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Proceedings of the FAO International Symposium on the Role of Agricultural Biotechnologies in Sustainable Food Systems and Nutrition

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Chapter 6

Student interactive session: Bringing fresh perspectives

6.1 Report of outcomes from the student session

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I would like to start by thanking Louise Fresco, Ren Wang and Marcela Villarreal for their tremendous support and encouragement to organize this session. It was a first for FAO and for the seven universities from the different regions of the world, who co-hosted it with us. These were the West Africa Centre for Crop Improvement from the University of Ghana; Universidad Nacional de Colombia; Bogor Agricultural University from Indonesia; La Sapienza from Italy; American University of Beirut, Lebanon; Wageningen University from the Netherlands; and Cornell University from the United States of America.

As you know, in preparation for this event, these universities hosted webinars of the opening plenary session which took place on the morning of 15 February. The student representatives who participated in the session yesterday collected inputs from their fellow students, colleagues and teachers and put together their comments which were presented yesterday. So, thanks to all the teachers, student representatives and the technical staff for making it happen. Thanks to Young Professionals for Agricultural Development (YPARD) for joining hands and organizing the session with us and to all who watched online and sent their tweets. I am pleased to report that it was the most visited session of the symposium with some 4 000 impressions.

The student session lasted one and a half hours and there were five panelists: Gebisa Ejeta (Purdue University), Louise Fresco (Wageningen University and Research Centre), Margaret Gill (CGIAR Independent Science and Partnership Council), Gunter Pauli (Zero Emissions Research and Initiatives Network) and Maria Helena Semedo (FAO Deputy Director-General). The session started with key messages from the five panelists. They were passionate in their messages. They urged the students to build a strong foundation of education, to bring their skills to transform agriculture, to understand the problems, to learn, to unlearn, to take risks and innovate and find new linkages and applications to address the current and future challenges of food security and nutrition. They did not mince words. They said that whatever you have learned you will probably need to unlearn and start learning again because things are changing really fast.

The students, in turn, presented their statements and posed a wide range of questions to the panelists. In fact, there were so many questions and so little time that probably we should repeat the initiative. These questions covered a lot of ground, starting from job opportunities, especially for agriculture students; engagement with FAO policy-makers – how to do it, who will take the lead, who will

support them?; integration of science so that the public have a better understanding; how to improve communication – the gap in communication between smallholders and researchers (a recurring theme which was heard in other sessions); access to new biotechnologies – how will small farmers benefit from these biotechnologies?; what are the issues linked to intellectual property rights; what are the issues about genetically modified organisms (GMOs) that bothered them?; and how to conserve local knowledge and local genetic resources?

Three main points came out of the session:

1. The student community wants to be part of the dialogue in the decision-making processes. They want to know about the opportunities, and the decisions being taken on their behalf. They emphasized that there is a need to improve communication between policy-makers, researchers and smallholders about biotechnologies in all its forms; its benefits, risks and opportunities. Panelists fully supported and welcomed this opportunity for dialogue. The proposal for Youth FAO energized the students and everyone was tweeting about it. The students would like to see such sessions repeated with FAO on different occasions and with different themes, particularly at the regional level.

2. Biotechnology has to be better integrated and linked with other topics and issues related to food and agriculture. Agricultural biotechnology should be considered a part of the whole production chain complemented by a programme to assure marketing of the product obtained in each one of the parts. Funding should be increased for research for local needs, extension and rural education programmes for smallholders and students, so that both can get involved with new technologies, and add dignity and improve life quality in rural areas.

3. Students emphasized that participation of farmers and inclusion of smallholders in policy processes is essential to be able to transfer biotechnologies for their needs. Universities and small and medium enterprises have to work together to develop the rural communities to take and adopt these technologies. They want to have better capacity, a better understanding of issues. Academia, research centres, industry and communities should create new opportunities that can help young people to access and go to rural areas. Students from the cities particularly feel isolated and that they are losing touch. They don't want it, but that's the way it is. What can we do to change the approach? Panelists, in turn, noted that this session has created an opportunity and it should be seized to move forward. In closing the session, Maria Helena Semedo and Louise Fresco thanked the students for their active participation and reiterated that there was a need for a comprehensive approach to biotechnology to build trust and reduce risks. Appropriate policies at a higher level, together with appropriate regulations, were essential for a better engagement with biotechnology.

