FAO-EPSO Consultation

Plant Sciences for Sustainable Crop Production: Strengthening Partnerships between Europe and Developing Countries

Meeting Report

Food and Agriculture Organization of the United Nations
and European Plant Science Organization
25-27 June 2012, Rome, Italy

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EXECUTIVE SUMMARY

The Plant Production and Protection Division of the Food and Agriculture Organization of the United Nations and the European Plant Science Organization held a two-and-a-half-day consultation aimed at promoting partnerships between plant science and development interface to strengthen food and livelihood security. The consultation took place at FAO in Rome on 25-27 June 2012 and was attended by 70 high-level participants including policy makers, relevant networks, academia, foundations, public and private sector from both Europe and developing countries. The participating organizations included European Commission, European grant agencies, CGIAR Consortium Centres, research institutions, African Union, and agricultural networks. The purpose of the consultation was to increase plant science and development interactions for strengthening food security, with a focus on Sub Saharan Africa (SSA).

The objective of the consultation was to establish a mechanism for developing long-term partnerships for engaging plant sciences in sustainable crop production through:

- a shared view for opportunities and building long-term partnerships;
- development of three coordinated project proposals focused on the cassava value chain, maize and associated legume crops, underutilized and local fruit and vegetable crop diversity;
- preparation of elements for a White Paper framework for establishing a long-lasting partnership platform between Europe and developing countries.

Key recommendations of the Consultation were:

- Partnerships in plant sciences should be of mutual benefit to both developing and developed countries. It should be fostered through sharing of expertise and closer linkages for addressing common challenges and goals.
- Capacity development is the top priority in SSA to ensure appropriate agricultural development for current and future needs.
- There is a need for the research to be demand-driven, providing practical and locally adaptable solutions. The three pilot proposals could serve as initial models.
- Improved donor coordination in agricultural research and development is necessary to increase stakeholder involvement and decrease fragmentation of initiatives and unnecessary duplication.
- Policy awareness is critical and must be strengthened, in order to make agricultural research a priority in national programmes. FAO should continue to highlight this in policy foruMs
- EPSO has identified European institutes/universities/researchers to contribute and build long-term partnerships to generate impact and outcomes. FAO should provide support in the provision of oversight, coordination and links with policy.

Next steps for action as identified by the Consultation are:

a) Continue to build on and strengthen existing partnerships by sharing news, knowledge and ideas to close the gap between research outputs and farmer needs to increase plant sciences contribution to development. This should be a two-way

process between scientists from Europe and SSA through technology transfer, adaptive research, access to facilities and capacity building;

b) Expand the donor portfolio to involve a wider range of stakeholders, add to existing European initiatives (e.g. FACCE-JPI, COST-Programme) or create new Joint Programming Initiatives;
c) Increase networking opportunities through current or new ERA-Nets, and embed initiatives for sustainable intensification in the EU's Horizon 2020 Framework Programme;
d) Encourage review of donor guidelines for CGIAR's CRPs and other ongoing programmes to increase involvement of diverse European academic and research institutions as well as build partnerships for the three pilot projects.
e) Develop pilot project proposals within set timelines on the Cassava value chain, Maize and associated legume crops and Underutilized local fruit and vegetable diversity, to capitalize on the interactions;
f) Together with institutional partners and stakeholders, prepare an EU green paper on longer-term joint action on plant science for development. This would be followed by an EU white paper containing proposals for joint actions.

Further information is available at the FAO and EPSO websites:

http://www.fao.org/agriculture/crops/core-themes/theme/seeds-pgr/epso/en/

http://www.epsoweb.org/sustainable-crop-production-fao-epso-rome-it-june-2012

CONTEXT

The world's population is predicted to increase to 9 billion by 2050 and it is estimated that agricultural production has to double to achieve food security for all. Improvements are also necessary in the management of natural resources upon which food production depends. Compounding this, climate change increasingly affects the resilience of food production systems and their dependent communities, and is a major factor in natural resource degradation. The current approaches of intensive crop production face major challenges in meeting these needs; yields of major staple crops are declining, and there is increasing competition for land, water and genetic resources. There is a growing recognition for the need to focus on sustainable crop production intensification, which can improve productivity, help in resource use efficiency, while conserving and enhancing natural resources.

Approximately 75% of the world's hungry and poor live in rural areas and derive their livelihoods from agriculture. This is particularly true in Sub Saharan Africa (SSA), which is characterized by different ecological, social, and economic conditions. SSA faces significant challenges in eradicating extreme hunger and poverty; tackling these issues involves enhancing agricultural productivity, promoting diversification, improving infrastructure, institutional, technical capacities and financial resources.

Increasing and improving contributions from plant sciences can play a significant role in boosting crop improvement, research and development. Advances and breakthrough innovations can accelerate the pace of the urgent and necessary intensification of sustainable production. By building on existing demand-driven processes, research institutions and crop networks, both from the North and South, can play a very important role, particularly by bringing to bear innovations, funding, technologies and interdisciplinary skills. Technical advances should go hand in hand with policy decisions and frameworks, implementation of priority actions, and resources allocation for targeted investments. Although there are some strong public international agricultural research programmes, such as those undertaken by the CGIAR, a significant potential to mobilize more actors, resources and partnerships remains. There is a need to increase global efforts for improving staple and local crops that traditionally have received little interest but remain essential for food security. New and robust long-term partnerships in plant sciences research and development need to be fostered to address the complex technical problems in widely differing production conditions that currently lack critical mass in research, development and innovation.

Undoubtedly, the challenges of poverty, hunger and malnutrition faced by today's world grow more complex, interconnected and intertwined. Consequently, efforts to tackle such matters cannot be confined to solely one organization or institution. Solid partnerships with multilateral and multi-stakeholder initiatives at global, regional and national levels are necessary to achieve food security. Mainstreaming long-term bilateral and multilateral partnerships, both within public and private sectors, as well as with academia, into national and international developmental plans and programmes, could lead the way forward to improve food security, nutritional health and economies in all regions.

Plant sciences through partnerships

Since 2010, FAO, through its Plant Production and Protection Division (AGP), has pioneered an integrated approach to sustainable crop production intensification under the title 'Save and Grow'[1], engaging widely with multiple partners and stakeholders. Innovative partnerships that strengthen sustainable production intensification based on plant sciences can be valuable to: increase uptake of research and innovations; improve linkages along the impact pathway by connecting farmers and researchers; and developing more streamlined and coherent responses to current development issues. Significant progress and impact on the ground can be seen when interventions are undertaken collaboratively. Forging North-South and South-South partnerships could benefit national research systems by bringing the results of research undertaken in the developed world to bear on the problems of the developing world and *vice versa*.

European universities and research institutions, with their strong focus on plant sciences technology and innovations can provide multiple opportunities to increase the role of plant science for development. With a solid research network, they are at the forefront of scientific advancements and bring novel opportunities through their engagement and partnerships. The European Plant Science Organization (EPSO) is a representative network of over 200 university and academic institutions with a prominent role in plant sciences with expertise ranging from fundamental plant biology to applied crop research, and with a focus on problem solving for agriculturally and economically important crops, pasture and forest species. Through structured partnerships, they can promote plant sciences, access to technologies and help streamline multiple European donor-led activities in the interest of food and livelihood security.

Purpose of the Consultation

As a first step, AGP organized a consultation together with EPSO, bringing together decision makers, researchers and members of regional and sub-regional fora from Europe and those from SSA and other developing countries. The purpose was to identify a common way forward for shaping long-lasting linkages in plant sciences for sustainable production intensification, and define a set of pilot activities for initial collaboration. The main objectives of the consultation were to:

1. Establish a platform for long-term partnerships between Europe and developing countries in plant sciences to address current challenges in sustainable production intensification.
2. Initiate the development of partnership-based pilot project proposals for crops important to African food security. These are for: a) cassava value chain, b) maize and associated legumes, and c) use of underutilized local fruits and vegetables. The partnership proposals will promote bilateral/multilateral collaborations between European and SSA research institutions, universities, and networks for increasing scientific collaboration, technology transfer and capacity improvement.
3. Gather inputs for development of a white paper to provide a framework for long-term partnership between Europe and SSA countries, and other developing countries through a participatory approach involving key stakeholders.

[1] FAO. 2011. **Save and grow**. A policymaker's guide to the sustainable intensification of smallholder crop production. Rome, Italy. Available at *www.fao.org/ag/**save-and-grow**/*

Preparatory meetings

The FAO-EPSO Task Force led by Ms Kakoli Ghosh, AGP-FAO and Ms Karin Metzlaff, EPSO, coordinated the preparation for the consultation. Participants included policy makers, senior academics and researchers international and national research centres, donor agencies, private sector, farmer organizations and regional and sub-regional crop networks from Europe, SSA and other regions. Over 70 delegates attended the meeting. The participation of EPSO members was self-funded and those from developing countries were supported by FAO, GlobalHort and APAARI. The meeting agenda is provided in Annex 1, the list of participants in Annex 2.1 and members of the Task Force in Annex 2.2.

