ICTs transforming agricultural science and innovation: implications for ACP agriculture

Final report
on
the 2009 e-consultation

in preparation for the 8th annual meeting
of the Advisory Committee on S&T for ACP Agricultural and Rural Development
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1. Introduction

CTA will convene the 8th annual meeting of the Advisory Committee on Science & Technology (S&T) for ACP Agricultural and Rural Development in Montpellier (France) on 16–20 November 2009. The theme of the meeting is 'ICTs transforming agricultural science and innovation: implications for ACP agriculture'. In preparation for this meeting, CTA conducted an e-consultation among the experts invited to attend. The e-consultation was facilitated by Contactivity in consultation and collaboration with CTA.

This report presents a summary of the outcomes of this e-consultation. Chapters 2 and 3 explain the methodology and discuss the response rate. Chapters 4–10 provide overviews of the contributions of the participants in the e-consultation, including the technological challenges and megatrends that are impacting on ACP agricultural science and innovation, and their suggestions as to what the ACP scientific community and ACP governments could do to address them. Chapter 11 presents some concluding comments, summarizing the main conclusions of the e-consultation.

2. Methodology

The e-consultation consisted of two rounds of questions. The first round concentrated on identifying megatrends in agricultural science and innovation, globally and in the ACP region, and the ICTs that would shape the ACP agricultural science and innovation agenda in the coming decade. The second round focused on ranking the megatrends and ICTs identified in round 1, in order of their importance for transforming ACP agricultural science and innovation; and on gathering suggestions for the formulation of policy options for addressing these trends.

In round 1, the following six questions were put to the participants:

1. What are the three major technological challenges that ACP agriculture will face over the next 5–10 years, and what are the major shortcomings that the ACP scientific community will need to overcome in order to address the challenges you identified?
2. Which three scientific disciplines will be key in transforming ACP agriculture over the next 5-10 years?
3. What are the three most important megatrends at the global level that are likely to have an impact on the development of agricultural science and innovation in ACP countries over the next 5–10 years?
4. Which three positive and three negative megatrends in ACP countries are likely to shape the agricultural science and innovation capacities in ACP countries over the next 5–10 years?
5. Which three ICT applications, or combinations of ICTs and other technologies, are likely to shape the ACP agricultural science and innovation agenda over the next 5–10 years?
6. What are the top five agricultural commodities (food and non-food) that will be produced in ACP countries and traded globally over the next 5–10 years?

In preparation for round 2, the responses to these first six questions were analyzed and collated to provide brief descriptions of the responses including the technological challenges and megatrends, and the major shortcomings the ACP scientific community will need to overcome in order to address them. From the summary descriptions, the participants were then asked to select the most important technological challenges and megatrends, and to suggest for each of them what key actions the ACP scientific community could undertake to address the major shortcomings. In addition, they were asked to list which policy interventions they expected from ACP governments to help them to overcome these shortcomings. The participants were also asked to rank the scientific disciplines and ICTs identified in the first round that are likely to transform ACP agricultural science and innovation over the next 5-10 years.

The qualitative approach used in this e-consultation is not grounded in a scientific qualitative or quantitative methodology. Therefore, the conclusions have been drawn only on the basis of the

responses received: the insights, ideas and suggestions presented in this report are meant to inform the meeting of the Advisory Committee on Science & Technology for ACP Agricultural and Rural Development in November 2009.

3. Participation in this e-consultation[1]

The first questionnaire was despatched to 33 experts and members of the Advisory Committee (AC). The second questionnaire was sent to the 21 AC members and experts who completed and returned the first questionnaire.

number of AC members who	first round	second round
received questionnaire	33	21
completed questionnaire	21	17
response rate	64%	81%

The response rate to the first round of questions was 64%. The response rate to the second round was 81%, in spite of the rather short response time that was given to the participants.

4. Major technological challenges for ACP agriculture over the next 5–10 years

In the first round, participants were asked which *major technological challenges ACP agriculture will face* over the next 5-10 years, and what *shortcomings the ACP scientific community* will have to overcome in order to address them. The technological challenges identified could be grouped into five categories:

1. coping with the adverse effects of climate change;
2. developing and utilizing biotechnology and nanotechnology;
3. establishing information and communication systems for agricultural R&D;
4. developing green agricultural innovations and to resolve issues of competing land use; and
5. trading in regional and global markets.

For each of these challenges, the respondents listed the *shortcomings the ACP scientific community will face in addressing them.* They also suggested *key actions needed to overcome* the shortcomings and recommended *key policy interventions that ACP governments* could take to enable them to implement their suggested actions.

