensure that benefits from the increased use of millets reach communities, particularly women and other disadvantaged members of the society. Introduction of these grains in school feeding programmes has strategic advantage of using low cost grain to provide nutritionally superior meals to children (Padulosi et al 2009)

Generalized lessons learned and strategies for up-scaling

These projects have led to a replicable innovative model for identifying promising NUS crops and exploring opportunities for their sustainable commercial use. The approach is linking small scale farmers to existing and potential new high-value markets for the benefit of the poor, and is building networks to facilitate transfer of knowledge and technology between the stakeholders. Methods and approaches developed and tested by Bioversity and its partners are ready for being validated and up-scaled in Sub-Saharan Africa.

The achievements of these and other similar projects have also contributed to growing international recognition of the need for adding NUS crops to the R&D portfolio. Their potential contributions towards agricultural sustainability, their nutritional properties, their climate change adaptive potential and their income generating potential are increasingly recognized and valued. To this end, the Food and Agriculture Organization of the United Nations (FAO) and the European Plant Science Organization (EPSO), at an international workshop in June 2012 in Rome, identified underutilised/local fruits and vegetable crops as one of three priority areas for European and African scientific collaboration. In December 2012, at an international meeting in Cordoba, Spain, the Director General of FAO, Graziano da Silva, stressed that neglected and underutilized species "play a crucial role in the fight against hunger and are a key resource for agriculture and rural development," and called for increased research on underutilized crops. He noted that "While some research is taking place, the results do not always reach smallholders". Many NUS could offer better opportunities than mass commodity products, provided supply capacities are linked to market and marketing opportunities.

As mentioned, an earlier project under by the EU-ACP Science & Technology programme has begun to develop such capacity, under the project "Building human and institutional capacity for enhancing the conservation and use of Neglected and Underutilized Species of crops in West Africa, and Eastern and Southern Africa" , due to end in November 2013.[13] The project's actions took place in Benin, Ghana in West Africa, and in Kenya, Malawi and Uganda in Eastern/Southern Africa, with training also targeting young scientists from Mali, Senegal and Nigeria in West Africa, and Ethiopia and Mozambique in Eastern/Southern Africa. The project is coordinated by the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM), and implemented in partnership with six African and two European organisations (five on which now collaborate on this proposed follow-up Action). The lessons from this project, outlined in the concept note, points at a set of needs that must to be addressed by the agriculture R&D system in order to make NUS research in Africa more effective, and for communicating results to policy makers, agriculture professionals, NGOs, the private sector and farmers.

This Action will address the recommendations and lessons learned as follows:

- The very high demand for capacity development on NUS research will be addressed by offering training opportunities on value chain research proposal development and science communication in 15 additional countries. One of the courses will target West African Sahel

[13] EU-ACP (S&T) Action, FED/2009/217072

and be offered in French. Two countries with weak scientific capacity, Malawi and Mozambique will get extended opportunity for training

- The courses will particularly focus on multi-disciplinary value chain research, a pronounced weakness among scientists trained in a narrow niche of agricultural research. Similarly, the private sector perspectives will be emphasized.
- The need for setting research priorities among NUS crops will be addressed through a national study in Zimbabwe, which will review past and on-going research projects, publications and literature. A national workshop of NUS stakeholder will give expert opinion and advice on priority setting within cereals, legumes and pulses, roots and tubers, leafy vegetables, and fruit.
- The need for informing scientists and policy actors on the issues confronting the upgrading of NUS value chains will be addressed via innovation platform workshops in the three focus countries, Benin, Kenya and Zimbabwe. These workshops will not only analyze blockages and constraints in the value chains of bambara groundnut and amaranth, they will also be a foundation for later dialogue with policy actors at sub-regional level during the Action. These crops are chosen because they are priorities in West, Eastern and Southern Africa, thus providing excellent ground for knowledge sharing, both regarding research, the use of research results for innovation, expansion of markets and strengthening the policy framework that facilitates these processes.
- The needs for better capacity in NUS R&D among graduates will be addressed by a new curriculum development initiative, lead by ANAFE, an educational network of 132 universities and colleges across Africa. The study of NUS curricula, not included in the previous project, will now be added as a main vehicle for developing the capacity of future graduates in this field, and for sensitizing policies on higher agricultural education on the role and potential of agricultural diversification. This component will not only review curricula, but also promote a shift from rote learning to experiential learning, an expansion of multi-disciplinary perspectives and more emphasis on skills of working in participation with farmers and their local knowledge. Such educational change would support the Bonn Declaration on education for sustainable development (UNESCO 2009).
- The need for knowledge sharing on NUS research, capacity and policy will be met by a nested approach with three focus countries. The national partners in these countries will serve as sub-regional hubs for knowledge sharing and policy dialogue. The Action will also contribute to regional-level knowledge sharing regarding higher education, and agricultural research and policy forums.

The proposed Action is organized around four interlinked results (Figure 1), which will lead to the achievement of two specific objectives:

1. Strengthened national and regional capacities for research, development, education on NUS value chain, and for communication of results to society
2. National and regional policy actors, research and education institutions in West -, East-, and Southern Africa informed on the role and benefits of deploying NUS into strategies and programmes for agriculture, nutrition and adaptation to climate change

These, in turn, will contribute to the Action's overall objective: Enhanced value chains of neglected and underutilized species (NUS) in Africa contributing to improved food and nutritional security, income of small holder farmers and entrepreneurs and mitigation of, and adaptation to climatic, agronomic and economic risks.