Working Groups were set up for developing the briefing notes and coordinating the sessions on maize and associated legumes, cassava value chain and underutilized crops (see Annex 4). Documents and presentation from the Consultation are available at http://www.fao.org/agriculture/crops/core-themes/theme/seeds-pgr/epso/en/

PROCEEDINGS

Mr Gavin Wall, Director OiC, AGP, welcomed the participants on behalf of Mr Modibo Traore, Assistant Director General, FAO. He stressed the importance of sustainable agriculture growth through an integrated approach for combating the dual challenges of food insecurity and depletion of natural resources. He emphasized the importance FAO attaches to facilitating innovative partnership strategies for assisting member countries in attaining the Millennium Development Goals. Mr Wall thanked EPSO for taking a lead in this area and pointed out that market and value chain development and sustainable use of crop diversity through demand-driven research, and building of local capacities, were essential for achieving sustainable crop production intensification in the African context.

Mr Alessandro Villa, on behalf of the European Union (EU) delegation in Rome, welcomed the initiative as timely and necessary. The EU was particularly supportive of sustainable crop production intensification through an integrated approach. Mr Villa emphasized that partnerships must be mainstreamed into food security and development plans and programmes. He hoped that the outputs of the consultation would further strengthen FAO-EU collaboration for assisting developing countries in increasing scientific and research collaborations.

Mr Charles Spillane, on behalf of EPSO, joined in welcoming the delegates and thanked FAO for facilitating the dialogue between EPSO and partners in Africa. He noted that EPSO's strength lies in the high level of expertise of its members and they were keen to develop long-lasting partnerships that would increase the contributions of plant science to food security issues. He felt that developing demand-driven projects jointly from the start was a proactive approach and could provide opportunities to share expertise and drive research and development. Mr Spillane gave an overview of the tasks ahead during the meeting and wished for a successful start on the partnership development process.

Ms X. Yao, Director, Office of Knowledge Exchange, Research and Extension, FAO, in her opening remarks welcomed the EPSO partnership initiative and noted that it provided a

good example for furthering the objectives of the Tropical Agriculture Platform (TAP) - a new multi-stakeholders initiative agreed by G20 in 2011. She also emphasized the need to develop capacity for creating an enabling policy environment, building institutional strength and local technical capacities.

Session I chaired by Ms Janet Edeme, African Union (AU) focussed on Global Linkages for Sustainable Crop Production

Ms Janet Edeme introduced the eminent speakers, who discussed the importance, experiences, demands and opportunities of linkages and collaborations at the international level. Mr Timothy Hall, Director General, Research & Innovation, European Commission, highlighted some of the main opportunities from Europe, such as the Seventh Framework Programme for Research and Technological Development and Horizon 2020 (currently under development) that could provide support to agricultural research in developing countries. Mr Ajit Maru of the Global Forum on Agricultural Research (GFAR) elaborated the role it plays in fostering partnerships and agreed that the EPSO initiative would facilitate agricultural research and development needs, stimulate investment and strengthen the Global Conference on Agricultural Research for Development (GCARD) process. Mr Kenton Dashiell, Deputy Director General, Partnership and Capacity Building, International Institute of Tropical Agriculture (IITA) continued the theme by emphasizing the value of win-win, functional partnerships as a key to obtaining mutually beneficial outputs.

Ms Edeme, in summarising the session, noted that successful partnerships are two-way processes. African stakeholders have the important responsibility of seizing opportunities presented by the European partners to strengthen dialogue and appropriate actions at national levels.

Session II, chaired by Mr Jean-Christophe Glaszmann, CIRAD, focussed on priorities and perspectives of Regional and national programmes

The speakers, Mr Philippe Petithuguenin of the European Initiative for Agricultural Research for Development (EIARD) provided the European regional perspective while Mr Hari Shankar Gupta, Director General, Indian Agriculture Research Institute, India, Mr Hugo Perales, Department of Agroecology, El Colegio de la Frontera Sur, Mexico and Ms Claudia Herok, Division Bio-Economy, Federal Ministry for Education and Research of Germany and Ms Amanda Reed, of Biotechnology and Biological Sciences Research Council (BBSRC), provided some priorities and perspectives on the national agriculture research and development and investment strategies.

Mr Petithuguenin noted that EIARD's main emphasis was on innovation, governance and multi-stakeholder approaches with special focus on nutrition and ecological intensification. The EPSO initiative could provide new opportunities for EIARD, the largest grouping of donors to the CGIAR, to support African plant science and research at national and regional levels.

Mr Gupta noted that although India had achieved food security through Green Revolution packages, malnutrition remained a major issue. Additionally, there are problems of water

scarcity, soil health depletion, and yield gaps, all exacerbated by climate change. Consequently, present agricultural research issues need to be interdisciplinary to increase nutritional security, breaking the yield barrier, and improving soil health and water availability. He also highlighted the Indo-African cooperation as a successful example of bilateral partnerships.

Mr Perales provided an overview of linkages between research and national programmes for crop production in Mexico. The country has had low agricultural growth rates since the 1990s, and more than 70% of the farmers are subsistence producers. The challenges faced by small holders include diminished assistance, unfavourable government policies and limited linkages with research institutions and universities. He concluded by highlighting the need to refocus agriculture in Mexico with new policies, partnerships, and institutional structures that strengthen local small holders in promoting sustainable crop production intensification.

Ms Herok elaborated on Germany's inclusive approach to plant research innovation and knowledge use. Germany is developing innovative solutions for regionally adapted and sustainable food systems in Africa using a demand-driven, systemic approach. A better coordination of national programmes was deemed necessary for the development of joint programmes and for making calls for new projects. This sentiment was echoed by Ms Reed from the BBSRC, which is the largest funder of research in the UK and promoter of an inclusive approach to innovation and knowledge use in plant research. It focuses on multi-donor initiatives, encourages North-South collaboration and uses scientific excellence, development relevance and capacity building as key assessment criteria.

Mr Glaszmann thanked the speakers for sharing valuable information and facilitated discussions among the participants. He noted that the emerging common themes both from country and donor perspectives were the increasing importance and need for interdisciplinary research, the building of multi-local partnerships and improvement of policy engagement and investment for resource use efficiency.

Session III chaired by Mr Diran Makinde, New Partnership for Africa's Development, focussed on means and opportunities for building long-term partnerships and capacities for sustainable crop production for increasing impacts and tangible benefits

Ms Metzlaff, EPSO, outlined the expected outputs from the discussions in the WG. She elaborated on the mechanisms necessary for building long-term partnerships, identifying joint research needs, mapping impact and identifying practical joint action roadmaps. She sought inputs for the preparation of a white paper from EPSO on establishing a long-lasting partnership platform between Europe and developing countries for plant sciences. Participants suggested that there should be time-bound commitments to link research with the needs of African partners; raise resources jointly; provide access to technologies; and, support infrastructure and capacity building. Ms Metzlaff proposed that a first draft would be prepared together, elaborating the scope and opportunities, with specific recommendations and subsequently followed up in the EU white paper.

For increasing impacts and benefits, Mr Stefano Padulosi, Bioversity International, Mr Emilio Rodríguez-Cerezo, Joint Research Centre-Institute for Prospective Technological Studies (JRC-IPTS) and Mr Sander van Opstal, Coordinator, European Research Area-Agricultural Research for Development (ERA-ARD) presented the roles of their organizations and through example of various projects, opportunities and costs for building long-term partnerships. Mr Padulosi stressed that the key to success in working with neglected and underutilized Species (NUS) was by building mutual trust between researchers and local networks, and ensuring appropriate linkages with farmers and custodians. Mr Rodríguez-Cerezo noted that uptake of modern tools and technologies associated with plant breeding, such as agro-infiltration and reverse breeding, required long-term collaboration and investments. Several plant breeding needs for EU food security/bio-economy not covered by the private sector were clear opportunities for the public sector and public-private partnerships. Mr Opstal explained the role of ERA and gave examples of its role in building greater synergy in Europe for science, capacity building and partnerships. He stressed the need to develop a common North-South research agenda for revitalizing breeding programmes for the benefit of Africa.

In ***Session IV***, Ms Joyce Mulila-Mitti, FAO and Mr Jean-Christophe Glaszmann, CIRAD, further elaborated on sustainable crop production in Africa. Ms Mulila-Mitti described FAO's priorities in Africa on cassava and maize and noted the need for research and innovative interventions. She mentioned that the Second Global Plan of Action, agreed in 2011, was a key instrument for Africa to ensure better conservation, management and use of their plant genetic resources, but that its implementation was highly variable and required collective action.

Mr Glaszmann then discussed some of the linkages and synergies between actors in the European plant research arena, the agreed indicators, and the urgency and relevance of research for development and highlighted the outputs of an earlier EPSO meeting on the subject. He emphasized that incorporating biodiversity issues in the innovation chain together with research in genome sequencing and molecular breeding could be "game changers" for promoting sustainable production systeMs

Outcome of the Working Groups

Ms Kakoli Ghosh, AGP, FAO, moderated the plenary discussion on the outcome of the discussions of the three Working Groups on cassava value chain, maize and associated legume crops and use of underutilized/local food and vegetable crops.