4.1 Technological challenge 1: coping with the adverse effects of climate change

The first technological challenge ACP agriculture will face over the next 5-10 years will be to *cope with the adverse affects of climate change*, in particular to:

[1] Wim Andriesse, Audia Barnett, Lennox Chandler, Arnold Dorsett, Raghunath Ghodake, Kachaka Sudi Kaiko, Margaret Kalloo, Ralph von Kaufmann, Norman Looney, Rufaro Madakadze, Michael Madukwe, Nadia Manning-Thomas, Demba Mbaye, Ephraim Mukisira, Agnes Wakesho Mwang'ombe, Lindela Ndlovu, Jean Daniel Ngou Ngoupayou, Peter Otim Odoch, Balasubramanian Ramani, Aleki Sisifa Aissétou and Dramé Yayé.

1. maintain and or enhance agricultural productivity
2. ensure food security by promoting crops that can withstand drought, flooding, etc.
3. find sustainable solutions for water scarcity in agricultural areas, and to develop and improve the production potential of crops, in particular indigenous and traditional food crops.

The participants listed the following *shortcomings that the ACP scientific community will have to overcome* in order to address this challenge as follows:|

1. insufficient scientific capacity for doing research in the complex area of natural and renewable resources
2. inadequate food production techniques and lack of innovative soil and water management systems that can be applied if climate conditions deteriorate
3. flawed understanding of technologies and interventions in their social, economic and eco-agricultural contexts
4. lack of climate information that can guide farmers in their farm management decisions.

In the second round of the consultation the participants suggested that *the ACP scientific community* could take a variety of actions, aiming at:

1. enhancing/strengthening ACP scientific and technical capacity in climate-related studies to cope with climate change and its adverse effects and to understand the complex area of natural and renewable resources
2. creating a community of practice to address the challenge of climate change
3. training staff of ACP governments and institutions on appropriate strategies and interventions that could be applied under agro-ecological conditions prevailing in their countries
4. focusing scientific research on the development of mitigation and adaptation strategies that can reduce the impacts of climate change on food production and natural resources. More specifically develop crops and livestock (cultivars and breeds) that can be productive under the adverse conditions caused by climate change and utilize traditional knowledge and food crops in their climate change research.
5. incorporating indigenous knowledge and skills, in the search for technologies that can be used in conserving natural resources
6. devising and implementing appropriate strategies and action plans for individual ACP countries
7. issuing guidelines to all stakeholders about efficient management of renewable and natural resources
8. collecting and interpreting climate change data to inform the agricultural R&D agenda and generating climate information that farmers can use in their farm management decisions and scientists can apply in the development of climate models for key agricultural areas.

One participant commented that what is needed is one programme combining all key actions to overcome the shortcomings identified, in recognition of their interdependence.

The participants also suggested a wide range *of key interventions to be undertaken by ACP governments*, aiming at:

1. declaring that climate change is a major policy issue
2. implementing awareness-raising programmes focusing on the need to address climate change, including courses on climate change, ecology and sustainable development (from primary up to university level)
3. introducing specific policies to support adaption to and mitigation of the adverse effects of climate change.
4. issuing incentives for adopting green technologies and penalties for maintaining unsustainable practices

5. assessing the Asian example of building scientific capacity and infrastructure for its relevance for ACP countries
6. strengthening the scientific capacity and infrastructure required for climate change research
7. increasing resource allocations for climate change research, in particular to develop drought- and flood-tolerant crop varieties, and other technologies to conserve water and soils
8. establishing regional research partnerships
9. implementing international agreements such as the EU-ACP programme Accords Multi-latéraux sur l'Environnement (AMEs).

4.2 Technological challenge 2: bio- and nanotechnology

The second technological challenge ACP agriculture will face over the next 5-10 years will be to *develop and utilize biotechnology and nanotechnology* for improving the production potential of agricultural crops, in particular indigenous and traditional food crops grown and consumed in ACP countries.

In order to address this challenge, the participants listed the following *shortcomings that the ACP scientific community will have to overcome*:

1. insufficient scientific and technical capacity and inappropriate laboratory and other research infrastructures
2. absence of appropriate legal regulatory frameworks for applying bio- and nanotechnologies
3. lack of public understanding of these technologies in their religious and cultural context
4. no regional and international partnerships that can up-scale and out-scale these technologies to benefit smallholder farmers.

In the second round of the consultation the participants suggested that *the ACP scientific community* could take a variety of actions, aiming at:

1. improving the understanding among policy makers and the general public of the pros and cons of bio- and nanotechnologies and mobilizing their support for researching these technologies by
   a. implementing awareness raising, advocacy and lobby campaigns
   b. educating policy makers and strategy planners on legal and regulatory frameworks
   c. training farmers and extension officers in the fundamentals of bio- and nanotechnologies.
2. developing databases with factual information for advising policy makers
3. developing scientific, technical and institutional capacity and creating a critical mass of scientists in the field of bio- and nanotechnology (e.g. as indicated in the final report of the Africa Commission 2009) by
   a. setting up appropriate laboratory and other research infrastructures
   b. offering student graduate and post-graduate fellowships and exchange visits
   c. improving the links between universities, agricultural research and agribusiness
   d. obtaining support from business to improve curricula and the contextual relevance of teaching and research.
4. establishing regional and international collaborative partnerships between educational and research institutes in the fields of bio- and nanotechnologies to share information, expertise, research infrastructures and successful models of up-scaling and out-scaling.