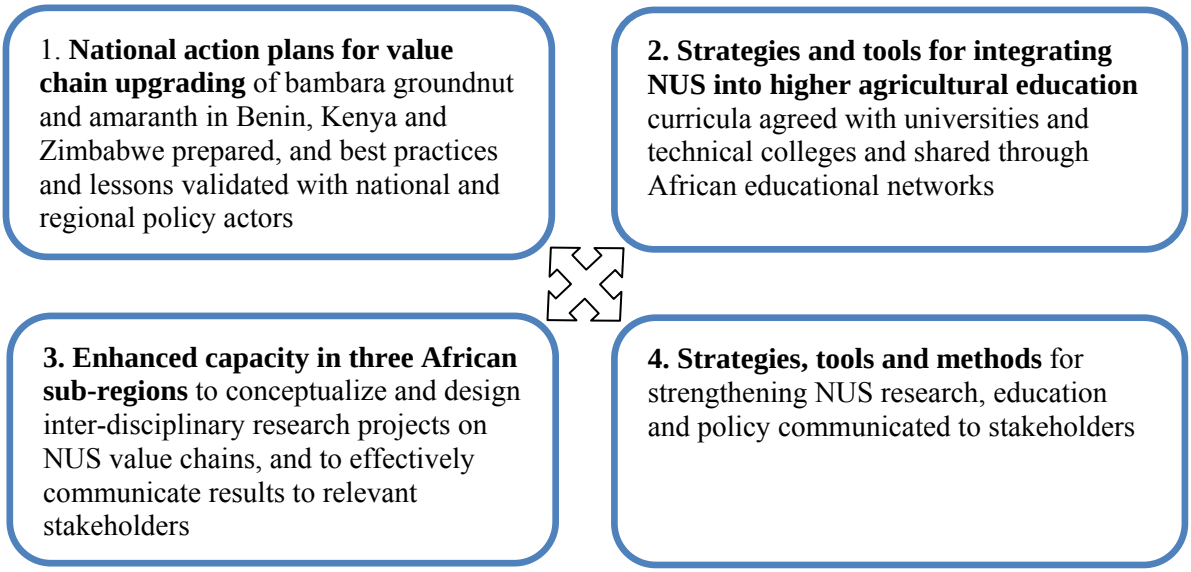

Figure 1. Results of the Action.

The regional capacity building approach used in the previous EU-ACP project was very effective in sharing knowledge between neighbouring countries, and in creating networks and a critical mass of scientists working on the same priority crops. The proposed Action will expand this approach. A new focus country, Zimbabwe, will be added to coordinate capacity building and policy dialogue for six countries in the Southern Africa sub-region. Benin and Kenya will remain the focus countries in West and Eastern Africa, respectively. The proposed action will thus address the needs for strengthening the research capacity of scientists in 19 countries (Table 1), as well as influencing supportive policies and strategies.

Table 1. The Action's target countries

Sub-region	**Partner**	**Target countries**
Eastern Africa	University of Nairobi, Kenya	Kenya, Tanzania, Uganda, Burundi, Rwanda, South Sudan,
Southern Africa	Africa University, Zimbabwe	Zimbabwe, Zambia, Botswana, Malawi, South Africa and Mozambique
West Africa	Laboratory of Agricultural Biodiversity and Tropical Plant Breeding (LAAPT), Benin	Benin, Burkina Faso, Niger, Mali, the Gambia, Togo and Ivory Coast

How results of the action will improve the situation for target groups

Scientists: Experience demonstrates that young scientists show significant interest in NUS, but that their research is fragmented and often narrow, lacking a holistic perspective. Their experience in working in multiple disciplinary value chain research of NUS is limited. The Action will bring scientists and key value chain actors together for more relevant and more applicable R&D. In particular, scientists attending proposal writing/value chain workshops will be required to demonstrate that they have consulted with relevant stakeholders prior to their being accepted as participants. Inputs from stakeholders at the research conceptualisation stage will go a long way to ensure relevance of the research being proposed.

University lecturers and education leaders: The issues relating to NUS are, by and large, ignored in higher agricultural education programmes in Africa. Educators need further awareness of, methods for integrating NUS into curricula, and a range of institutional and capacity constraints needs to be addressed. The Action will invite stakeholders to participate in a regional workshop with the aim of

making recommendations for integrating NUS and value chain methods into higher education curricula.

Policy actors: By and large, agricultural policy actors are rooted in a high-input agricultural paradigm that works for a narrow range of crops. As the international agenda increasingly emphasizes sustainable agriculture and points at the role of agricultural diversification as one element of this, there is a significant need to sensitizing policy actors. This Action will do this at national, sub-regional and regional levels, through consultations, communication and publications.

How results of the action will improve the situation for final beneficiaries

Final beneficiaries: Smallholder farmers, processors, traders, entrepreneurs, consumers and scientists, currently lacking adequate support for NUS development, will benefit from more effective participation in value chains, Results from scientists' research projects made relevant by stakeholder consultation and scientists' understanding of the dynamics of value chains would likely benefit value chain actors. Scientists careers will be enhanced through being able to demonstrate productivity through publications and through their research being relevant and thus increasing the possibility of putting their results into use. Many NUS are highly nutritious and expanded markets will benefit the diets of consumers. Many NUS are well adapted to marginal environments; in climate change scenarios, this will help to ensure food security and incomes in vulnerable regions and also will benefit all stakeholders along a value chain.

How technical and managerial capacities of target group (and local partners) will be enhanced

The experience of working within the framework of value chains will provide scientists with a holistic perspective that starts when a research project is being conceptualized. Even though research may seem at first sight to be relevant, the consequences of e.g. increased yields of a crop may not be advantageous to because of bottlenecks further along the value chain. A systems view of the value chain helps identify and consider such trade-offs, and therefore helps keeping research relevant and results applicable.

A second key competence to be developed through this Action is the ability to work with, and understand scientists and development specialists in other sectors. The courses will bring together biophysical scientists and socio-economists; agriculturists and nutritionists. By working together on team projects, they will learn to appreciate the knowledge that other disciplines bring to the table.

Foreseen publications

1. National status report on research, capacity and policies for NUS in Zimbabwe
2. Three national Action Plans on strategies for upgrading value chains of bambara groundnut and the leafy vegetables amaranth for Benin, Kenya and Zimbabwe.
3. Proceedings from regional workshop on the teaching of NUS value chain development in higher agricultural education institutions.
4. Three policy briefs on NUS value chain development in West-, Eastern- and Southern Africa, respectively.
5. Curriculum guide on integrating NUS value chain into courses and programmes of African universities and technical colleges, or on-the-job training of staff in agricultural organizations.
6. Two learning case studies on NUS value chain development

Activity

The project design is illustrated in Figure 2 below.