Working Group on Cassava value chain (WGC) deliberations were presented by Mr Chikelu Mba, AGP, FAO. He outlined the key features of cassava as a crop, key constraints and how these are currently addressed. The group recognised the overall limited expertise in research in cassava in Europe and emphasized the need to need to leverage technical inputs from existing platforms (e.g. Global Cassava Partnership for the 21st Century (GCP21)). The main areas of partnership could be identification of traits for making cassava commercially viable, increasing its role in maize and groundnut cropping systems, possible use as a cash crop for biofuel production and improvement of the nutritional quality. For a specific proposal development, the focus should be on strengthening capacities, preferentially targeting in-service training of scientists and farmer-specific interventions. One of the challenges was the

need to assess how to boost cassava research and development activities as part of donor investment of European countries.

Fig.1. Discussions in the Working Group on Cassava value chain.

As a next step, WGC will:

- Identify stakeholders and local scientists and institutions;
- Link with FAO regional project on cassava to identify research gaps and to target the research towards those needs;
- Link with ASARECA, who are already working in a network and have key scientists, and CGIAR on Collaborative Research Programme on roots and tuber crops;
- Strategize for tapping into the EC's Horizon 2020 Research and Innovation funding;
- Ensure relevance, secure buy-in and pool resources by leveraging existing frameworks, including CAADP and Agricultural Investment Plan, regional networks (CORAF, ASARECA), regional economic development entities, and FAO's TAP.

Working Group on Maize and associated legume crops (WGM) was presented by Mr Noel Ellis, IBERS, UK. He gave an overview of the maize-legume cropping system and defined the scope of the intended proposal. It was emphasized that the gaps in capacity (number of plant scientists in Africa), training (programmes and projects) and trait requirements (growth, seed quality) needs to be addressed. The WGM recommended partnerships to complement existing programmes, covering institutional and individual needs, and be relevant in covering costs and include private sector involvement.

The WGM felt that for developing a project proposal, it would be essential to define the type of legumes required and this should be explored using gap analysis. As very few projects

specifically address maize-legume systems, including in CGIAR, there is an acknowledged gap in this area. Enabling the policy framework and the participatory environment was essential in Africa to facilitate the change from maize-only systeMs The emergence of a stronger poultry sector could create a larger need for legumes, especially soya beans. For developing a project in this area, the nutritional benefits of such systems should be highlighted, seed market for legumes expanded and the whole seed value chain assessed. The possibility of adapting a variety of rotation systems as opposed to one countrywide system should be considered. There was also a view that maize/legume breeding should take into account their growth as mixtures rather than monocultures, so that new breeding approaches may be required.

Fig.2. Discussions in the Working Group on Maize and associated legumes.

As a next step, WGM will:

- Identify and link with key legume programmes in West Africa, such as the CORAF-WB project in West Africa, currently under development;
- Develop collaborative work (for instance, with relevant programmes in Brazil, including the programmes on common bean, soybean and sugar, where some exchange with Africa has already started);
- Focus on Client-Oriented Breeding, identifying target traits through participatory research
- Promote investment in developing legume systems, selection for performance as mixtures/alternative cropping systems and develop supporting policies.

Outcomes of the Working Group on Underutilized fruits and vegetables (WGU) were presented by Mr Ulrich Schurr, Forschungszentrum Julich, Germany. He highlighted the

diversity of challenges in this area including the heterogeneous group of species and their environments, role of countries, stakeholders, and technologies. He noted the Working Group explored the various options for specific improvement given the high potential and the significant impact they can have in developing sustainable food systeMs It was proposed that the project proposal should address topics such as the conservation of diversity, quality of seeds, evidence-based studies on nutritional value options, and in the context of urbanization and food systeMs Other considerations should include seed sector development, genebank management, addressing post-harvest losses (in vegetables and fruits), sanitation and (grey) water utilization, and socioeconomic issues.

Fig.3. Discussions in the Working Group on Underutilized fruits and vegetables

As a next step, WGU will:

- Conduct a mapping-analysis to identify past and current initiatives and identify and shortlist priority crops according to country;
- Develop efficient and effective post-harvest systems including commercialization and promotion of consumption;
- Work together to identify and prioritize major constraints to the development of UFVs value chain;
- Prepare a project proposal for presentation during the International Conference on Neglected and Underutilized Species to be held in Accra, Ghana 2013.

Ms Ghosh facilitated discussions following the Working Group presentations. Participants raised the following points:

- It was essential to ensure follow up on project proposal development post-meeting in order not to miss this opportunity for partnerships.
- There was a gap between the research topics of importance in the African context and those that are undertaken by European counterparts. For successful technology transfer, there is a need to fully understand the local demands and needs.
- Scientific exchange and training offer strong opportunities, but it is important to develop a long-term approach. Developing sustainable crop production systems needs interdisciplinarity and adaptation, particularly to tackle rapid changes in climatic

conditions. EPSO was requested to coordinate possibilities for engaging with experts in soil, pest and water management, as appropriate.

- Developing local seed systems in Africa is a necessity with regard to markets and value chains. Despite the high demand for seeds of local crops, there is little infrastructure to support it. Therefore, it is necessary to consider this when developing the project proposals.
- With regards to partnerships, the representatives from Brazil and Philippines offered exchange of training and capacity building.

Session V moderated by Mr Charles Spillane was the Round Table on Priorities for an integrated approach that can leverage plant science research outcomes and participatory technology development for improving food security in Africa

The Round Table panellists discussed priorities for integrated approaches to leverage plant science research outcomes and participatory technology development for improving food security in Africa. The panellists were:

- Christine Andela, COSADER
- Arnaud Goolaerts, ERA-CAPS, BE
- Timothy Hall, EC
- Jörg Lohmann, EIARD & GIZ DE
- Emmanuel S. Monyo, ICRISAT
- Eric Yirenkyi Danquah, WACCI
- Wilhelm Gruissem, ETH Zurich
- Frederic Lapeyrie, CRAI, FR
- Hodeba Jacob D. Mignouna, AATF
- Ruth Ssebuliba, AfSTA

Three main priorities were identified as main outcomes of the discussions held during the Round Table.

1. <u>Local solutions:</u> Plant science research needs to be translated into action in a practical way that is directly useful to local communities, farmers and consumers. From the outset, the research needs to be demand-driven from both producers and consumers. This could include use of most effective science for screening of local germplasm to identify or develop the best local varieties, the selection of varieties suitable for different agroecological regions and farming systems, and practical possibilities for improvement of the supply-chain for providing higher quality varieties and seeds to farmers.

2. <u>Capacity development through partnerships</u>: European and African researchers need to liaise on the necessary tools and approaches for efficiently advancing sustainable production intensification, in the first instance on maize, legumes, cassava and underutilized vegetables. The private sector also has a role to play in contributing to food security, health and education. Greater dialogue is needed between research/academic organizations, development institutions and private companies, with impact-oriented local projects and partnerships established. Civil society and farmer organizations can be an essential link between research institutions, farmers and farmer organizations, and should be included in regional and global partnerships. Fragmentation and duplication of research interventions should be avoided and partnerships should be built on existing interventions for greater and more sustainable long-term impact. Further information exchange will be initiated on possible areas of partnerships on a regular basis through programmes such as COST.

3. Policy and governance: Awareness-raising is required, focused on policy makers and interest groups of strategic importance for accelerating plant science for development. This will contribute to agricultural research on crops and forestry being prioritized in national programmes, and increase the extent of engagement with local stakeholder groups. Common research priorities and goals should be discussed and decided in a participatory and collaborative manner that is coherent with national or regional level on policies (including national plans, frameworks and regulatory systems). There was a particular need to ensure that these processes are encouraged by member governments to strengthen the CAADP process.

4. International funding: Restrictions for building long-term partnerships need to be overcome to generate impacts that are more substantial and outcomes. Donor guidelines should be reviewed to better link farmers to research programmes. Existing initiatives should be built upon (e.g. FACCE-JPI) or new Joint Programming Initiatives could be created for the development of long-term partnerships. Networking activities in Europe (COST-Programme) will assist in reducing the fragmentation in European research investments and opening plant sciences in Europe to demand-driven research. Opportunities for embedding EU programmes such as Horizon 2020 and ERA-Nets, can expand communication and raise awareness of this initiative. FAO should explore and expand partnership opportunities and help raise resources for supporting them in other developing countries.