The respondents also suggested a wide range of key interventions to be undertaken *by ACP governments*, aiming at:

1. developing evidence-based policy framework on bio-safety and bio-security to function as the policy environment for research in and use of bio- and nanotechnology for producing key agricultural commodities
2. including the enhancement of bio- and nanotechnology research for raising agricultural productivity and increasing food security in national plans for economic and agricultural development
3. providing budgets for the reconstruction of the scientific and institutional infrastructures of universities and research institutes and for the building and staffing of their bio- and nanotechnology laboratories
4. encouraging universities to provide training courses in bio- and nanotechnology at graduate and post-graduate level
5. including bio- and nanotechnologies in the curricula of primary and secondary schools
6. ratifying the International Treaty on Plant Genetic Resources for Food and Agriculture and implementing policy declarations, such as Maputo Declaration (2004) with respect to an annual allocation of 10% of the national budget for the development of the agricultural sector.

4.3 Technological challenge 3: information and communication systems for agricultural R&D

The third technological challenge ACP agriculture will face over the next 5-10 years involves *information and communication systems for agricultural R&D*, in particular to

1. develop systems that derive from local and regional sources of knowledge
2. apply ICTs and exploit the potentials of the information superhighway to enhance informed decision making and to create online networks between researchers, technicians and farmers.

The participants listed the following *shortcomings the ACP scientific community will have to overcome* in order to address this challenge:

1. the isolated nature of agricultural R&D activities
2. inadequate access to the large body of (un)published work within national and regional agricultural research centres
3. weak linkages between researchers and famers and insufficient research focus on the real problems faced by farmers
4. the limitations of poor and unstable connectivity and inadequate ICT infrastructures.

In the second round of the consultation the participants suggested that *the ACP scientific community* could take a variety of actions, aiming at:

1. improving the poor, restricted and unstable connectivity and inadequate ICT infrastructures in research and development institutes in ACP countries
   a. to allow ACP scientific community to link, interact and network with rest of the world
   b. to enhance scientists' ICT capabilities to use ICT applications (in combination with other technologies) in agricultural research projects
2. developing databases and documentation systems, with digitized documents
3. assessing the development and implementation of ICT protocols that are essential in understanding and appreciating current difficulties and improvement needed in the area of ICT systems for agricultural research for development.

4. developing ICT-based networks for agricultural extension and knowledge management systems that farmers can use
5. developing ICT-based knowledge management systems that farmers can use
6. establishing ASTI systems
7. addressing farmer problems by conducting on-farm adaptive research, including farmers in setting research priorities and involving farmers throughout the research chain
8. identifying farmers' innovations and uncovering the science that drives successful innovations.

The respondents also suggested a wide range of key interventions to be undertaken *by ACP governments*, aiming at:

1. resolving the restricted connectivity that prevails in most ACP countries and increasing the speed of internet connections by investing in ICT backbone infrastructure at national and local levels
2. relaxing the regulations on ICT access, liberalizing telecommunication markets and reducing the costs of using the internet
3. enacting enabling legislation (for example legislation with respect to freedom of information)
4. introducing policy frameworks to promote ICT development and the utilization and sharing of information
5. improving and upgrading the ICT infrastructure in rural areas and farming communities
6. improving restricted and unstable connectivity and inadequate ICT infrastructures in research and development institutes in ACP countries strengthening of extension services with ICTs.
7. developing integrated national agricultural research systems
8. strengthening the endogenous capacity for innovation within ACP countries
9. supporting public research and extension services to address farmer's access to information
10. increasing funding for community-based research projects and promoting adequate knowledge management at farmers' level.

4.4 Technological challenge 4: green agricultural innovation and competing land use

The fourth technological challenge ACP agriculture will face over the next 5-10 years will be to *develop green agricultural innovations and resolve issues of competing land use*, in particular to

1. increase agricultural output at lower energy costs or with decreasing dependence on fossil fuels
2. resolve the dilemma involved in decisions to allocate land for the production of food or bio fuels

The participants listed the following shortcomings that the ACP scientific community will have to overcome in order to address this challenge:

1. a policy environment that is not conducive to greener forms of agriculture
2. dependency of agricultural production systems (including extension services) on fossil fuels
3. competing demands on arable land (food versus biofuels)
4. lack of databases with information on biofuels.