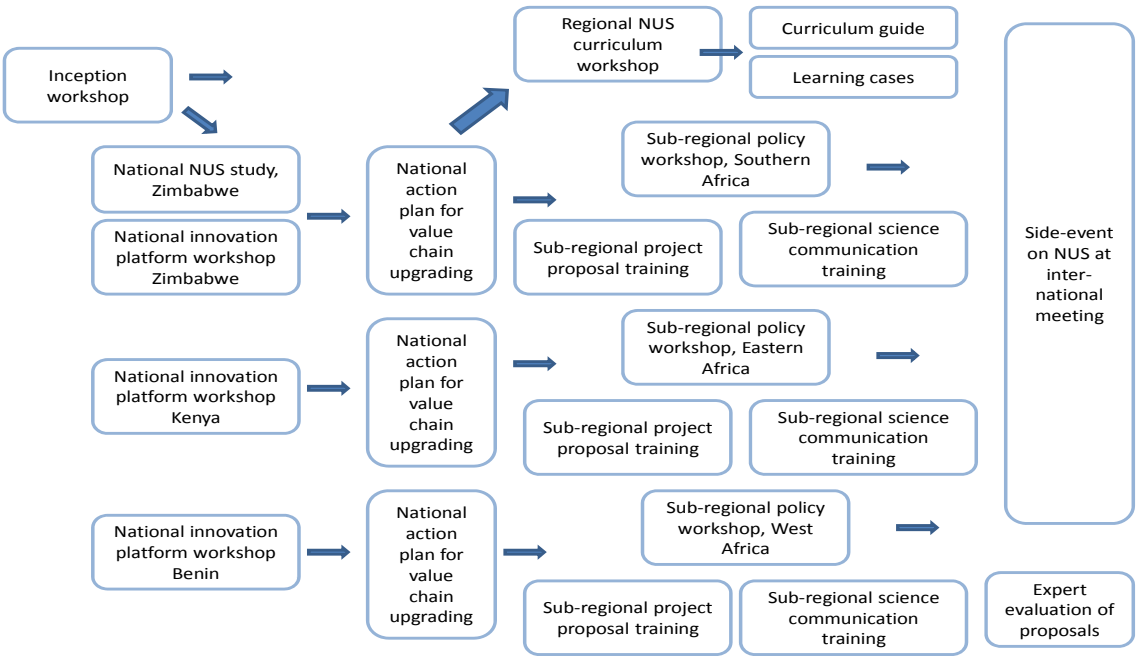

Figure 2. Project design

Activity 1.1 Inception workshop

A three-day project inception workshop, to be held in Nairobi, Kenya, will gather all EU and Africa project partners, as well as the Associates of the Action, in total 9 organizations. The purpose of the Activity is three fold: i) As a project team, to learn from Kenyans' recent experience in upgrading value chains of neglected and underutilized crops and integrate these lessons in the project's detailed activity plan; ii) to prepare a detailed project implementation plan, iii) to develop a clear and transparent administration mechanism for the project, especially regarding financial reporting. The workshop is also important for the coordination of actions between the three sub-regions West Africa, Eastern Africa, and Southern Africa.

Activity 1.2 National study of NUS in Zimbabwe

This Activity, led by Africa University, Mutare, Zimbabwe, has two functions: i) it will inform the project on current status and needs with regard to NUS research, policy and capacity in Zimbabwe; ii) it will raise awareness and interest among national stakeholders about the project. A baseline of current status of and needs for capacity of NUS research, with emphasis on value chain development, will be established using a combination of literature studies and interviews. The baseline report will then be presented at a one-day national stakeholder meeting and the findings verified or modified, as appropriate. The expected outputs include research needs on NUS value chains established, constraints to value chain upgrading identified, and priorities for research, development and policy to be established. A national status report on NUS R&D in Zimbabwe will be produced and be used in future project activities and communications. Such national studies were already conducted in Benin and Kenya in 2010 under a previous EU-ACP project. The national partners in Benin and Kenya continue to address the issues raised in these reports also in the current Action.

Activity 1.3 National innovation platform workshops on bambara groundnut and amaranth value chains in three countries

A priority setting in the earlier EU-ACP project identified bambara groundnut and amaranth as priority NUS in both West and East Africa. Literature surveys confirm that these crops are important in Southern Africa also. The need and potential for value chain upgrading is significant, but scientists working on these species typically lack experience of a broader value chain approach in their research, which tends to be fragmented and 'narrow'. In particular, the research is lacking a business perspective both in the conceptualization of research and in the application of results. This activity aims to inform scientists and value chain actors on blockages and constraints to value chain upgrading, and farmers' gainful participation in value chains. These constraints, whether they are research- , policy- or business-related issues will be analyzed. Each national partner in the three project countries – Benin, Kenya and Zimbabwe – will perform a mapping exercise of the institutional landscape regarding key actors (farmer associations, research institutes, universities, private sector processors, retailers, NGOs, regional and national governments) for each target crop. These key actors will then be invited to a three-day innovation platform workshop in which a value chain analysis of constraints and bottlenecks will be performed and fields of upgrading/improvement be identified. Bioversity, IFS and ANAFE will play a facilitating role in these innovation platforms, each drawing on their own experiences from value chain research (Bioversity), individual/collaborative team research on NUS (IFS) and university-private sector linkages (ANAFE). A small number of outstanding young researches trained in the earlier EU-ACP project will be invited to share their experiences. The insights and outputs from the workshops will be used in a number of ways, within the project and beyond:

- a list of pertinent research issues for each crop will be identified, which will inform future project proposal training courses in the natural and socio-economic sciences (Activity 3.1).
- policy constraints and needs will be mapped out, which will inform and be further analyzed in sub-regional policy multi-stakeholder workshops (Activity 2.1) and communications activities (Activity 4.1).
- capacity development needs will be listed, to be addressed in the projects training courses and curriculum development (Activity 2.3) and an inventory of other constraints to value chain development.