To sum up, the interaction confirmed that the student community is both hopeful and concerned about the role of biotechnologies and the state of food and agriculture and its impact on small farmers. They are aware of the new technologies, the vast new potential and the rapid advances that are being made. But will it translate into a better future? Will it make the world better? These are the larger questions that merit our reflection. Thank you.

6.2 Inputs from American University of Beirut, Lebanon

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Today, food production in the Near East region is facing many challenges, the primary one being climate change which is shifting our region from semi-arid to arid. Further, it is estimated that by 2050 we will have almost 692 million mouths to feed in one of the driest areas in the world. We believe that biotechnology is one of the tools to face this problem but, unfortunately, in most countries of our region, research in biotechnology is very limited and faces many problems, as noted below:

- the absence of national/regional strategies to address biotechnology-related issues as reflected in the absence of legislation and policies regarding biotechnology research, biosafety, transgenic crops and new technologies such as precision genetics;
- lack of proper communication resulting in poor public knowledge of the issue and their fear of biotechnology, as people are asking "Is it safe for consumption? Does it harm the environment?" or making statements such as: What you are doing is unnatural;
- lack of sustainable research funds to conduct long-term research along with the absence of proper infrastructure such as adequately equipped high-tech laboratories (which we have only few), appropriate glasshouses and research facilities;
- lack of cooperation and coordination between NGOs, governmental organizations, farmers and research establishments along with the limited governmental support to the agricultural sector;
- failure to attract and retain local expertise or skilled and experienced personnel by failing to provide them with the tools to achieve their ambitions;
- limited baseline data on the inventory and characterization of some or most local genetic resources.

American University of Beirut students support the advancement of biotechnology especially in terms of plant and animal tolerance to abiotic factors such as heat, drought and salinity, improving productivity and nutritive value of crops, resistance/immunity to plant and animal diseases. We believe that research in these areas can aid in overcoming the problems previously described as long as the ethics are conserved along with the safety of consumers and the environment.

We believe that intellectual property rights (IPR) should be reconsidered. Multinationals make use of the genetic resources found in developing countries, selecting genes of interest and using them for

their benefit in producing transgenic crops. It is reasonable to be rewarded because they are spending money, time and effort in studying biodiversity and discovering beneficial genes. However, these companies should be prevented from monopolizing this technology. We demand a way to allow firms and developing countries to mutually benefit from advancements in science and technology. This can be accomplished through:

- reconsidering IPR and breeders' rights to meet the needs of smallholders;
- supporting developing countries to upgrade their infrastructure, training of administrators, researchers and policy-makers, issuing proper legislation concerning biotechnology research and biosafety, and to take the right decision based on their own risk assessment. Developing countries should have the right to ban the entry, or ask for appropriate labelling, of any product containing or derived from GMOs;
- encouraging developing countries to engage in dialogue with smallholders and, based on the local need assessment, invest in biotechnology by making use of existing indigenous knowledge and resources;
- establishing deterrent penalties on firms/persons who hide information about the biosafety of a newly introduced product;
- developing capacities for management of genetically engineered crops.

Additional important points include:

- establishing a regional platform for sharing expertise and harmonizing laboratory procedures;
- encouraging innovative farming practices through merging biotechnology, conventional breeding and organic agriculture for sustainable development in reference to Professor Gunter Pauli on enhancing resource productivity;

With globalization, sustainable development in developing countries becomes the world's responsibility; problems in one country may result in problems in other distant countries as evidenced by immigration waves to developed countries.

Questions:

1. The major concern in Lebanon is biosafety and hiding information about labelling. How can this be addressed?
2. How can compromise be found on IPR to make technology more accessible to resolve problems in developing countries?