In the second round of the e-consultation the participants suggested a variety of key actions *that the ACP scientific community* could take, aiming at

:

1. studying alternative (biomass) sources of energy and the implications of growing biofuels crops on agricultural , and on marginal and unutilized land (e.g. abandoned sugarcane fields) and selecting the most appropriate models of green agriculture for a healthy and sustainable agricultural sector
2. increasing research into organic farming and the utilization of food crop waste as biofuels
3. developing databases containing information on biofuel crops and exchanging them among ACP countries,
4. publishing objective assessments of the social and economic costs and trade-offs of using land for food and biofuel crops, for evidence-based political decision making
5. advocacy and lobby for enacting appropriate evidence-based policies on sustainable uses of land and fast-tracking green innovations and resolving the issue of competing land uses.

One participant commented that there is no direct relationship between green agricultural innovations and the (complex issue) of competing land use. Dealing with competing claims implies negotiating multi-stakeholder interests as well managing multi-level decision making and policy implementation. In this process, science can make a contribution both as a supplier of (hard) knowledge and, based on that knowledge, as a process facilitator.

The respondents also suggested that *ACP governments* introduce a wide range of key interventions, aiming at:

1. presenting an integrated policy statement on food security and the production of biofuels from the by-products of food production
2. introducing solutions to the problem of competing demands on land utilization (food versus biofuels)
3. enacting laws restricting the use of land for growing biofuel crops by foreign firms
4. reviewing government policies for small-scale renewable energy production
5. encouraging private enterprises to invest in small-scale renewable energy production
6. promoting a political environment that is favourable towards green agriculture
7. promoting participatory decision making in land use allocation processes.

4.5 Technological challenge 5: trading in regional and international markets

To trade in regional and international markets, in particular to participate in markets dominated by the need to offer value-added products that meet the ever-increasing demands of consumers and of ever stricter trading regulations.

The participants listed the following *shortcomings to be overcome by the ACP scientific community will have to overcome* in order to address this challenge:

1. no knowledge of regional and international markets, and no understanding of their demands
2. lack of traceability regimes
3. the competiveness of agricultural products in regional and global markets.

In the second round of the consultation the participants suggested that *the ACP scientific community* could take a variety of actions, aiming at:

1. adopting a value chain approach to agricultural research, linking farmers to markets
2. intensifying research on improving the quality and quantities of agricultural products and on conserving, processing and packaging

3. developing local standards, including testing and measuring facilities, which mirror international benchmarks
4. establishing a state of the art national agricultural and food safety systems
5. formulating codes of practice and auditing systems to ensure adherence to consumer demands and trading regulations in local, regional and international markets (e.g. HCAAP).
6. developing a methodology for rapid assessment survey s of commodities which have the potential to be competitive enough and other qualities to penetrate the region or international markets
7. identifying markets, understanding of their demands and of farmers' ability to access them (empowerment of small holder farmers in these markets) by collecting and analyzing information from these markets
8. Implementing advocacy and lobby campaigns for
    a. improvement of the access of the products to the regional and international markets
    b. reduction of tariff protection and the subsidies granted to the agricultural sector in developed
    c. the taking into account of the intellectual property laws in the agricultural sector
9. developing advanced systems of market assessment and adaptation of these systems to individual country situations.

The respondents also suggested a wide range of key interventions to be undertaken *by ACP governments,* aiming at

1. promoting sustainable trade of agriculture products at the regional and international level while protecting the interest of farmers and without compromising the environment in ACP countries.
2. facilitating ACP farmers and agro-processors to benefit from access to regional and international markets with commodities with which they have competitive advantages, and training them in meeting required quality standards, adhering codes of practice and complying international standards of food safety.
3. using specialist advice during WTO regional and international trade negotiations before signing them.
4. introducing policy and legal frameworks for stimulating regional and international trade and enactment of food safety regulations and promoting codes of practice for production to be adhered to by small holder farmers
5. establishing national agricultural and food safety authorities and regulatory bodies to oversee and advise on codes of practice, international quality standards, food safety standard, etc.
6. developing a robust supply chain management systems through centralized processing facilities and enhancing entrepreneurial skills of farmers
7. creation of a favorable investment climate for agro-processing business
8. improving road infrastructures in rural areas
9. removing unnecessary costs of trading between ACP countries.

5. Megatrends at the global level impacting on the development of agricultural science and innovation in ACP countries

In the first round of this e-consultation, the respondents identified the following *megatrends at the global level* that will have an impact on the development of *agricultural science and innovation in ACP countries* over the next 5-10 years:

1. climate change
2. spread of ICTs and their applications
3. growing food insecurity
4. globalization, including outsourcing of food and energy production
5. developments in energy markets (fossil fuels, biofuels, renewables)
6. biotechnology and genetic engineering
7. increase in industrialized farming
8. global financial instability
9. population growth
10. growth of mega holdings that control production-consumption chain
11. international push for more effective agricultural research
12. growing market power of Asia
13. increasing water shortages
14. depletion of natural resources and growing desertification

In the second round ten (10) participants selected *climate change* , two (2) *increasing water shortages* and another *two (2) growing food security* as the most important megatrends that will impact on development of agricultural science and innovation in ACP countries over the next 5-10 years.