Activity 1.4 Prepare National Action Plans on value chain promotion for bambara groundnut and amaranth

Using the outputs of the innovation platform workshop (Activity 1.3), each national partner will further analyze and validate the findings in consultation with relevant specialists. Three National Action Plans will be prepared, listing knowledge gaps to form the basis of future research projects, concepts for upgrading and comparison of value chain strategies, or for integrating NUS into strategies and programmes. Special efforts will be made to communicate these National Action Plans broadly.

Activity 2.1 Sub-regional policy multi-stakeholder workshops

We hypothesize that the detailed mapping of value chain upgrading strategies for bambara and amaranth in Benin, Kenya and Zimbabwe will generate lessons that go beyond these crops and countries. The three national partners, with support from ANAFE, Bioversity and IFS, will organize three sub-regional multi-stakeholder policy workshops in West Africa, Eastern Africa and Southern Africa, respectively, early in Year 2. The workshops will target policy makers and technical advisers from agriculture, conservation and health and nutrition sectors, as well as the private sector and farmers' organizations. The purpose is to present the National Action Plans, validate them in the light of broader agricultural development trends, and draw out sub-regional lessons for policy actors. By inviting a small number of researchers to the workshops they will also demonstrate the value of interfacing between the researchers and stakeholders to fine-tune research towards the relevant needs of target beneficiaries, and for formulating future training strategies.

The sub-regional policy workshops will target the following countries:

- West Africa: Benin, the Gambia, Ghana, Nigeria, Senegal, Niger, Burkina Faso, Mali, Togo, Cote d'Ivoire
- Eastern Africa: Kenya, Uganda, Tanzania, Rwanda and Burundi, South Sudan
- Southern Africa: Zimbabwe, Botswana, Zambia, South Africa, Malawi, Mozambique

Activity 2.2 Develop policy briefs to inform national and sub-regional strategies regarding NUS crops

The results of Activities 1.4 and 2.1 will be re-packaged into policy briefs, which will be shared widely at national and sub-regional events, and be promoted online (Action 4.1). The policy briefs will be produced jointly between the projects' international partners: Bioversity, IFS and ANAFE, whereas dissemination of the policy briefs will be a shared responsibility among all project partners and associates.

Activity 2.3 Regional NUS curriculum workshop

Earlier studies of several of the project partners have found that the teaching of agrobiodiversity in higher education institutions is weak or absent in most institutions. The coverage of NUS crops, and the modern methods for upgrading their value chains are rudimentary. One of ANAFE's key mandates is to contribute to increasing the relevance and quality of higher education in Africa. A curriculum development methodology that ANAFE has been promoting on related subjects such as agroforestry will be used for developing NUS curriculum guidelines. The method, DACUM – Developing A CurriculuM − is highly participatory and involves both educators and outside stakeholders, including private sector and farmers' organizations. To this end, ANAFE will organize a 4-day workshop in Year 2.

The DACUM is a competence-based curriculum development method. The DACUM process enhances the ability of learners to meet specific objectives formulated according to set standards. The process works on the following principles:

- Stakeholders (workers, employers, farmers) can define their job requirements more accurately than anyone else.
- Any job can be effectively described in terms of the tasks that successful workers in that occupation perform.
- A curriculum for a specialized training should aim at developing the required competencies for performing the identified tasks.
- In order to be performed correctly, all tasks demand certain knowledge, skills and attitudes from workers.

The process goes through the planning stage, the in–situ DACUM training, analysis of the DACUM chart and course development. The process needs to be updated so that we incorporate new elements that ensure the training needs are adequately evaluated; taking into account development and environmental needs; assessing institutional settings; estimating resource requirements for implementation of new curriculum; focusing on competencies to be developed; adequate stakeholder representation and capturing multidisciplinary opportunities.

Activity 2.4 Develop NUS curriculum guidelines

The outputs of the regional NUS curriculum development workshop will be further elaborated into NUS curriculum guidelines. This publication will be flexible, and point at a number of options for integrating NUS into higher education courses or programmes, whether informally or through formal curriculum development in a university or technical college. The Guide should also be useful for in-the-job training of working professionals. The development of the Guide will be led by ANAFE, and be co-authored by the project partners. It will be promoted via the project's communication strategy (Activity 4.1).

Activity 2.5 Write and publish learning cases on NUS value chain upgrading

One of the obstacles to teaching a new subject is often the lack of user-friendly training materials, especially material that lends itself to experiential learning (as opposed to teacher-centred rote learning). Using a learning case study approach, piloted by Bioversity on related topics, recent research on NUS value chain upgrading will be presented in compact, user-friendly learning cases that are suitable for a wide range of teaching and learning situations. Within this project two learning cases will be developed, under the leadership of Bioversity in collaboration with ANAFE.

Activity 3.1 Organize sub-regional project proposal training courses on NUS value chain research

This activity will address two related urgent training needs: to conceptualize and prepare convincing research proposals, and to apply a value chain approach in NUS research. Six training courses to conceptualize and prepare a good scientific research proposal on NUS value chain research will be held during the Action, one course per sub-region in Year 1, and a second course in Year 2. Each course will have 25 participants, equally distributed by gender.

All courses will be organized and implemented jointly by IFS, the national partners in the respective sub-region, and Bioversity. ANAFE will facilitate the participation of its member institutions in the target countries which are all members of its network. The courses will follow routes that were successfully tested in the previous EU/ACP-funded project. This is as follows:

- A call for concept notes will be issued detailing the focus and specific researchable questions arising from the National innovation platform workshops in Activity 1.3.
- Applicants will be required to write a Concept Note of one or two pages outlining a project with potential for submission to IFS' Granting Programme. (An IFS Research Grant has a maximum value of USD 12,000 and a duration of 1-3 years). A pre-condition of participation will be that the candidate must consult with relevant stakeholders when conceptualizing their research project outlined in the concept note and evidence of this must be demonstrated.
- The proposed research should address research topics related to the upgrading of value chains of one of the focus NUS crops. The themes will be related to the researchable questions identified at national innovation platform workshops (Activity 1.3).
- The Concept Notes will be assessed by a joint panel from IFS, Bioversity, ANAFE, and the national partners. At least 25 successful applicants will be invited to the proposal writing workshop.
- Selected participants are required to prepare a draft research proposal prior to the workshop, using the IFS application form.
- The course will mentor the applicants regarding their research proposals, research methods, etc, and hone their skills in writing quality proposals, thus preparing participants to submit their proposals to the IFS Granting Programme
- The course will be combined with an introduction to understanding and analysing value chain training (see below).
- Following the workshop, when participants submit a proposal to IFS, they must show evidence of having consulted further with the relevant value chain actors and consequently explain how their projects are relevant to a particular value chain problem.
- The participants will also be mentored after the workshop to help strengthen the proposals, if necessary (see Activity 3.2)
- Applications for an IFS Research Grant will be screened according to the normal IFS process, including assessment by (independent) IFS Scientific Advisers and recommendations from the (independent) IFS Scientific Advisory Committees. The timeframe from the application deadline to final decisions on awarded grants is roughly 6-7 months.
- Successful proposals will be approved and contracts will be signed with the new IFS grantees and their institutions.

Activity 3.2 Expert evaluation of proposals for granting programmes

Through the scientific networking strengthened through Action 3.1, young scientists will gain access to experts who will review and evaluate proposals. Evaluators and mentors will be made available through Partners and Associates, including the independent Scientific Advisers at IFS and its independent Scientific Advisory Committees, and scientists linked to Crops For the Future. These resources will be made available as in-kind contributions to the project. Such mentoring is particularly valuable to young NUS researchers because mentors might not be available in his/her institution. The mentoring programme will continue throughout the duration of the Action, and will be advertised in workshops, courses and meetings, as well as on Internet Platforms (See Activity 4.1). Periodic 'auditing' will help to resolve any problems which arise in these projects, identify any needs to provide expert advice and so assure continuation of the projects and maximise the opportunities for satisfactory outcomes.

Activity 3.3 Organize sub-regional courses on scientific communication

Three training courses on effective scientific writing and communication of research results will be held during this Action. The course for Eastern Africa will be held in Year 2 at the University of Nairobi, Kenya. The course for West Africa will be organized by The Laboratory of Agricultural Biodiversity and Tropical Plant Breeding (LAAPT), Benin, jointly with ANAFE in Year 2. Finally, the course for Southern Africa will be held in Zimbabwe the University of Africa, also in partnership with ANAFE.. For all courses, IFS and Bioversity International will play a key role in advising on the content and delivery of the course, building on past experience from similar courses. Each course will invite 25 participants who have a documented research interest in the specific priority NUS crops and processes for value chain upgrading. The target countries will be identical to those in Activity 3.2 (see Table 1). The participants would be drawn preferentially, but not exclusively, from those who took part in the proposal preparation courses and who submitted a quality project proposal to IFS.

The course content will emphasize two kinds of science communication, the rationale for which is given below: i) Publishing in scientific journals; and ii) Popularizing science/policy briefs:

i) Publishing in scientific journals: a critical aspect of the scientific process is the reporting of new results in scientific journals in order to disseminate that information to the larger community of scientists. Communication of results contributes to the pool of knowledge within a discipline (and others) and very often provides information that helps others interpret their own experimental results. Most journals accept papers for publication only after peer review by a small group of scientists who work in the same field and who recommend the paper be published (usually with some revision).

The experience of all the partners in this application is that a degree of academic isolation dissuades a large proportion of researchers in Sub-Saharan Africa from developing first drafts through to completion for submission of a manuscript to a reputable scientific journal. In the absence of a supervisor who is experienced and prepared to assume the role of mentor in this regard, scientific writing workshops are expedient alternatives. The participatory workshops, in which attendees would obligatorily bring drafts of a chosen scientific paper for improvement during the course, would cover the following topics:

> *General guidelines; title; abstract; rules for scientific writing; using an outline to prepare your paper; description of an outline; value of the outline; developing the outline; word usage in scientific writing; grammar ; active versus passive voice in writing ; when to use the active voice; when to use the passive voice; active-passive exercise; writing the Introduction; writing the methods; writing the results and discussion; results section; numbers and statistics; tables; figures; discussion section; preparing the reference section; examples of citation formats; examples of reference formats; answers to active-passive exercise; sources for further information; websites; book sources.*

ii) Popularising science/policy briefs: is an interpretation of scientific matters intended for a general audience. This can be in many formats, e.g. for newspapers, magazines, radio, TV etc., but the goal is

to inform the target audience so that they understand precisely the nature of the scientific subject matter as well as the opportunities to society that the science in question may offer. Scientists themselves often find that they have to do this in order to, e.g. engage stakeholders which is particularly important in the project being proposed, or to source funding for a project or to simply inform the public about research being undertaken which the public themselves are (indirectly) funding through taxation. Writing policy briefs is another form of popularising science, the specific aim being to convince the target audience of the importance of a current problem and the need to adopt the course of action proposed.

Activity 4.1 Develop and implement a project communication strategy

Tools, research methods, training manuals and approaches for NUS research will be published and made available electronically on a web platform, and will include training manuals on i) data management and experimental design, and ii) value chain analysis. Bioversity will take the lead in the development of these resources, in close cooperation and engagement with all partners. ANAFE and IFS in particular will be closely involved.

The rationale: Research capacity, particularly with regard to holistic, inter-disciplinary and value-chain research is frequently weak. Toolkits, methodological guides and reference materials to support and backstop training and available in one location, will help to improve this.

A key component of this activity is the continued development and maintenance of NUS content on the partners' websites, which will serve as the information gateway to these services. A separate section will be developed on the website to host the 'research support' tools, such as the training manuals. The ANAFE websites will also serve as a repository for such information, while that of IFS permits communication between invited scientists and stakeholders and also provides a private "space" for, e.g. NUS entrepreneurs who need to maintain the confidentiality of their communications.