6.3 Inputs from Bogor Agricultural University, Indonesia

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Good evening, Ladies and gentlemen, my name is Irvan. I am the student representative from Indonesia. It is an honour to be invited to organize and participate in the agri-biotech webinar event of FAO. We conducted a discussion with eight universities across Indonesia and have concluded that biotechnology is a factor to achieving success for a sustainable food system and nutrition in Southeast Asia, especially in Indonesia.

In the modern world perspective, biotechnology in Asian countries, especially in Southeast Asia, is far behind the Western world. For instance, many biotech seeds (GMO) are monopolized by giant multinational companies. They protect their seeds with IPR, which causes dependency of developing countries and smallholder farmers on multinational companies. However, the costs for developing countries, like Indonesia, to develop their own seeds are expensive and it takes a long time to create a successful output. If food sustainability and nutrition are rights for every country, then we need to eradicate capitalism in biotechnology. In Indonesia, however, we don't rely on GMOs. Our farmers put a great effort to developing and making hybrid seeds themselves. Therefore, we urge the panelists to prioritize support to local biotechnology development.

In order to protect the rights of good food and nutrition to all people, FAO and related institutions must focus on how to educate and strengthen the local farmers to be independent and developed. This might be done by giving capital support which include human, financial or even constructed capital. Developed countries should help developing countries in term of biotechnologies education and help them to be independent, not to be dependent. Biotechnology should be the property of government, NGOs and local communities and not the responsibility of private sector for profits.

Traditionally, Asia is a rich continent with thousands of heritage cultures and high biodiversity. This legacy has proven to be the crucial resource for sustainability. Asia is already aware of simple biotechnology for centuries. For instance, fermentation processes. Biotechnology is part of our culture. We have tempe in Indonesia, kimchi in Korea, appam in India, gundruk in Nepal etc. We have hundreds of fermented foods. Many of our fermented foods are healthy nutrition sources, a cultural treasure and source of income to communities.

On biodiversity, the focus on high productivity in developing countries often contradicts the preservation of biodiversity. Illegal deforestation is happening every year. As a developing country, we believe that high productivity should be hand-in-hand with protecting nature. We propose:

- Policy-makers, scientists and international bodies to consider the local wisdom in the making of policy. Deeper research should be done before making any policies.
- Policy-makers need to consider the biodiversity. Illegal activity that could harm preservation should be punished, without exception.

Lastly, in Asia's case, especially Indonesia, we have obstacles in agricultural branding, especially with youth interest in agriculture. Young generations tend to choose popular topics such as medicine, law, engineering, etc. Agriculture is considered far inferior to those topics. Agriculture is related to dirt, crops and low salary jobs. Following these issues, we propose to FAO and policy-makers to support student associations and youth activities that relate to agriculture. We believe that more participation from youth equals higher success rates in our agriculture. This will automatically affect the sustainability of agriculture, especially biotechnology. This is why I joined the International Association of students in Agricultural and related Sciences (IAAS), the largest agricultural student association in the world. IAAS Indonesia has an activity called Youth Agricareture which aims to make agriculture sexier than ever before.

Questions:

1. For Gunter Pauli: Earlier in this statement, we proposed to focus on giving capital support to local farmers. How can the Blue Economy support this proposal, what is the relation between them, and how can Blue Economy support the 2020 Goals related to the proposal?
2. For Maria Helena Semedo: In Asia, the image of agriculture is less popular than other subjects such as economics, law and medicine. How will the effects of Zero Hunger programmes raise the image of agriculture to youth as a career?
3. For Gebisa Ejeta: Imagine that sorghum projects are being implemented in Asian countries where farmers already have other crops growing on their land. What is the argument supporting urgency to plant sorghum in Asian countries?
4. For Louise Fresco: You have vast experience in running boards across several continents and see agricultural development in many parts of the world. Which country is more likely to succeed in reaching independence to ensure the sustainability of food and nutrition – the country using GMOs, or the country against GMOs?

6.4 Inputs from Cornell University, the United States of America

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We are impressed with the scope of this FAO symposium to address the role of agricultural biotechnology in our global food system. The students at Cornell University noted an overall recognition of the importance of communication in the implementation of new technologies. We certainly do not disagree.