NEXT STEPS AND CONCLUDING REMARKS

The following action points were identified as next steps:

- Develop pilot proposals through the Working Groups with the aim of presenting it to EU call for proposals;
- Harmonise with national-level partnership-building mechanisms for plant sciences for development across EU member states;
- Foster transnational collaboration in plant sciences and development between SSA and Brazil, India and SEARCAS to build upon this initiative;
- Initiate further information exchange on possible areas of partnerships on a regular basis. Expand communication and raise awareness of this initiative to expand involvement. Opportunities could be at the EIARD meetings, inputs into the GCARD II and for the TAP;
- EPSO to work jointly with FAO to explore and expand partnership opportunities and resources for supporting these in developing countries;
- EPSO to engage with CGIAR Consortium to indicate the interest of EPSO members in strengthening collaboration with the CGIAR, both in research and in capacity development.

Closing the meeting, Ms Metzlaff and Ms Ghosh, on behalf of the FAO-EPSO Task Force, thanked all the participants for their tremendous participation and continuous engagement. They recalled that the main objective of the consultation was to increase plant science and development interactions for strengthening food security. Although the challenges to achieving food security were significant, strong long-term partnerships were the best

available pathway to deliver impact. They stressed that the Consultation presented many opportunities to encourage donors to channel resources for developing a joint programme of work in plant sciences for sustainable production. The consultation was the first step and FAO, EPSO, partners and participants should take it forward and build on the recommendations.

ANNEX 1. Meeting Agenda

FAO-EPSO CONSULTATION

PLANT SCIENCES FOR SUSTAINABLE CROP PRODUCTION: STRENGTHENING PARTNERSHIPS BETWEEN EUROPE AND DEVELOPING COUNTRIES

25-27 June 2012
Rome, Italy

Objectives of the workshop:

- Shape long-term partnerships and linking stakeholders in plant sciences for sustainable intensification of agricultural production
- Define a set of pilot projects for initial collaboration in Sub Saharan Africa
- Develop a white paper on establishing partnerships between Europe and developing countries

DAY 1	**25 JUNE, 2012, SHEIKH ZAYED CENTRE, FAO, ROME** **Rapporteurs:** C. Spillane, L.B. Nilsen
OPENING SESSION	**WELCOME AND REMARKS**
11:00 – 13:30	*Participant registration*
13:30 – 14:00	**Introductory remarks** Gavin Wall, Director, Plant Production and Protection Division (AGP), FAO **Opening remarks** • Modibo Traore, ADG, Agriculture Department, FAO • Laurence Argimon-Pistre, Ambassador, EU Delegation, Rome • Charles Spillane, EPSO • Xiangjun Yao, Director, Office of Knowledge Exchange, Research and Extension (OEK), FAO
SESSION I	**GLOBAL LINKAGES FOR SUSTAINABLE CROP PRODUCTION: OPPORTUNITIES AND ALLIANCES** **Chair:** Janet Edeme, African Union
14:00 – 14:15	**Strategic opportunities for sustainable crop production: FAO perspective** Gavin Wall, Director OiC, AGP, FAO
14:15 – 14:30	**Increasing scientific collaboration and partnerships: Opportunities from Europe** Timothy Hall, European Commission (EC), DG Research & Innovation

14:30 – 14:45	**African national agricultural research and extension system for the 21st century: Sierra Leone's Experience** Alfred Dixon, DG, Sierra Leone Agricultural Research Institute Sierra Leone
14:45 – 15:00	**A new global agricultural research system: The road to GCARD II** Harry Palmier, Senior Partnerships Expert, Global Forum on Agricultural Research
15:00 – 15:15	**Working together with national agricultural research and extension systems in Africa: CGIAR's experience** Kenton Dashiell, DDG, Partnership and Capacity Building, International Institute of Tropical Agriculture (IITA)
15:15 – 15:45	*Coffee Break*
SESSION II	**NATIONAL PROGRAMS AND SUSTAINABLE CROP PRODUCTION: PRIORITIES AND PERSPECTIVES** **Chair:** Jean-Christophe Glaszmann, CIRAD
15:45 – 16:00	**The European Initiative for Agricultural Research for Development (EIARD): Coordinating policies to facilitate partnership and increase impact** Philippe Petithuguenin, Senior Advisor, EIARD, EC
16:00 – 16:15	**Role and emerging partnerships for crop improvement in India** Hari Shankar Gupta, DG, Indian Agriculture Research Institute, India
16:15 – 16:30	**An inclusive approach to plant research innovation and knowledge use: Experience of Germany** Claudia Herok, Division Bio-Economy, Federal Ministry for Education and Research, Germany
16:30 – 16:45	**Linkages between research and national programmes for crop production in Mexico** Hugo Perales, El Colegio de la Frontera Sur, Mexico
16:45 – 17:00	**An inclusive approach to plant research innovation and knowledge use: Experience of the UK** Amanda Reed, Biotechnology and Biological Sciences Research Council, UK
17:00 – 17: 30	**Discussion**
18:00	*Departure from FAO for Group Dinner at Hotel Aran Mantegna, Rome*

DAY 2	26 JUNE 2012, HOTEL ARAN MANTEGNA, ROME
SESSION III	**BUILDING LONG-TERM PARTNERSHIPS AND CAPACITIES FOR SUSTAINABLE CROP PRODUCTION: INCREASING IMPACTS AND TANGIBLE BENEFITS** **Chair:** Diran Makinde, New Partnership for Africa's Development **Rapporteurs plenary:** C. Spillane, L.B. Nilsen
9:00 – 9.15	**Setting the scene** Karin Metzlaff, Executive Director, European Plant Science Organization
9:15 – 9:30	**Building capacities and partnerships through local networks: Lessons from Asia and Latin America** Stefano Padulosi, Senior Scientist, Bioversity International, Italy
9:30 – 9:45	**European Commission Joint Research Centres' activities supporting agricultural research and innovation with developing countries** Emilio Rodriguez Cerezo, Joint Research Centres, EU
9.45 – 10:00	**Building capacities and partnerships for agriculture science and technology: Lessons from ERA-ARD** Sander van Opstal, Coordinator, European Research Area - Agricultural Research for Development (ERA-ARD) & NL
10:00 – 10:30	*Coffee Break*
10.30 – 18:00	*Lunch and Coffee will be provided during the course of the day.* **Three parallel Working Groups:** **Working Group (WG) 1: Cassava value chain** **Chair:** Wilhelm Gruissem, ETH, Switzerland **Rapporteur:** Chike Mba, FAO, Italy **Working Group 2: Maize and associated legume crops** **Chair:** Noel Ellis, IBERS, UK **Rapporteur:** Bruce Osborne, UCD, Ireland **Working Group 3: Underutilized local fruit and vegetable crop diversity** **Chair:** Remi Nono-Womdin, FAO, Italy **Rapporteur:** Ulrich Schurr, Forschungszentrum Jülich, Germany ***Topics for Working Group discussions:*** • Increasing scientific collaboration, research and development • Improving education based on needs-driven research • Advancing participatory technology development and access • Recommendations for white paper and the specific project proposals of the Working Groups

DAY 3	27 JUNE 2012, HOTEL ARAN MANTEGNA, ROME **Rapporteurs:** J.C. Glaszmann, L.B. Nielsen
SESSION IV:	**PRESENTATIONS ON PROJECTS AND PARTNERSHIPS** **Chair:** Ulrich Schurr, Director of the ICG-3 Phytosphere Institute, Germany
9:00 – 9 :15	**FAO role and technical assistance for sustainable crop production in Africa** Joyce Mulila-Mitti, Plant Production and Protection Officer, FAO
9.15 – 9.30	**EPSO assistance for sustainable crop production in Africa** Jean-Christophe Glaszmann, Head, Genetic Improvement and Adaptation of Mediterranean and Tropical Plants Joint Research Unit, CIRAD
9:30 – 10:30	**Cassava value chain Project: Report of WG1** Presentation (15min) and Discussion (45min)
10:30 – 11:00	*Coffee Break*
11:00 – 12:00	**Maize and associated legume crops Project: Report of WG2** Presentation (15min) and Discussion (45min)
12:00 – 13:00	**Underutilized local fruit and vegetable crop diversity: Report of WG3** Presentation (15min) and Discussion (45min)
13:00 – 14:00	*Lunch*
SESSION V	**EMERGING OPPORTUNITIES, NECESSARY ACTIONS AND RECOMMENDATIONS** **Moderators** Charles Spillane, Professor of Plant Science, NUI Galway, Ireland Mike Robson**,** Senior Officer, AGP, FAO
14:00 – 15:30	**Round Table:** Priorities for an integrated approach that can leverage plant science research outcomes and participatory technology development for improving food security in Africa
15:30 – 16:00	**Next steps and closing remarks** • Kakoli Ghosh, Team Leader, Seeds and Plant Genetic Resources, AGP, FAO • Karin Metzlaff, Executive Director, EPSO
16:00	*Departure*

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2.2. FAO-EPSO Task Force

Plant Sciences for Sustainable Crop Production: Strengthening Partnerships between Europe and Developing Countries

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ANNEX 3: Briefing Notes
3.1 Briefing Note for the Working Group on Cassava Value Chain in Sub Saharan Africa

Note: This Briefing Note was prepared by a committee consisting of Wilhelm Gruissem (ETH-Z, Switzerland), Chike Mba (FAO), Christian Nolte (FAO) and Valerie Verdier (IRD, France) as an input for workshop discussions. It does not reflect the views of FAO, EPSO or the organizations in the FAO-EPSO Consultation. Selected examples on the cassava value chain are presented below.