Activity 4.2 Organize side-event on NUS at an African international meeting

In Year 3, the project partners, lead by ANAFE will organize a side-event on NUS research, development and policy. The side event will be held during CORAF/WECARD or ASARECA Science Weeks occurring every 3 to 4 years, or during the next Global Conference on Agricultural Research for Development (GFAR). Each of these scientific events usually brings together more than 300 participants from all over the world. Other opportunities could be also seized to present the projects and its outcomes, such as the ANAFE symposium on Managing risks and Agribusiness planned for 2014, the FARA General Assembly to be held in 2016 or the World Congress of Agroforestry planned for 2016.

Activity 4.3 End-of-project workshop

And end-of-project workshop will be organized back-to-back with Activity 4.2. The workshop will bring together stakeholders including researcher, academicians, graduates, private sectors, farmer organizations, etc. from all participating countries, but also from non target countries. The media from the country hosting the workshop will be invited to increase the visibility of the project outcomes. The workshop will critically review the outputs and results of this Action, with the aim of i) documenting lessons learned; ii) making recommendations for further strengthening NUS research capacity; iii) making recommendations for enhancing science communication and knowledge sharing on NUS research and marketing; and, iv) advising education and R&D policies on strategies for mainstreaming NUS, and in particular value chain approaches, into higher education, on-the-job training, and R&D programmes and strategies.

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2.2.2. Methodology (max 4 pages)

The fundamental principle behind this Action is drawn from the insights from recent research projects that upgrading value chains of NUS crops requires a multi-disciplinary, multi-stakeholder approach, and a strong gender perspective. For example, biophysical scientists will need to collaborate effectively with socio-economic scientists; agriculture specialists need to work with nutritionists and public health experts. Crucially, the R&D problems need to be identified and prioritized in participation with a wide range of stakeholders, including the private sector and farmers' organizations.

All this contrasts starkly with the findings from the earlier mentioned EU-ACP project in which five of the partners in this proposed Action are involved: the young scientists trained were mostly working on a narrow part of the value chain with limited links with downstream or upstream stakeholders. To break this pattern, this Action will carry out a deep analysis at the national level of value chains of two priority NUS crops: bambara groundnut and amaranth, an African leafy vegetable. National innovation platforms that gather a wide range of stakeholders will identify constraints in the value chains, and agree on upgrading strategies. This will be done in 3 countries: Benin, Kenya and Zimbabwe, each representing one sub-region. West-, Eastern- and Southern Africa, respectively.

The knowledge gained from the national value chain upgrading strategies will be used in several ways in subsequent project Activities, at national, sub-regional and regional levels:

- At national level, National Action Plans for NUS value chain development will be prepared, outlining how the identified constraints could be addressed through research, capacity building, public-private-partnerships or policy change.
- At sub-regional level, the insights in value chain upgrading will be discussed with stakeholders in the West, Eastern and Southern Africa sub-regions, seeking to validate the funding in order to generate policy advice.
- Also at the sub-regional level, the researchable questions identified will form the basis for the selection of participants in sub-regional project proposal writing workshops. The courses will at the same time serve as a knowledge sharing mechanism from the three focus countries to scientists and their institutions in 15 African countries.
- At the regional level, the Action will use a methodology for informing curricula of higher agriculture education used by one of the project partners, the African Network for Agriculture, Agroforestry and Natural Resources Education (ANAFE). The methodology, *Developing A Curriculum* (DACUM) emphasizes participation of stakeholders in defining competences – knowledge, skills and attitudes – required in graduates. This is then used to outline the objectives and learning elements in a new or a revised curriculum. A flexible curriculum guide for NUS education will then be written and disseminated.
- Finally, the project will develop a joint communication strategy, using existing partners' websites, for economy and sustainability, rather than creating new ones. In Year 3 of the project, a side-event at a key African agriculture conference/event will be organized to share knowledge widely.

A project steering committee consisting of representatives of all partners and associate organizations will be established at the project's Inception workshop. Parts of the committee will also meet in connection with implementation of project activities, as well as virtually.

The project will also closely study the forthcoming final report and evaluations of the above mentioned related EU-ACP project, to draw additional lessons, which will be built into the detailed design of the Action's activities.

For a project of this nature and duration, and evaluation cannot be carried out within the project implementation period.

Organisational structure and the team proposed for the implementation of the action

The project implementation team includes the following functions (Table 2):

Table 2. Partners and their roles

Partner	**Description**	**Roles in the Action**	**Staff involved in the Action**
Bioversity International – EU partner	International research organization specializing in R&D on the conservation and use of agricultural biodiversity	Project management; Methods for value chain upgrading; Co-facilitation of training courses; co-responsible for communication	• Project Manager • Senior Scientist/NUS specialist • Value chain specialist • Communications specialist
International Foundation for Science (IFS) – EU partner	International foundation that supports the development of scientific capacity in low- and mid-income countries	Member of project steering committee; Leading of training courses on project proposal writing and scientific communication; co-responsible for communication	• Research adviser #1 • Research adviser #2

African Network for Agriculture, Agroforestry and Natural Resources Education (ANAFE) -- ACP partner	International non-profit organization, with a mandate to strengthen the quality and relevance of higher agricultural education in Africa. Has 132 members in 37 African countries	Member of project steering committee; Leading of Activity 3 on higher education curricula. Leading activities to inform and influence policy makers at the regional level. Co-responsible for communication	• Executive Secretary • Network Manager • Communications officer
Africa University, Zimbabwe; University of University; LAAPT, Benin	Academic institutions, with research and education programmes on agricultural biodiversity	Member of project steering committee; Lead national innovation platform processes; Develop National Action Plans for value chain upgrading; Validation and sharing of knowledge at sub-regional level; Policy influence	Each of the three national partners will involve one Project Manager for national and sub-regional activities. Additionally, Africa University will involve one Senior Lecturer

The Action also has three Associate organizations (Table 3):

Table 3. Associate organizations and their roles

Associate	**Description**	**Roles in the Action**
Excel Hort Consult Ltd (EHC)	A registered company that specializes in agribusiness and agro industry value chain development and trade in East and Central Africa	Support and strengthen the capacity of value chain platform of actors using designed models for facilitating access to market and agribusiness trade
Global Horticulture Initiative (GlobalHort)	Global facility for coordinated horticultural research that provides solutions towards increasing health, productivity and safety in sustainable environments, to uplift the quality of life of the poorest populations in the world.	Monitoring and back stopping, using experts from its various Board member organizations. - Facilitating communication and knowledge exchange at regional level.
The West and Central African council for Agricultural Research and Development (CORAF/WECARD)	International Association with an objective to improve the efficiency and effectiveness of small-scale producers and promote the agribusiness sector.	To facilitate project implementation in West and Central Africa through the NARS of the target/beneficiary countries

<u>The main means proposed for the implementation of the action</u>

The implementation of the Action requires office space (provided in kind by partners), and resources and facilities for organizing workshops and meetings, including office supplies and communication facilities. Travel will be required for national and international participants in courses and workshops. Human resources is a key input for capacity development, facilitation of value chain innovation platforms, and policy dialogue. Information and communication infrastructure will be required for implementing the projects communications strategy; we will use the partners' existing websites and also those of associated organizations.