However, we suggest focusing on the following four points:

1. Existing communication gaps between policy-makers, researchers, farmers and consumers inhibit actions in implementing solutions to food security that require input from each stakeholder.
2. Agricultural extension systems provide a "way in" for policy-makers and researchers to work with smallholder farmers, who often lack a voice in decision-making. More fully supporting those working in extension is necessary to strengthen these systems.
3. We must embrace innovative solutions to foster specific and successful networks. Too long have we relied on imprecise methods of capacity building instead of using data-driven methods.
   - Network analysis and visualization tools offer tangible solutions that can be implemented TODAY to help address capacity building in smallholder communities. Additional data-driven solutions should be regularly employed to help farmers make smart decisions about what to grow, and when.
4. As we know, scientific methods include successful and failed experiments and we learn from both. It is important for policy-makers to become comfortable with the fact that science is cumulative, and failure is a necessary part of the process. Funding science does not always mean funding success – at least the first time around.

That being said, I would like to challenge you to facilitate a more in-depth discussion that takes full advantage of the people and stakeholders you currently have available.

Few people disagree with the fact that local knowledge is valuable and community wants and needs should be incorporated into development work. Rather, we need to address the communication gap by utilizing existing extension networks to facilitate a system that transports ideas, wants and needs in both directions. Many see the current system of implementing biotechnology as a top-down approach, where researchers and policy-makers develop solutions independently from beneficiaries.

The scientific community has the responsibility to communicate the benefits and limitations of research. This is especially true in agricultural biotechnology, where the objections move beyond those which science can answer. Policy-makers must reconcile with competing economic and development interests, while still amplifying the voices of their constituents.

I would like to thank each of you for including students in this symposium. We are excited and enthusiastic about participating, and agree that incorporating a diverse number of stakeholders in your approach to agricultural biotechnology policy is an important step in creating an effective strategy. Thank you.

Question:

What are some policy incentives that would encourage public–private partnerships in the biotechnology sector while creating opportunities for small businesses and researchers to capture some of the potential profit?

6.5 Inputs from Universidad Nacional de Colombia, Colombia

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Colombia is a unique country with a privileged geographic position, giving it a wide variety of ecosystems, weather and biodiversity, including its own genetic material of livestock, fishes, forest, crops and micro-organisms. Our country traditionally has been an agricultural producer.

Eighty years ago, 70 percent of Colombia's population lived in rural areas. Today, rural areas are inhabited by only 25 percent of the population (approximately 11 300 000 people). This is largely due to migration of the rural population to cities, resulting from internal conflict (paramilitaries, guerrilla and drug trafficking) and poor living conditions of the rural areas. Notably, 70 percent of the total food consumed in Colombia is produced in its rural areas by smallholders, an incredible number taking into account that less than 55 percent of the smallholders do not receive technical assistance.

Today, Colombia is negotiating a peace treaty between the government and the guerrilla, which should change the rural environment in our country.

Suggestions, opportunities and challenges: "A rich country with poor people"

Income generation through development of new biotechnologies can be one tool for combating narcotic trafficking, especially for smallholders living and working in areas of conflict. Development of biotechnologies should be considered as a part of the production value chain, and with a complementary marketing programme can ensure income stimulation. Investment in research funding to address local needs such as extension and rural education programmes and engaging smallholders in new technologies can add dignity and improve the quality of life to people living in the rural areas.

It is important to choose and prioritize the research applied to local needs, including traditional knowledge of the communities. This research can create a link between academia, research centres, smallholders and the market to develop new value-added products (i.e. certificate of origin, products coming from conflict areas now in peace and gastronomic new trends).

Considering that Colombia is a biodiverse country, it is necessary to conduct research on the identification, depuration, evaluation, conservation and uses of native species and varieties produced in local communities to preserve genetic heritage resources. This is especially relevant given the change in global climatic conditions. An example of such research is a project undertaken at the Institute of Biotechnology at the Universidad Nacional de Colombia, with the cooperation of the Netherlands, to conduct research on genetic identification, depuration and increased pest resistance of varieties of yams and the use of biopesticides and biofertilizers in small communities.