1. Current status of cassava value chain in developing countries

Cassava is a major staple crop in Sub Saharan Africa for many smallholder farmers. For about 40% of Africans, cassava is a major source of calories. The crop is capable of producing some yield even in degraded soils, it is relatively drought resistant, and it can be stored easily in the field. Such attributes indicate why subsistence farmers rely on it for food security, particularly in West, Central and East Africa. Cassava processing is also a major source of income for women in these regions. However, subsistence farming does not by far tap the potential of the crop.

It has long been established that a more efficient production and commercialization of cassava holds enormous economic potential for African countries. West, Central and East Africa already account for about 121 million metric tonnes (>50%) of the global cassava production and yet average cassava yields (about 9 t/ha) in these regions are less than half the yields of major Asian and Latin American producers. In Africa, cassava production is mostly without fertilizer and irrigation.

To increase the commercial production of cassava requires a re-orientation of production along a value chain approach, a fact that has been acknowledged by the Regional Conference for Africa. The Conference commanded a pilot initiative of the Africa Results Task Force for value chain development of cassava in DR Congo and Ghana. Several individual countries, such as Nigeria, Ghana, Cameroon and Sierra Leone have equally developed policies and programs aimed at value chain development.

New disease-resistant and higher-yielding germplasm and varieties, more efficient distribution of improved planting material, better pest and disease management techniques, reducing post-harvest losses and more intensive cropping system management are preconditions for a substantial increase in production. At the same time, an intensification of production must be based on sustainable management techniques that use internal ecosystem services and external inputs, such as fertilizers, efficiently and minimize negative effects on the environment.

However, farmers will only be willing to undertake these investments if they have access to markets and information and if post-harvest technologies exist that would lead to a diversification and higher value of market produce. It is mainly for these reasons that a coherent value chain approach must be pursued.

If research and development efforts to boost commercialization of cassava production are undertaken in collaboration with clusters of smallholders, it is to be expected that spin-off effects on household level production will incur. On the other hand, if large-scale production of cassava for commercialization purposes is anticipated in countries, it must be assured that these activities are not undertaken at the expense of food security aspects of cassava production. It is important to simultaneously improve and sustain production systems that feed resource-poor smallholders in SSA.

2. Past and ongoing large-scale initiatives on cassava production

Although cassava, as other root and tuber crops, has benefitted less from research and development efforts than have cereals, there have been major efforts in the recent past to change that. Notably IFAD has funded large projects on root-and-tubers, focussing on germplasm improvement and dissemination in several countries of West and Central Africa. In 2000, FAO and IFAD initiated a Global Cassava Development Strategy in collaboration with IITA, CIAT, CIRAD, and NRI.

In 2003, NEPAD and IFPRI launched a Pan-African cassava initiative with workshops in Nigeria, Uganda and Malawi. Nigeria and Ghana have special presidential initiatives that aim at transforming cassava production into a major commercial crop by creating strong supply chains for industry to produce high quality flower, starch, dried chips and ethanol. In particular, Nigeria intends to double its production in the next 4 years by increasing cassava yield from ~12 t/ha to ~25 t/ha and to become a major national and international supplier to industry.

The African Development Bank is financing a large project on strategic crops, including cassava, which is implemented by IITA in DR Congo, Sierra Leone, Tanzania, Nigeria and Zambia. The focus of this project is *inter alia* to:

- develop, test and evaluate new high-yielding varieties with improved nutritional quality, pest and disease resistance, and industrial and other end-use traits
- establish seed systems including seed multiplication farms and contract seed farmers
- evaluate best-bet crop management options for sustainable intensification and yield stabilization
- evaluate and promote best options for mechanized production
- support value chain development

The newly devised CGIAR research programs (CRP)[2] address cassava problems in different CRPs. The two most important for SSA are the system program CRP 1.2 for the humid tropics and the commodity program CRP 3.4 on roots, tubers and bananas.

Within CRP 3.4, cassava will receive the largest investment of the program with ~54 million USD, representing 29% of the total program budget for 2011-2013. Nearly 46% of the cassava budget will be spent on development, conservation and dissemination of improved planting material. Lack of access to quality planting material appears to be the single most important limiting factor contributing to the observed yield gap in developing countries.

[2] http://www.cgiar.org/our-research/cgiar-research-programs/

Another major investment will be done in the area of pest and disease management, receiving 11% of the cassava budget. About 7% of the cassava budget will be allocated to developing tools (such as crop modelling) for more productive, ecologically robust cropping systeMs

The development of intensive and sustainable cassava production systems will be targeted in collaboration with CRP 1.2, aimed at the development of integrated systems for the humid tropics. CRP 1.2 tries to re-adjust the over- emphasized commodity focus of R&D projects in the past towards a more system-oriented approach by integrating market-level innovation with production system intervention. A specific research objective is to develop an integrated research program on sustainable intensification of rain-fed smallholder farming systems in the humid and sub-humid tropics. Although cassava is not specifically targeted in CRP 1.2, it is an important system component and intercrop with potential for improvement. One such example is the development and testing of an improved cassava-legume system in the Eastern Province of DR Congo that increased cassava yields by 30-50% and doubled the legume (local common bean) yield by modifying crop varieties, applying modest amounts of fertilizer and improving the intercrop management.

3. Summarise current status of cassava in countries of SSA.

Cassava is one of the major staple food crops for food security of smallholder farmers in the humid and sub-humid zones of SSA. The crop is generally produced without any external inputs and often intercropped or after more resource demanding crops, such as maize and grain legumes.

Most cassava germplasm has been developed in the past for these conditions. The TMS varieties released by IITA were bred for resistance against the most common pests, such as mosaic virus, bacterial blight, the mealy bug, and the green mite. They produced 40% higher yields at the farm level than local varieties when grown without fertilizer, as established by the COSCA study in Nigeria, and attained their peak yield around 13-15 months after planting as compared to 22-24 months for local varieties. There are the now newer TME varieties that have cassava mosaic disease (CMD) resistance because the TMS varieties were not very resistant

Access of the vast majority of farmers to improved germplasm is limited, although major improvements have been made in recent years through large-scale dissemination projects. However, these efforts were targeted towards increasing food security of smallholders and not necessarily to improve commercialization of production.

Yield levels on farm under these conditions are usually low with less than 10 t/ha of fresh roots. Yet yields can attain 25-30 t/ha under intensive management and appropriate input use. Most of the cassava production is in small quantities on very disaggregated farms that are only accessible by feeder roads of poor quality, notably in the rainy season.

There are two objectives that need to be accomplished: 1. Improved and more nutritious varieties for smallholder farmers (but also the population in general as well as animal feed— these need not necessarily be high-yielding varieties) and commercial traits, such as yield

and starch modifications. 2. Time to market is essential (i.e., improved feeder roads), unless we can convincingly decrease post-harvest physiological deterioration.

The crop is frequently processed. For example already in the late 1990s, about 60% of cassava in Ghana was sold as a cash crop. Even in Nigeria (the largest cassava producer globally and apart from Southern Africa the most industrialized country in SSA) it is estimated that about 90% of cassava production is processed into food. More than 50% of processing is done in individual households with only a few large-scale processors in the country. The steady supply of high quality products is the major bottleneck for new major investment into a cassava processing industry. In many countries this is the biggest problem for processors. In good years there is an overproduction of cassava, in others not enough. This is a major problem for any processing industry.

There is nevertheless a usually dynamic market-oriented cassava sector for food in peri-urban areas of larger cities. In Nigeria, the largest cassava producing states are Ogun, Oyo, and Ondo to supply Lagos market and it is similar around Yaounde in Cameroon, where cassava production is concentrated around the city.

4. Summarise current key constraints facing cassava value chain in SSA

The most important technical constraints to the development of a cassava value chain are the low yield, a lack of appropriate post-harvest technologies and disaggregated production in smallholdings, resulting in difficult access and varying quality. Investments in road infrastructure and clustering of farmers into producer communities can addressed by policy and institutional changes, but to increase yield a change in crop management is necessary.

A shift to more market-oriented production requires new planting material that is starch rich (25-27% starch) and has quality parameters essential for industry. Research in recent years has produced a number of cultivars suitable for industrial purposes, but mass production and dissemination of such material is limited. Lack of access to quality planting material appears to be the most important limiting factor for higher yields at farm level.

New germplasm has to be tested for inclusion into existing cropping systems often dominated by the traditional cassava-maize intercrop in West Africa; where at current 50% of the African production is located. Cassava-legume associations, (such as with groundnut, beans or cowpeas), are most desirable in terms of a sustainable intensification of production.