The *spread of ICTs and its applications, globalization and outsourcing of food and energy production* and *biotechnology and genetic engineering* were each selected by one (1) respondent and the suggestions of the participants have not been included in this report.

The participants collectively provided a wealth of suggestions on how the ACP scientific community could address each of these megatrends and outlined in detail which key policy interventions they would expect from their governments.

5.1 Climate change

The nine participants, who selected climate change as the most important global megatrend, suggested that *the ACP scientific community* could take a variety of actions, aiming at:

1. developing research capacity to study climate change in ACP countries and to understand trends at local levels and the nature of adaptation mechanisms
2. improving research methodologies for the evaluation of the effects of climate change and methods of assessing the impact of carbon sequestration schemes
3. intensifying research geared towards the development and adaption of agricultural technologies under changing climate change scenarios
4. implementing programmes that aim at adaption to climate change and mitigation of its adverse effects
5. introducing green policies that eliminate the use of fossil fuels as the main source of energy
6. participating in joint projects, collaborative networks and information sharing groups.

The participants also suggested a wide range of key interventions to be undertaken *by ACP governments*, aiming at:

1. showing clearly political will to battle climate change
2. creating an enabling environment for the scientific community to implement an action plan that addresses the issues of climate change at both national and local levels
3. unlocking resources required for research in climate change and making available funds for the development and implementation of appropriate strategies and programmes that aim at managing and containing the adverse effects of climate change
4. protecting low lying atolls and coastal regions
5. ensuring that the population in ACP countries conforms to activities that will reduce deleterious effects on the environment and that promote a sustainable environment
6. strengthening the position of the ACP countries during international climate change negotiations.

5.2 Increasing water shortages

The two participants, who selected increasing water shortages as the most important megatrend, suggested that *the ACP scientific community* could take a variety of actions, aiming at:

1. investing in research in improved water harvesting and conservation methodologies and in drought resistant crops
2. promoting awareness of the interactions between depletion of fresh water resources and the other global megatrends that were identified in the first round of the e-consultation.

The participants also suggested a wide range of key interventions to be undertaken *by ACP governments*, aiming at:

1. securing fresh water resources for future economic growth and development
2. developing and implementing sustainable policies to reverse the negative trends before it is too late.

5.3 Food insecurity

The two respondents, who selected food insecurity as the most important megatrend, suggested that *the ACP scientific community* could take a variety of actions, aiming at:

1. strengthening research capacities and methodologies for improving agricultural productivity
2. improving crop productivity through new varieties that are adapted to local agro-ecologies and resistant to biotic and abiotic stresses and improved soil fertility.

The participants also suggested a wide range of key policy interventions to be undertaken *by ACP governments*, aiming at:

1. increasing market access
2. improving access to good seed and integrated soil fertility management technologies through provision of support to small holder farmers.

6. Positive megatrends in ACP countries with an impact on the development of agricultural science and innovation in ACP countries

In the first round of this e-consultation, the participants identified the following positive megatrends in ACP countries that will have an impact on the development of agricultural science and innovation in ACP countries over the next 5-10 years:

1. growing consensus about efforts to address climate change and agricultural development
2. policy support for agricultural research and education (from e.g. AU and NEPAD)
3. growing support for agricultural innovation systems research
4. developments in biotechnology and genetic engineering
5. rise of greenhouse and other technologies to intensify and increase agricultural production
6. growing demand for fair trade and organic products
7. spread of ICTs and their applications
8. acceptance of participatory approaches in facilitating learning.

In the second round eight (8) participants selected *growing consensus about efforts to address climate change and agricultural development issues* and three (3) selected *policy support for agricultural research and education (from e.g. AU and NEPAD)* as the most important positive trends that will have an impact on the development of agricultural science and innovation in ACP countries over the next 5-10 years. Two (2) participants selected *the spread of ICTs and its applications*.

The *rise of greenhouse technologies* and a *growing demand for fair trade and organize products* were each selected by one (1) participant. Only the trends that have been selected twice or more have been included in this report. Three participants did not register their response to the question.

6.1 Growing consensus about efforts to address climate change and agricultural development issues

The eight participants, who selected growing consensus on climate change as the most important positive megatrend, suggested that *the ACP scientific community* could take a variety of actions, aiming at:

1. building international consensus and collaboration to address the adaptation to and ameliorate the impacts of climate change
2. building a critical mass of scientists and practitioners to address the challenges of agricultural development under a changing climate

The wide range of key policy interventions undertaken *by ACP governments*, suggested by the participants to reach these policy aims could be summarized as follows:

1. supply of intellectual and engineering resources to conserving water of a similar magnitude as the funding developed and developing countries (India) have allocated to finding water on the moon.
2. support to and encouragement of scientists who do research on agricultural development under a changing climate
3. propagation of regional (e.g. CARICOM) policy initiatives that include reporting and accountability requirements

6.2 Policy support for agricultural research and education

The three respondents, who selected increasing policy support for agricultural research and education as the most important megatrend, suggested that *the ACP scientific community* could take a variety of actions, aiming at:

1. boosting the visibility and usefulness of agricultural research to tax payers and thus enhancing future investments by governments and others
2. increasing the priority granted to research and education by the political decision makers.