Attitudes of all stakeholders towards the action in general and the activities in particular

All partners have participated enthusiastically in the design of the project and its activities. It is perceived as a value-added component to partners' research, education and development mandates.

Planned activities in order to ensure the visibility of the action and the EU funding.

A strong web-based communications strategy will be developed in Year 1, using partners and associates existing websites. A team of communications specialists in the Partner organizations will be set up, lead by a senior Knowledge Management Officer at Bioversity International, Projects activities will be advertised broadly via partners' extensive mailing lists, and via Websites of like-minded organizations. The range of knowledge products, including policy briefs, produced during the Action will be broadly available on partners' websites. Visibility actions are also planned in connection with major African agriculture conferences/events. Finally, the calls for applications for the six training courses will also serve as important project visibility instruments.

2.2.3. Duration and indicative action plan for implementing the action (max 4 pages)

The duration of the action will be 36 months.

Year 1													
	Semester 1						Semester 2						
Activity	M 1	2	3	4	5	6	7	8	9	10	11	12	Implementing body
Preparation Activity 1.1 Inception workshop	X	X											Bioversity
Execution Activity 1.1 Inception workshop			X										Bioversity
Preparation Activity 1.2 National study, Zimbabwe			X										Africa University
Execution Activity 1.2 National study, Zimbabwe			X	X									Africa University
Preparation Activity 1.3. National innovation platform workshops			X	X									Bioversity, Africa University; LAAPT, University of Nairobi;
Execution Activity 1.3. National innovation platform workshops					X	X							Bioversity Africa University; LAAPT, University of Nairobi;

Execution Activity 1.4 Writing 3 national Action Plans on bambara and amaranth value chains							X	X	X				Africa University; LAAPT, University of Nairobi;
Preparation Activity 3.1 Sub-regional NUS project proposal writing training								X	X	X			IFS, Africa University, LAAPT University of Nairobi, Bioversity, ANAFE
Execution Activity 3.1 Sub-regional NUS project proposal writing training											X	X	IFS, Africa University, LAAPT University of Nairobi, Bioversity, ANAFE
Preparation Activity 4.1 Communication							X	X	X				Bioversity, ANAFE, IFS
Execution Activity 4.1 Communication										X	X	X	Bioversity, ANAFE, IFS

For the following years:					
Activity	Semester 3	4	5	6	Implementing body
Activity 1.5 Sub-regional policy multi-stakeholder workshops	X				Africa University, LAAPT, University of Nairobi, ANAFE
Activity 1.6 Develop policy briefs to inform national and sub-regional strategies on NUS		X			Africa University, LAAPT University of Nairobi,
Activity 2.1 Regional NUS curriculum development workshop	X	X			ANAFE
Activity 2.2 Develop curriculum guidelines		X	X	X	ANAFE
Activity 2.3 Develop NUS learning cases		X	X	X	Bioversity
Activity 3.1 Sub-	X				IFS, Africa University,

regional NUS project proposal writing training					LAAPT; University of Nairobi;Kenya, Benin, Bioversity, ANAFE
Activity 3.2 Expert evaluation of proposals for granting programmes					IFS, Bioversity
Activity 3.3 Sub-regional scientific writing and communication training			X		IFS, Africa University, LAAPT; University of Nairobi;Kenya, Benin, Bioversity, ANAFE
Execution Activity 4.1 Communication	X	X	X	X	Bioversity, ANAFE, IFS in collaboration with national partners
Activity 4.2. Side event on NUS at African conference			X	X	ANAFE
Activity 4.3 End of project workshop				X	Bioversity

2.2.4. Sustainability of the action (max 3 pages)

Expected impact of the action

The results of the action are expected to contribute to the following changes in behaviour in the key target groups (Outcomes):

- **National and Institutional policies, strategies and programmes** are becoming supportive of NUS R&D.
- Significantly increased **sub-regional and regional collaboration** among scientists and institutions on value chain development of two priority crops: bambara groundnut and amaranth.
- **Scientists and leaders of NARS and universities** applying multi-disciplinary, multi-stakeholder R&D programmes on NUS in their programmes of work.
- **Universities and technical colleges** strengthen their curricula and teaching methods on value chain development of NUS crops, using multi-disciplinary, multi-stakeholder processes.
- **Leaders of regional & sub-regional agricultural bodies and educational networks** include and address NUS dimensions in African agricultural development frameworks and forums.

In the longer term these changes are expected to contribute to impacts that include:

- Increased production, consumption and commercialization of NUS crops, contributing also to the conservation of genetic resources on farms.
- A recognized role of NUS in enhancing the resilience of agricultural and social systems, including climate change adaptation.
- Increased income of rural households, processors and traders, many of which are women, from more efficient and equitable value chains of NUS crops
- Increased recognition of African NUS in agricultural, food and nutritional strategies and policies
- Enhanced resilience of agricultural systems and adaptation to climatic, agronomic and economic risks.

Dissemination plan and possibilities for replication

The project design has an in-built scaling out mechanism: National Action Plans for value chain upgrading of two crops of regional importance will be prepared in one country in each sub-region: Benin, Kenya and Zimbabwe. The findings will be presented to agricultural policy makers, universities and private sector stakeholders in sub-regional workshops in Year 2 and in a regional meeting in Year 3.