Belloti et al (2012) predict that a commercialization of production along with anticipated climate change will modify the pest/disease dynamic of cassava. Large-scale production units, expansion of cultivated area and modifications in crop management will likely increase arthropod pests, such as the whiteflies, mites and mealy bugs. Whiteflies are the most important vector for major diseases, such as mosaic and brown streak virus.

In the context of climate change, interesting results are emerging from a FACE experiment done with cassava in Illinois last year. They could show that cassava yield goes up almost 60% with 500 ppm CO_2, which is what we expect to reach by 2050. Clearly, in this case there is potential for cassava that is not found for other major crops under similar conditions.

Most cassava germplasm in the past was developed without or with low use of mineral fertilizers. Yield levels of less than 10 t/ha do not seriously deplete soil nutrients provided the tops are left in the field, which is why subsistence farming can be practiced over longer periods on the same field. However, yield increases for commercial production of cassava require the use of mineral fertilizers in order to replace the nutrients exported with roots, stems for planting material, and often leaves for consumption. This has also been found by Fermont et al (2009) in Kenya and Uganda, where moderate use of fertilizers doubled the yield. There is a need to test new germplasm for its response to fertilizers in integrated soil fertility management systeMs Cassava management practices for intensification and diversification under a wide range of conditions can be more effective if built on an improved understanding of the crop physiology and at the field scale through an agro-ecosystem perspective.

Knowledge of farmers of improved cropping systems is limited and extension systems in many SSA countries are usually weak. Therefore, effective knowledge transfer mechanisms, such as farmer field schools should be envisaged.

5. Summarise current plant science opportunities for improving impact of a cassava value chain on poverty and food security in developing countries

Biological limitations

According to Taylor *et al*. (2012), cassava faces two major challenges in terms of research and development investment: (1) to increase understanding of the physiology of root storage and (2) to solve constraints to cassava production.

As a vegetatively propagated crop, cassava is physiologically unbalanced between root storage and top growth. The sink strength for allocating carbon to starch synthesis in the storage roots is limited, varies between early and late branching varieties and is determined by growth conditions and crop management. To capitalize on the full potential for high yield starch production in cassava requires a comprehensive understanding of the regulatory mechanisms behind source–sink interactions, sink strength, carbon partitioning, and storage root formation (Jansson et al 2009).

Environmental issues including climate change

A cassava value chain production must be based on sustainable intensification of the crop management system. Integrated pest and soil fertility management systems, combining local resources with external inputs, have to be developed based on location specific conditions. The basis for this are diversified cropping systems and crop rotations to minimize pest/disease pressure and optimize the use of nutrients in the system.

Cassava is potentially highly resilient to future climatic changes compared to other crops, such as maize and sorghum (Jarvis *et al*. 2012). It therefore has potential to support Southern Africa's agricultural production to adapt to future climate change. However, cassava production faces challenges in other regions of Africa due to a possible shift of pest and disease pressure and therefore priorities for research are to increase resistance to key pests and diseases.

Economic factors

Production costs of cassava in many African countries are too high compared with production in Asia and Latin America. This is largely due to high transport cost of inputs and marketing produce and a result of missing or bad road infrastructure and highly disaggregated production. Low yield and inefficient marketing schemes contribute to the cost structure.

Social and political factors

Policies have to create an enabling environment for implementing a value chain approach. Farmers need incentives for a shift towards a more commercialized production. Access to inputs, such as fertilizers, and to new technologies for post-harvest management and storage has to be improved to facilitate high quality production. Output prices may need stabilization if the seasonal variation is too high.

Industrial investors require consistent policies and regulations for a longer-term engagement. An example is the presidential decree in Nigeria to replace 10% of imported wheat flour with cassava flour in bread production. Farmer associations and industry representatives need to come together to discuss supply problems and market price structures.

Where industries cannot protect their investments in cassava breeding and trait development, there may also be IP and policy issues that need to be addressed.

Expected outcomes & follow up from the workshop regarding cassava value chain

- identification of major constraints to developing a cassava value chain
- summary of needs-driven research from farmers point of view
- identification of research gaps in ongoing initiatives and the specific role of plant sciences
- ideas on increasing scientific collaboration and partnerships between universities and research institutions in Europe and SSA

3.2 Briefing Note for the Working Group on Maize and associated legume crops for Sub Saharan Africa

Note: This Briefing Note was prepared by a committee consisting of Noel Ellis (IBERS, UK), Mulugetta Mekuria (CIMMYT, Zimbabwe), Joyce Mulila-Mitti (FAO, Zimbabwe) and Peter Stamp (ETH-Z, Switzerland) as an input for workshop discussion. It does not reflect the views of FAO, EPSO or the organizations in the FAO-EPSO Consultation. Selected examples on maize and associated legumes are presented and discussed below.

2. Current status

Maize (*Zea mays*) and soybean (*Glycine max*) are major world commodities and are significant crops in Sub Saharan Africa (SSA). Accordingly, both have extensive research infrastructural support (including whole genome sequences).

Legume crops are widely grown because they have high protein content (in the leaves or seeds). Consequently, they are highly suitable for human diets low on animal protein, or as animal feed delivered by a variety of routes. This high protein content is associated with nitrogen fixation that also contributes to soil fertility.

Legume crops are diverse and their functions range widely: fodder and ground cover (e.g. *Desmodium triflorum*), niche value crops such as carob beans (*Ceratonia siliqua*) or for 'tea' production (roobios *Aspalathus linearis*) or staples. African legumes grown on a wide scale for their protein rich seed include groundnut (*Arachis hypogaea*) and cowpea (*Vigna unguiculata*). Cowpea is legume domesticated in African and is grown widely. Other legumes grown for grain include chickpea (*Cicer arietinum*), pea (*Pisum sativum*), common bean (*Phaseolus vulgaris*), pigeon pea (*Cajanus cajan*) and lablab (*Lablab purpureus*), all of which are also significant crops in other parts of the world. Grass pea (*Lathyrus sativus*) is noted for its heat and drought tolerance and grown in East Africa, but the seed toxins remain a problem. The tuber crops 'mamara bean' (*Tylosema esculentum*) and 'bambara groundnut' (*Vigna subterranea*) also have potential as drought tolerant species.

Legumes are grown as vegetable crops (with a home market and in Europe), in agroforestry (carob beans, *Ceratonia siliqua*), as vegetables or for niche products such as 'tea' production (roobios, *Aspalathus linearis*). Legumes are often grown as intercrops and can supplement grazing.

Maize has markedly gained consumer preference in some regions of Africa. The favourite grain colour is white, creating some concern due to lower level of carotenoids and a lower drought tolerance than sorghum and millets. Although maize has a long tradition in Africa, high-yielding varieties are in use in many areas, often drawing on CIMMYT germplasm. However, most farmers cannot exploit the yield potential as the soil in many parts of Africa is leached, with low pH, low content of phosphorus and mostly lacking nitrogen fertilization. Furthermore, in contrast with maize, many of the minor legume species are often neglected in breeding schemes, remaining at the status of landraces. A major focus is also placed on boosting diverse maize-legume systems to produce more plant proteins, and exploit the

ability of most legumes to provide nitrogen to the soil as well as improve the phosphorus availability. Therefore, the adoption of maize-legume systems, which often demand higher labour and financial inputs, depends strongly on the genetic improvement of selected legume species. These can be chosen from a long list of candidates that have proven economic and ecological benefits in mixture systeMs Activities that will enable farmers to co-select maize and legume species in mixed cropping systems are needed.

2. Past and ongoing large-scale initiatives

Maize/legume systems have been tested in many SSA countries at international and national levels. An important long-term commitment was undertaken by CIAT's African Bean program, at its Uganda research station. In this, as in many other collaboration, the benefits as well as the biological and socioeconomic weaknesses of diverse maize/legume combinations were studied in depth.

IITA undertakes breeding in soybean and ILRI works on legume forages in addition to livestock research. There are, in addition, National Research Centres that engage directly in breeding and extension. Significant research efforts have also been funded by the Bill and Melinda Gates Foundation - Tropical Legumes I & II http://www.generationcp.org/gcptli/, http://www.icrisat.org/tropicallegumesII/), the Gatsby Foundation (sorghum and legumes) (http://www.gatsby.org.uk/en/Africa/Projects/Cowpea-and-Sorghum.aspx) and the Kirkhouse Trust (http://www.kirkhousetrust.org/projects.html). SIMLESA – (http://simlesa.cimmyt.org/) is another example that will be presented briefly in the workshop.

National programs in close cooperation with CIMMYT, together with regional African efforts by IITA and others, have improved maize germplasm tremendously. In recent decades, CIMMYT efforts were quite successful in the development of tolerant material towards the parasitic weed *Striga*, the increasing cause of yield failures. Furthermore, efforts have been taken to increase the tolerance towards drought, a stress that can affect maize at all stages of development, as well as improving the nitrogen efficiency.

Many financial and personnel resources are in invested in maize. Due to the ease of breeding hybrids that can often be sold in many world regions, the return of investment is highest here. This is understandable from a commercial perspective but, consequently, minor legume species are neglected in breeding, staying often permanently at the status of landraces.