The participants also suggested that *ACP governments* should provide adequate resources and increasing investments in research and education.

6.3 Spread of ICTs and their applications

The two participants, who selected spread of ICTS and their applications as the most important megatrend, suggested that *the ACP scientific community* could take a variety of actions, aiming at:

1. enhancing application and integration of ICTs in their R&D work
2. developing and implementing ICT protocols that take into account current restrictions and required improvements in the area of ICT systems for agricultural research for development.

The participants also suggested a wide range of key interventions to be undertaken *by ACP governments*, aiming at:

1. designing appropriate interventions in ICT areas tailored to the specific conditions in individual countries
2. unlocking the potential of ICT technologies for agricultural and rural development in ACP countries
3. promoting the use of ICTs and investments for human resource development, infrastructure, facilities, etc.

7. Negative megatrends in ACP countries with an impact on the development of agricultural science and innovation in ACP countries

In the first round of this e-consultation, the participants identified the following *negative megatrends in ACP countries* that will have an impact on the development of *agricultural science and innovation in ACP countries* over the next 5-10 years:

1. climate change
2. globalization
3. financial crisis
4. food versus bio fuel dilemma
5. food insecurity
6. growing food insecurity
7. population growth
8. impact of diseases such as of HIV/AIDS
9. increased regulations
10. low priority of agricultural development on the political agendas
11. lack of commitment towards reducing the digital divide

12. brain drain
13. no consensus regarding biotechnology and GMOs
14. growing labor shortage in agricultural sector

In the second round five (5) participants selected *climate change*, three (3) *low priority of agricultural development on the political agenda* and two (2) *food insecurity* as the most important negative trends that will have an impact on the development of agricultural science and innovation in ACP countries over the next 5-10 years.

The *population growth*, *brain drain*, *no consensus regarding biotechnology, globalization*, and *growing labour shortage* and the *food versus bio fuel dilemma* were each selected only by one (1) participant and have not been included in this report. One participant did not register his or her response to the question.

The participants suggested a wide range of key interventions to be undertaken *by ACP governments*, aiming at:

1. boosting agricultural output
2. increasing priority to agricultural research and training in line with the contribution of agriculture to GDP in ACP countries
3. strengthening agricultural research, and building capacity of growers and processors.

8. Key scientific disciplines in transforming ACP agriculture over the next 5-10 years

In the first round of the e-consultation, the participants identified scientific disciplines that, in their opinion, would be key in transforming ACP agriculture over the next 5 – 10 years. Their answers were grouped under the following 15 headings:

1. Biotechnology and genetic engineering
2. ICTs
3. Biological sciences
4. Economics, sociology, political studies
5. Plant health and crop protection
6. Agricultural engineering
7. Natural resources (including biodiversity)
8. Soil sciences
9. Post-harvest technologies
10. Agronomy (including organic agronomy)
11. Animal health (including zoo noses)
12. Food technology
13. Greenhouse technology
14. Innovation systems
15. Embryology

In the second round of the e-consultation, the participants were asked to select four of the scientific disciplines, which in their opinion would be the most important for the transformation of ACP agriculture.

Scientific disciplines n=17	number of investments	total sum of investments	**ranking**
Biotechnology and genetic engineering	11	290	**17**
ICTs	13	270	**16**
Natural resources (incl. biodiversity)	12	250	**15**
Post-harvest technologies	13	240	**14**
Innovation systems	8	133	**8**
Economics, sociology, political studies	8	125	**7**
Soil sciences	6	80	**5**
Food technology	4	65	**4**
Greenhouse technology	4	63	**4**
Agronomy (incl. organic agronomy)	4	42	**2**
Plant health and crop protection	4	40	**2**
Biological sciences	2	15	**1**
Agricultural engineering	3	15	**1**
Animal health (incl. Zoonoses)	3	7	**0**
Embryology	0	0	**0**

For purposes of ranking of these disciplines, the participants were also asked to allocate an investment capital of Euro 100 million over the four disciplines they had selected. A ranking has been determined on the basis of the sums of the investments allocated to each of the disciplines (see table previous page).

Collectively, the respondents consider clearly four scientific disciplines namely; biotechnology and genetic engineering, ICTs, natural resources and post harvest technologies, the most important for transforming ACP agriculture over the next 5 – 10 years.