Colombia's national policy of science, technology and innovation is focused on the biotechnology, but it is only designed for funding of big biotechnology enterprises (industrial producers). While some biotechnologies may not be relevant to smallholders, there may be opportunities to bridge and adopt this knowledge for the smallholders' benefit. We suggest support and inclusion of smallholders in policy dialogue and policy development for increasing strong governmental extension programmes and addressing smallholders' biotechnology needs and concerns. This could be possible through promotion of smallholders associations and organizations with political will.

As Colombian students, we would like to ask FAO to support the involvement of smallholder organizations in the development of biotechnology policies and applied research programmes. Also, financial support is required to develop local projects and build capacities of smallholder associations and cooperatives, leading to increased incomes which will raise the welfare and dignity of the rural population.

Finally, we would like to emphasize the integration of academia, research centres, industries and communities to jointly develop new opportunities which will encourage the return of young people to the rural areas.

6.6 Inputs from Universidade Federal do Rio Grande do Sul, Brazil[15]

Felipe Vargas

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Brazil

Before addressing the panel and to all the students that are watching and listening to right now, I would like to thank FAO for giving me the opportunity to be here.

As a social scientist, I would like to address many subjects. However, I recognize the need to be short and sharp in my contribution in this particular session. For the record, I emphasize an interesting feature of these debates: that some ideas and concepts such as "small farmer" do not mean the same in all corners of the world; that the word "biotechnologies" encompasses many old and new technologies and techniques; and even the heterogeneity of the stratum of students present in this session, including graduates and postgraduates, engineers, biologists, agronomists and sociologists.

At a parallel session yesterday, I attempted to formulate a question about the relation between biotechnological processes and the logical way to implement them on behalf of small farmers. For me, two main ideas seem to be often repeated in the symposium: 1) biotechnologies are not equal to GMOs; and 2) we need to integrate small farmers into biotechnological development. Useful ideas were presented in this axis. I will try, at least, to address them.

"Biotechnology" has multiple meanings, even if sometimes we use it indistinctly. It is a definition that is not easy to grasp. In this idea, with the gratitude that I feel about this open debate, there comes also worries or concerns. My worry about "biotechnologies are not equal to GMOs" is in the way that this "broader" definition de-emphasizes the particularities of each biotechnology. For instance, the recent history regarding what the implementation of some biotechnologies implies. In Brazil, as well in other countries such as Uruguay, Bolivia (Plurinational State of) and Mexico, for instance, there are plenty of examples of farmers who have lost access to seeds or the right to save them. This has resulted in diminished varieties, which have lost some features of the social, cultural and historical processes of farming because of the GM crops and some "biotechniques" such as *in vitro* fertilization or laboratory fermentation.

[15] Felipe Vargas delivered his statement while attending the student session in Rome. Unlike those from other universities, the statement was not prepared following the hosting of a webinar to gather inputs from other students at his university.

I will address biotechnologies in the framework of the processing (part of) of farming materials outside the context of the small farmers' lands. Biotechnologies give power, but they do not allow one to define its use or the directions it should take. It is, of course, a technical insight but also a political one, and I'm going to define politics as the various possible ways we assemble persons, things or institutions all together.

In the implementation of GMOs, for example, we have a tricky assemblage. To be adapted and become productive, the GM crops must rely on the local varieties (the crossbreed that takes place after the laboratory modification and before the sowing) the same varieties that come to be reduced after a while in the name of production. This is a paradox.

And my second concern, about "the need of small farmers' integration", goes in the same direction. Taking forward what Dominic Glover said in a parallel session of this symposium, that these are the same varieties passed on by generations and they require and express the attachments of small farmers at "homemade knowledge". But taking these away for laboratory analyses and "improvement" can de-contextualize them. This is the case in Brazil and for some southern states such as Rio Grande do Sul, Santa Catarina and Paraná. Such varieties carry specific potential in facing food scarcity, nutrition and climate change within the assemblages they respond to. Another paradox. It is not that we must avoid change. But it is important to envisage change without taking "production" and "integration" for granted. I have seen many of the presentations during the symposium about fungus cultures, fermentation, livestock with artificial insemination and so on, and my worries apply to them in the sense that they might also activate this historical framework.