Therefore, the adoption of maize-legume systems, which often demand higher labour and financial inputs, strongly depends on the strong genetic improvement of selected legume species. These can be chosen from a long list of candidates that have proven economic and ecological benefits in mixture systeMs No major programmes for maize have been undertaken for co-selection of maize and legume species in mixed cropping systeMs This is strong motivation to start activities in this direction.

3. Current problems and constraints for maize and associated legumes in SSA.

Maize is the major staple food crops for food security of smallholder farmers in many regions of SSA. It predominantly delivers starch, i.e. energy, but there are many breeding programs on the way in African countries to integrate Quality Protein Maize types (a significant achievement by CIMMYT) into adapted germplasm. Recent publications have demonstrated that the rather low 9 to 10% grain nitrogen can be almost sufficient for the protein needs of infants forced to subsist predominantly on maize. It is more difficult to estimate the importance of grain legumes in SSA countries. Indigenous and *Phaseolus* beans have played a large role in the past as well as the indigenous *Bambara* groundnut. It is of vital importance to assess more accurately the suitable species of legumes fitting into mixture systems with respect to their socioeconomic and ecological fitness.

For maize, it is a challenge to combine all major achievements of breeding, ranging from *Striga* tolerance to nitrogen efficiency, into regionally adapted varieties. This must be supplemented by co-selection programs with legume species. The question arises when to shift from open pollinated varieties to hybrids and how to combine the fitness to low input systems with high yield potential once the market prices allow for higher inputs. It should be emphasized here that the grass/legume system has nutritional complementarity in addition to its environmental benefit.

4. Summarise current key constraints facing maize/legume systems in SSA

Major difficulties for these crops concern disease and abiotic stresses. These represent diverse challenges for the different species of interest. Drought tolerance is a major constraint and is being addressed in several ongoing programmes, but this needs further support. There is a lack of funding, preventing adequate exploitation of the use of legume diversity, leading to fragmentation of efforts.

Another important constraint to maize/legume systems is the availability of maize varieties at farm level that combine acceptable potential and consistency of yield with quality protein content (QPM). The challenge is still much higher with respect to farmer-accepted legume species, with a greater range of purposes than for maize, where reliable varieties of high performance are not readily available and are a current constraint. There are also many gaps in our knowledge with respect to suitable partners (maize/legume) in mixed systeMs These efforts require regional activities, closing the gap between existing knowledge from research and farmers practice.

5. Summarise current plant science opportunities for improving impact maize and associated legumes on poverty and food security in developing countries

Biological limitations

Major difficulties for these crops concern disease and abiotic stress. These represent diverse challenges for the different species of interest.

Drought tolerance is a major constraint and is being addressed in several ongoing programmes, but this needs further support. For example, the genetic basis of neurotoxin production in grass pea and its relation to drought stress and heat tolerance seems an obvious target for research (some low toxin lines are available). For the minor and niche market species these are largely under-developed crop species and broad investigations into their basic biology should enhance their breeding. For maize (and sorghum), soybean, groundnut, common bean and cowpea, major projects are underway and development of tools and partnerships to address the constraints to productivity in SSA should be a high priority.

Efforts should be directed to gaps in upgrading maize and selected already well-tested legumes for mixture systeMs Crop rotations and/or intercrops need to be optimized on a local and regional basis. This is probably best achieved by a hierarchical approach - identifying appropriate groups of cultigens at a regional level and then optimizing combinations locally with farmer participation. By contacting breeders in Europe, South East Asia, looking at websites from CIMMYT and CIAT, it becomes obvious that almost no efforts have been seriously made for a co-selection of partners.

One outstanding example comes from the European company KWS. They started to select for organic farming maize germplasm selected under strong weed or green manure competition. Now they have a major breakthrough: hybrids are coming that do much better than any varieties did before in mixture systems Therefore, we can propose to optimize the mixed cropping systems starting from the farmer's viewpoint of variety/species (maize/legumes) level up to the selection and molecular level. This systems approach in selection would be innovative.

Environmental issues including climate change

The maize/legume crop rotation is intrinsically productive and has a relatively low environmental impact (e.g. compare US vs. European agriculture). The use of legume inter- or break-crops delivers enhanced soil nitrogen and soil organic matter. The potential for inhibition of parasitic weeds with specific combinations is also worth further investigation.

Maize as a C4 crop will probably benefit less from future CO_2 increases and suffer a lot from increasing drought spells at flowering, issues to be covered by ongoing breeding prograMs Still, maize is one of the most water efficient cereals, equal to sorghum and millet. Combined with legumes, problems due to an insufficient soil cover can be minimized and soil fertility improved. This latter aspect is highly important in many SSA countries, where ecological deficits of management are no longer covered by traditional slash and burn approaches with forest interval for more than 20 years. Maize-legume systems may allow for long-term soil fertility when land has become scarce.

Economic factors

Maize and legume varieties can have high yield potentials, but when market access is poor due to insufficient governance, progress is delayed. Farmers who invested in green legume manure at their private risk have complained that the biological impact was good but the

additional yield did not cover the costs of investment. High transport costs can inhibit the distribution of fertilizer and pest control agents. The use of the crops themselves to provide at least part of these services should be attractive.

Social and political factors

These factors have to be considered differently when relating to traded commodities (where transport is also an issue). Regulation and certification of varieties is an important consideration (especially in certain contexts e.g. grass pea q.v.)

6. Issues to discuss at the workshop

- Background:
  - Rationale for production:
    - Maize: Staple food, high, consistent yields needed; ideotype, breeding needs
    - Legumes: Quality food, soil fertility; species, varieties, breeding needs
    - Mixed: Competition light, water; barriers to disease
    - Rotation: Food and/or soil fertility
  - Rationale for acceptance:
    - Taste, nutrition etc.
    - Marketable products (local and for export)
    - Input demand
    - Labour demand
  - Requirements:
    - Match to climate, soil and water availability
    - Marketing opportunities: local and traded acceptability
- Impediments to, and potential approaches to improve scientific interactions
- What are the educational and training needs & how can they be delivered
- Which technologies can have the greatest impact for farmers and how can these be delivered?
- How does science in the EU and SSA contribute to delivering technology and education?
- What are the major constraints to effective interaction?

7. Expected outcomes & follow up from the workshop regarding maize and associated legume crops

- Identification of major constraints of sustainable systems
- Priority list of:
  - target crops (and cropping systems)
  - target traits
  - appropriate technologies at all levels

- Recognition of institutional needs in the EU and SSA
  - recommendation of a modus operandi for fostering and supporting research collaborations

3.3 Briefing Note for the Working group on Underutilized Fruits and Vegetables in Sub Saharan Africa

Note: This Briefing Note was prepared by a committee consisting of Enoch Achigan-Dako (Plant Resources of Tropical Africa, Benin), Eckhard George (Leibniz Institute, Germany), Ian Graham (CNAP, UK) and Remi Nono Womdim (FAO) as an input for workshop discussions. It does not reflect the views of FAO, EPSO or the organizations in the FAO-EPSO Consultation. Selected examples on underutilized fruits and vegetables are presented below.

1. Current status of indigenous fruits and vegetables in developing countries

For many people in the tropics, the daily food diet is made up of cereals, starchy root crops, and a source of lipids (seed plant oil). Meat and fish enter the diet to a certain extent for the "happy few" or for special events. Fruits and vegetables are often considered as a side-product to add some flavour, rather than a main source of nutrients. To date, government priorities in food production have largely resulted in the promotion of three key crops: wheat, rice and maize. These cereals have become food staples in most developing countries, also where they traditionally have had little dietary significance.

Simultaneously, food and nutrition security policies have largely ignored fruits and vegetables which are a more diverse and abundant source of nutrients. Food diversity is an essential component in reaching food and nutrition security, as it contributes positively to availability, access, utilization and stability. The current situation, where a very limited number of staple crops represents almost the entire food intake of large populations, contribute to vulnerability through low quality diet, malnutrition, lack of sovereignty and little or no room to adapt to changes and/or new situations, especially among those in low income groups.

Fruits and vegetables have a crucial role to play in combating food and nutrition insecurity, especially the so-called "hidden hunger" caused by micronutrient deficiencies, as they represent unique sources of fibre and a diversity of micronutrients and other bioactive substances. The Food and Agriculture Organization (FAO) and the World Health Organization (WHO) recommend a dietary intake of more than 400 g of fruits and vegetables per day to prevent malnutrition. To address this, we need to put in place sustainable mechanisms to improve the diets of rural and urban poor.

Greater attention is paid to field crops, rather than underutilized species, including indigenous fruits and vegetables, which in many cases are collected from the wild or grown in traditional farming systems and home gardens. Modern varieties dominate the seed systems, crop fields and commercial orchards. A significant number of fruit and vegetable species and varieties are little known outside specific regions. As a result, lack of priority given by local and national governments, inadequate financial support, lack of trained personnel, insufficient seed or planting material, lack of consumer demand and legal restrictions are key constraints that continue to make these species less relevant and vulnerable to genetic erosion.