Similarly, the actions on studying NUS value chain education will be done in 3 subregions, with broad participation of key stakeholders. The results will then be synthesized at the African level. Curriculum guidelines will be prepared, published and disseminated within an Africa-wide university network, managed by one project partner, ANAFE.

All project partners will disseminate project results and outputs through their respective websites. By working with existing partner organizations and networks, such as ANAFE, there is an established infrastructure for sharing the result of the Action with ANAFE's 132 member universities in 37 countries. This will contribute to the integration of knowledge on NUS in educational curricula and research programmes and scaling out of lessons learned from the multi-stakeholder/innovation platforms and value chain upgrading. ANAFE has established an on-line repository of information to which all relevant information, manuals training materials etc. will be freely available.

At the national level, the three national partner universities/institutes will integrate project results into their institutional mandate of knowledge sharing for local and national development.

Risk analysis and contingency plan

The project is associated with relatively low risks. An earlier EU-ACP project (referred to above), has successfully tested the capacity building approach the proposed action will geographically expand to 15 additional countries. There are strong indications that there is a very high interest for the type of capacity building that the project offers.

The impact of capacity development, however, is always linked to the institutional environment to which trainees will return. The main risks are associated with inadequate institutional support such as leadership and resources, hampering application of new skills. Many NUS scientists also work in relative isolation, lacking colleagues to interact with. Such risks will be mitigated by stimulating Internet-based collaboration among teams of scientists using tools such as Moodle and Podio, to involve, inform and raise awareness in institutional leaders about the benefits of NUS, and to work towards embedding NUS and value chain education at the tertiary level.

The environmental risks are small. In fact, the project aims to counter genetic erosion by strengthening the conservation of NUS crops on farms by making them more profitable for small scale farmers to grow instead of relying solely on major commodities such as rice, wheat, maize and bananas. Unlike major commodity crops, NUS, not having been bred for productivity at the expense of the loss of other important natural characteristics, such as natural pest and disease resistance, have a lower environmental footprint as far as the need for pesticide applications is concerned.

The financial risks related to the sustainability of the action relate to the funding allocation in national research systems, and donor institutions, which is largely beyond the control of the project. However, forty years of supporting carefully selecting researchers and helping them to become established as scientists nationally and internationally by IFS has consistently shown that a proportion of them are able to source ambitious funding for their research interests.

The risks related to political instability and conflicts are low to medium. The project has geographical flexibility since regional actions could be organized in alternative countries. The political risks could involve political instability in one or more of three selected focus countries. Kenya is approaching an election, which could lead to instability but on the last such occasion, international programmes were not significantly interrupted. Zimbabwe has recently stabilized and bounced back somewhat after

years of economic decline and loss of human capital. That improved situation may not persist. At the regional level, the unstable political situation in Mali may hinder scientists' and policy actors participation in project activities.

Economic risks are limited, since the project is primarily dealing with low-input crops that do not require large investments. Four of the partners have a solid history of successful collaboration with the Applicant, the fifth partner, Africa University is new, but is an established well-regarded private university in Zimbabwe. All partners have included an accountant in their project team.

Upgraded value chains, functioning more efficiently could sustain their innovation platform approach through self-financing,

Social risks are small. Work on NUS strives to enhancing social cohesion and collaboration with stakeholders, building trust and equity. NUS are also often seen as 'women's crops', thus adding a positive gender effect when their value chains are strengthened.

Main preconditions and assumptions during and after the implementation phase.

The earlier EU-ACP project identified sub-regional priority species of NUS crops in need of enhancement through R&D and capacity development. The project found that there is a great interest in NUS research in Africa, but that existing research is highly fragmented. In particular, scientists lack lacking holistic value chain perspective and a view that their research is addressing constraints to successful NUS-based business. Their experience in working in teams with peers from other disciplines is limited, such as biophysical with socioeconomic scientists, or agronomists with nutritionists. There is also a generally weak ability to consult with stakeholders in the conceptualization of research, leading to research which is not sufficiently applicable.

In higher education institutions, earlier work of Bioversity International has shown that underutilized crops are not emphasized in agricultural education. Courses that address the special needs of and conditions for NUS value chain research are rare.

At the international level organizations such as FAO, and the European Plant Science Organizations and other actors are increasing their attention to NUS crops for a number of reasons, and UN has declared 2013 as the International Year of Quinoa, an Andean NUS crop that is recently commercialized.

Policies on climate change adaptation, and health & nutrition are taking an increasing interest in the role of NUS

Financial, institutional and policy sustainability after the action

This project primarily concerns developing young scientists' capacity to use a value chain approach in designing and implementing research-for-development activities on NUS crops. By training them in project proposal writing, their success-rate in funding their own research is increased. The scientists trained in the various workshops will also become trainers and they will be encouraged to conduct their own follow-up workshops, rendering these elements of the project self-sustaining. Through IFS support for their research projects both financial and mentoring and possibly through travel grants; these scientists have an opportunity to establish their careers nationally and internationally. Some of these scientists will become acknowledged experts in their fields and as such will access more ambitious funding for their departments and thus be in a position to train their own students and employees as well as expanding research inputs into NUS and their value chains,

The project deliberately works with existing networks, institutions and regional organizations, rather than establishing new ones. To this end ANAFE will disseminate the projects' products and processes for strengthening higher agricultural education via its own regional, sub-regional and national networks that cover 37 African countries.

As for the policy level advice, the project is working with the key African agriculture organizations, including FARA, ASARECA and CORAF/WECARD, who will assist in communicating results and informing policy instruments such as Science Agenda for African Agriculture

Environmental sustainability

One of the primary drivers behind R&D on NUS crops is the widely reported loss of agricultural diversity of these crops, and their wild relatives, associated with agricultural and demographic change, and a perception that NUS are 'poor men's' crops'. By building capacities and influencing policies and strategies that lead to the commercialization of NUS crops, their conservation on farms will also be enhances. Moreover, NUS crops are often grown in low-input systems, thus providing fewer negative environmental externalities compared to high-input systems.

2.2.5. Logical Framework

Please fill