9. ICT applications likely to shape the ACP agricultural science and innovation agenda

In the first round of this e-consultation, the participants in the e-consultation were asked to identify ICT applications, or combination of ICTs and other technologies that in their opinion would most likely shape the ACP agricultural science and innovation agenda over the next 5-10 years. Their responses are summarized as follows:

Technology	Sector/purpose of use
• Fibre optic networks	• Creation of more bandwith
• Mobile phone	• General personal communications
	• Marketing infomation /business applicatons
	• Agricultural extension, Linking farmers with experts worldwide
• Mobile phone+internet	• Marketing infomation /business applicatons
	• Weather forecasting
• Internet	• Agricultural extension and training, e-learning
• Internet+video conferencing	• Two-way communication farm/extension/research
	• Collaborative networking for AR4D
• Internet+video+podcats_mobile	• Agricultural extension and training
• Internet+web 2.0	• Collaborative networking
• Internet+survey tools	• Involving stakholders in research planning
• Internet (wireless)+digital imaging+GIS	• Pest and disease identification/managment
• Internet+GIS+diagnostic software	• Remote diagnostics
• Internet+databases	• AR4D knowledge sharing, E-resource centres
• Internet+scanning+digitalization	• E-libraries/vertual libraires
• Internet+mobile phones+other ICTs	• E-villages, e-governments
• Internet+databases+integrity checking	• Policy negotiations, research, distance education
• Satellites+video conferencing	• Agricultural extension and training
• Satellites+radio	• Agrciltural extension and agro-technology transfer
• GPS	• Landuse planning
• Satellite communication+GIS	• Landuse planning
• GPS+GIS	• Pest and disease management
• PC+internet+planning software	• Farm management
• PC/laptop+internet (wireless)	• Monitoring and gathering data crop production
• PC+modelling software	• Modelling studies
• Radio	• Extension
• Radio+internet	• Interactive radion/info exchange/local vernaculars
• Radio+Internet+other ICTs	• Interactive radio
• NBIC (nanotech, biotech, InfoCognitive)	• Development of many innovations
• Laboratory technologies	• Enhancing laboratory work

In the second round of the e-consultation, the participants were invited to invest Euro 10 million in the development of ACP research capacity and infrastructure for a maximum of three of the listed ICTs which they considered most relevant for shaping the ACP agricultural science and innovation agenda over the next 5-10 years. Their collective investment preferences have been summarized in the table on the next page. This list of collective preferences clearly indicate that the respondents consider mobile phones in combination with the internet and other ICTs as the leading ICT applications for shaping the ACP agricultural science and innovation agenda over the next 5-10 years. However, rolling out fiber-optic networks for more bandwidth and faster internet connection, and the radio (used in combination with the internet) are also considered important in shaping this agenda.

Investments in ICTs n=17	number of investments	total sum of investments	ranking
Mobile phones in combination with internet and other ICTs	10	38	**22**
Fibre-optic network for more bandwidth	5	28	**16**
Radio and internet	5	20	**12**
Internet and online databases	5	14	**8**
Agricicultural extension and technology transfer	4	13	**8**
Satellite , GIS and GPS	5	12	**7**
Laboratory technologies	3	12	**7**
Internet for networking and communication (web 2.0, video conferencing)	4	9,5	**6**
Satellite and video conferncing	2	6	**4**
NBIC (nanotech, biotech, Infocognitive)	1	4	**2**
Collaborative networking for ARD	1	3	**2**
Market information systems	1	3	**2**
Wheather forecasts and information systems	1	3	**2**
Modelling software	1	2,5	**1**
Internet and planning software	1	2	**1**
Totals	**49**	**170**	

When their investments in the development of ACP research capacity and infrastructure are categorized on the basis of their use, the respondents showed great preference for ICTs for communication and collaborative networking, followed by online databases for research information and natural resource planning and fiber-optic networks for faster internet connections.

Investements in ICTs for n=17	number of investments	total sum of investments	ranking
Communication and collaborative networking (mobile phone and other ICTs)	17	56,5	**33**
Online databases for research information and natural resource planning	11	28	**16**
More bandwidth and faster internet (fibre-optic networks)	5	28	**16**
Broadcasting information (radio)	5	20	**12**
Agricultural support services	6	19	**11**
Better equipped laboratories	3	12	**7**
Other purposes and uses (nanotech, biotech, infocognitive, modeeling)	2	6,5	**4**
Totals	**49**	**170**	

10. Agricultural commodities, food and non-food

In the first round of this e-consultation, the respondents were asked to identify the most important agricultural commodities (food) that will be produced in ACP countries and traded globally over the next 5-10 years. They listed the following commodities:

1. Grains (rice, maize, wheat, sorghum)
2. Horticultural crops - vegetables
3. Horticulture – fruits
4. Coffee, tea and other beverages
5. Cassava, root and tuber crops
6. Bananas
7. Cacao
8. Spices
9. Sugarcane
10. Livestock, poultry and dairy