According to information provided by a large number of national and international genebanks in the Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture (2010), vegetables and fruits accounts for less than 13% of the total number of accessions in all *ex situ* collections in the world. With few exceptions, phenotypic and molecular characterizations of these accessions are also low. Compared to the world's major crops, there is relatively little research on, and improvement of the less-utilized crops and species, especially in Sub Saharan Africa. For plant breeding to play a more useful role in developing indigenous fruits and vegetables, efforts are needed to characterize, evaluate and further develop both cultivated and wild germplasm for nutritionally related traits etc.

Nevertheless, fruits and vegetables are key commodities on the international market and represent almost 80 percent of the world horticulture market. According to FAO, the value of all fruits and vegetables traded globally is more than double that of cereals. However, there appears to be considerable variation among countries with regard to availability and size of local and international markets for indigenous fruits and vegetables. In Sub Saharan Africa, greater public awareness of the importance of crop diversity, especially of formerly neglected and underutilized species is a continuous need. Positive awareness and recognition of traditional vegetables and fruits would be expected to stimulate and expand market opportunities, strengthening cooperation among producers, create street fairs, diversified farming, niche variety registration systems, initiatives in schools, product labelling schemes, etc.

Only a small number of species of fruits and vegetables have been promoted and traded while hundreds of other locally valued fruits and vegetables have rarely received any attention. This makes this an area with major potential for improvement and growth.

For instance *Vernonia amygdalina,* an important leafy vegetable in West and Central Africa, is involved in a steadily growing international market. Currently, AfriProducts is selling a kilogram of fresh/frozen *V. amygdalina* leaves at USD $4.55 and its powder at USD $7.5 (AfriProduct, 2010) while RGL enterprise sells a kilogram of powder at USD $10 (RGL enterprises, 2010). Plant health products formulated with *V. amygdalina* have been commercialized. EdoBotanics under the Jackson State University is selling processed *V. amygdalina* under the name of EdoTide Plus (which contains 600 mg of leaf extract with the suggestion of 600 to 1200 mg oral intake per day) (60 capsules at USD $42) (EdoBotanics, 2010).

2. Ongoing large-scale initiatives

- There are no explicit initiatives on indigenous fruits and vegetables in the current CGIAR CRPs, although bananas to a certain extent are addressed through CRP 3.4: Roots, Tubers and Bananas.
- The World Vegetable Center included in its ''2010 Strategy plan'' work on indigenous vegetables as one of its core programmes (AVRDC, 2002).
- At the continental level in tropical Africa, FAO and PROTA-Africa are engaged into a collection of success stories on 40 indigenous fruits and vegetables.
- At sub regional level CORAF/WECARD recently (March 2012) invites proposals on non-staple crops including leafy vegetables. Throughout this programme three core functions of CORAF/WECARD are of particular focus in this project and include: 1) Capacity

strengthening of national agricultural research partners specialized in leafy vegetables research and development, 2) Facilitation of research cooperation and partnerships among and within three clusters of national research and development partners, 3) knowledge generation and management through sharing of methodological approach, experiential learning, dissemination and exchange of knowledge with rural and urban communities.

- A selected number of indigenous fruits and vegetables are involved in the GRP 1 programme of ICRAF where research activities on domestication are underway.
- Initiatives such as "Crops for the Future" and the Global Horticulture Initiative promote research on and the improvement of underutilized crops.

3. Summarise current key constraints facing indigenous fruits and vegetables in developing countries

- An estimated 1,500 species are listed to be primarily used as fruits and vegetables, amongst the approximately 8000 useful plants in Africa. These plant genetic resources are subject to continuous degradation caused by population pressure, industrialization, and unsustainable use. Detailed information on these plant resources is often lacking or not widely available. A few fruit bearing plants are tended in natural stands but only a handful of species have been selected for improvement and domestication. The knowledge on indigenous fruits and vegetables of the tropics still requires a comprehensive documentation as many of them exhibit great potentials.
- Indigenous fruits and vegetables have largely been neglected by research, policy makers and extension services; governments rarely allocate resources for the promotion and development of indigenous fruits and vegetables that are seen as non-valuable crops/species. Consequently, the use of these resources by urban population is declining with more people preferring exotic species. Rural areas are following this trend. In addition, there is still in many countries a poor attitude towards local vegetables. People associate them with poverty.
- Limited research work has been conducted on indigenous fruits and vegetables causing these species/crops to be subject to: 1) poor quality of planting material seedlings; 2) inappropriate production technologies – lack of adequate capacity in management of horticultural nurseries; 3) poor handling techniques that lead altogether to low productivity.
- Fruits and vegetables, especially traditional and locally used varieties, account for a relatively small proportion of the germplasm accessions stored in genebanks around the world. Characterization and utilization of this material is also relatively low, according to the SoWPGR-2 (2010). Efforts in breeding and improvement of fruit and vegetable crops are therefore limited.
- The education system has for a long time focused on exotic species for which more information is available. Detailed curricula on indigenous fruits and vegetables are lacking. ''PROTA 2 Vegetables'' can serve in some instances to fill this gap.
- Indigenous fruits and vegetables are not able to meet requirements of the market because of the limited capacity in compliance to the marketing standards. In addition, there is a lack of reliable statistics (production, yield, and commercialization data) on indigenous horticulture species, which limits prospects for investment. When the information is available, it is dispersed and not focused.

4. **Summarise current plant science opportunities for improving impact of indigenous fruits and vegetables on poverty and food security in developing countries**

Biological limitations

- Development of a sustainable mechanism that will facilitate access to quality seeds and planting material of improved varieties by small holder farmers
- Development and promotion of appropriate crop variety production and protection technologies
- Development of efficient and effective post-harvest systems including commercialization and promotion of consumption

Environmental issues including climate change

- Biodiversity of indigenous fruit and vegetables (IFVs) for the mitigation of the impact of climate change
- Understanding on the role of IFV biodiversity for resilient food systems and ecosystems

Economic factors

- Contribution of IFVs to livelihood improvement, poverty reduction and economic development

Social and political factors

- Awareness-raising and understanding on the role of IFVs in food security and nutrition
- Building human resources with knowledge and skills on IFVs value chain
- Promotion of conducive environments for the increased role of IFVs in productive and healthy life

5. **State expected outcomes & follow up from the Workshop regarding indigenous fruits and vegetables**

- Major constraints to the development of IFVs value chain prioritized
- Key stakeholders to address the above constraints identified and their respective role defined
- Action plan designed
- Monitoring and evaluation tools developed

ANNEX 4: List of Abbreviations

AATF	African Agricultural Technology Foundation
AGP	Plant Production and Protection Division of the FAO
AGRA	Alliance for a Green Revolution in Africa
APAARI	Asia-Pacific Association of Agricultural Research Institutions
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
AVRDC	World Vegetable Centre
BBSRC	Biotechnology and Biological Sciences Research Council of the UK
CAADP	Comprehensive Africa Agriculture Development Programme
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Centre for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Centre
CORAF	Conference of the agricultural research leaders in West and Central Africa
COSADER	Collectif des ONG pour la Sécurité Alimentaire et le Développement Rural
CMD	Cassava Mosaic Disease
COST	European Cooperation in Science and Technology
CRAI	Committee on International Agricultural Research
CRP	CGIAR Research Programme
EC	European Commission
EIARD	European Initiative for Agricultural Research for Development
EPSO	European Plant Science Organization
ERA-ARD	European Research Area - Agricultural Research for Development
ERA-CAPS	European Research Area - Coordinating Action in Plant Sciences
ETH	Eidgenössische Technische Hochschule Zürich (Swiss Federal Institute of Technology)
EU	European Union
EU-ACP	European Union and the African, Caribbean and Pacific countries

FACCE-JPI	Joint Programming Initiative Agriculture, Food Security and Climate Change
FAO	Food and Agriculture Organization of the United Nations
GCARD	Global Conference on Agricultural Research for Development
GFAR	Global Forum on Agricultural Research
GIZ	German Academy for International Cooperation
IBERS	Institute of Biological, Environmental and Rural Sciences at Aberystwyth University, UK
ICRAF	World Agroforestry Centre
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
ILRI	International Livestock Research Institute
IRD	Institut de Recherche pour le Développement
NUI Galway	National University of Ireland, Galway, Ireland
NUS	Neglected and Underutilized crop species
OEK	Office of Knowledge Exchange, Research and Extension, FAO
SEARCA	Southeast Asian Regional Center for Graduate Study and Research in Agriculture
SSA	Sub Saharan Africa
TAP	Tropical Agricultural Platform
UCD	University College Dublin
WACCI	West Africa Centre for Crop Improvement
WB	World Bank
WGC	Working Group: Cassava value chain
WGM	Working Group: Maize and associated legumes
WGU	Working Group: Underutilized fruits and vegetable