In the second round of the e-consultation the participants were requested to select maximum three commodities for which they would like to set up research programmes and allocate in total Euro 10 million to these programmes. They collectively spread their investments as follows:

Agricultural commodities (food) n=17	number of investments	**total sum of investments**	**ranking**
Grains (rice, maize, wheat , sorghum)	11	**39,8**	**23**
Horticulture – fruits	10	**32,8**	**19**
Horticulture – vegetables	8	**23,3**	**14**
Livestock, poultry and dairy	7	**25,5**	**15**
Cassava, root and tuber crops	5	**16**	**9**
Sugarcane	3	**12,5**	**7**
Coffee, tea, other beverages	3	**7**	**4**
Spices	2	**4**	**2**
Bananes	1	**3**	**2**
Cacao	1	**3**	**2**
Totals	**51**	**166,9**	

The list of investment preferences indicate that the respondents consider further research in grains, horticulture (fruits and vegetables) and livestock, poultry and dairy the most important objects for further research.

In the first round of this e-consultation, the same question was asked, but now regarding the most important agricultural commodities (**non food**) that will be produced in ACP countries and traded globally over the next 5-10 years.

The respondents listed the following commodities:

1. Cotton and other fibers
2. Biofuels
3. Coffee, tea and cocoa
4. Medicinal plants
5. Wood and timber
6. Flowers
7. Rubber
8. Essential oils and gum from plants
9. Spices

In the second round of the e-consultation the participants were again requested to select maximum three commodities for which they would like to set up research programmes and allocate in total Euro 10 million to these programmes. They collectively spread their investments as follows:

Agricultural commodities (non food) n=17	number of investments	**total sum of investments**	**ranking**
Medicinal plants	13	42	**25**
Essential oils and gums from plants	9	32,8	**19**
Flowers	7	24,3	**14**
Coffee, tea and cocoa	6	21,5	**13**
Biofuel crops	5	17,6	**10**
Cotton and other fibres	6	17	**10**
Wood and timber	4	13	**8**
Spices	1	4	**2**
Horticulture – fruits	1	4	**2**
Rubber	1	2	**1**
Total	**53**	**178,2**	

The list of investment preferences indicate that the respondents consider in medical plants and essential oils and gums from tree the most important objects for further research, followed by flowers and coffee, tea and cocoa.

11. Concluding comments

This e-consultation has been conducted in preparation of the annual meeting of the Advisory Committee on Science and Technology for ACP Agricultural and Rural Development in Montpellier, France, on 16 – 20 November 2009. The purpose of the e-consultation was to gather and compile the AC members' ideas and opinions on the theme of the annual meeting in order to inform the deliberations during the meeting and to facilitate formulation of conclusions and recommendations for future interventions.

The participants of this e-consultation have identified coping with *climate change, bio- and nanotechnology, information and communication systems for agricultural research and developments, green agricultural innovations and competing land use* and regional and *international trade* as the major technological challenges for ACP agricultural science and innovation over the next 5 – 10 years.

Climate change, *increasing water shortages* and *growing food insecurity* have also been identified as the most important megatrends at the global level that will impact on ACP agricultural science and innovation in ACP countries. Growing consensus on *climate change*, featured together with policy support for agricultural research and education and the spread of ICTs as positive mega trends.

In addition, *climate change* along with *low priority of agricultural development on political agendas*, and *growing food insecurity* have also featured as the most important negative megatrends in ACP countries which will impact on ACP agricultural science and innovation.

It therefore seems that overall the participants of this e-consultation consider climate change, first and foremost, the area of major concern for the ACP scientific community and their governments for investments in terms of research, capacity building and policy and financial support.

The spread of ICTs and their applications and bio- and nanotechnology are also seen as important for shaping the future agricultural science and innovation agenda in the ACP region and unlocking the potential of ACP agriculture. This is corroborated by the fact that the participants have clearly singled out biotechnology and genetic engineering, ICTs, natural resources and post-harvest technologies as the *most important scientific disciplines* for transforming ACP agriculture over the next 5-10 years.

With respect to the identification of agricultural commodities, food and non-food, that will be the most important ones in ACP countries for trade and consumption within the next 5 – 10 years, the participants singled out grains, fruits, vegetables, livestock, poultry and dairy, and cassava, root and

tubers as the most important *food crops*; and medical plants, and essentials oils and gums from plants as the most important *non-food crops*.

The participants have pointed to ICT applications for communication and collaborative networking (mobile phones together with internet and other ICT applications) as the most important combination that will likely shape the ACP agricultural science and innovation agenda in the years to come. Online databases for research information and natural resource planning follow second. The call for more bandwidth and faster internet connections (ranking 3) underscores the importance the participants attach to effective and efficient communications for collaborative networking and accessing online databases.

In conclusion, the results of this e-consultation could provide the basis for shaping the future ACP agricultural science and innovation agenda.

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