My questions then are very concrete: how to target the new biotechnologies to small farmers so that no one loses, especially them? Which policies or decision-making tools do we have to account for farmers' choices? I do not know if IPR can answer that, but it is imperative that small farmers are included in discussions at each step.

To me, this is a concrete question with a concrete line of action. I hope it will make us hesitate about the "certainties" of benefits. Certainties, I emphasize, in contrast with "supposed" risks that biotechnologies produce. Thank you all once again.

6.7 Inputs from Università degli Studi di Roma "La Sapienza", Italy

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Sustainable food systems: A point of view of the Italian students

In 1944, the agricultural initiative known as the "green revolution" had an aim to save over a billion people from hunger and malnutrition. According to FAO data, at the end of the 1960s, 34 percent of people living in developing countries were malnourished. In the last 25 years, this has declined to 13 percent, with a slight increase from 2002 to 2007.

Through science and technologies, the aim of the current generation will be to improve food production while reducing soil erosion and minimizing use of fossil fuels and water resources. The key words are "productivity" and "sustainability". To find medium- and long-term solutions, it will be essential to investigate basic biological and molecular biology research. For example, research will allow for: 1) greater understanding of plants and the biological inefficiencies to improve yields while starting from the same input resources; 2) understanding how a plant responds to environmental stresses in order to develop stress-resistant plants; and 3) sequencing of the most important agronomic species. Modern biotechnology techniques, such as genome editing, can enhance scientific knowledge and its applications.

Agricultural biotechnologies have a key role in sustainable food systems and nutrition, particularly in food safety. Notably, fungal pathogens generate severe safety and economic losses by killing plants or reducing their yield through contamination of mycotoxins; hazardous side effects caused by chemicals continue to emerge; environmental pollution is impacting human and animal health. To preserve safety and quality of crops, such as cereals, biotechnology research programmes can stimulate plant defence through biocontrol agents, using biopesticides to limit pathogen growth, inhibiting or degrading toxins with biodegraders.

A great percentage of worldwide energy comes from fossil fuel refineries. The use of biomass as a renewable energy resource has gained attention in the last decade due to its potential to reduce the carbon dioxide burden of the atmosphere. In most cases only parts of the incoming biomass are actually used for the generation of a particular food product, with potential biogenic residues occurring in large quantities during the food processing stage ("product specific residues"). The most prominent use of food processing residues includes biomaterial resources, animal feedstock, chemical feedstock and energy resources.

In the last few years, the development of mixed culture processes for polyhydroxyalkanoates (PHAs) production from agro-industrial waste effluents has gained considerable attention from researchers. PHAs are among the most promising candidates as substitutes for synthetic polymers. Indeed, PHAs are biologically synthesized polyesters completely biodegradable to water and carbon dioxide and can be produced from renewable resources. The main applications of PHAs include packaging, compost bags, agriculture/horticulture films and bags (e.g. mulch films), durable goods and consumer retail goods (cosmetic and hygiene materials).

Environmental pollution is one of the risk factors increasing incidence of non-communicable diseases, together with poor diet, physical inactivity and psychological stress. According to the World Health Organization, in 2008 approximately 37 million deaths were attributed to non-communicable diseases. Increasing consumption of fruits and vegetables containing nutraceuticals and bioactive substances can reduce the risk of death due to non-communicable diseases. Further research in health medicine and modern biotechnologies can provide assessments on disease predictive index throughout metabolic suitable parameters.

In sum, it is the duty of wealthy countries, companies and international organizations to realize a more equitable world through a redistribution of wealth, regulating processes and involving local communities in the development of their nations.

Questions:

1. In order to enhance productivity, sustainability and food safety of the most important agronomic species that are best adapted to each environment, it is key to develop solutions through modern biotechnologies. Do you think it will be possible in Europe?
2. People are concerned about the use of modern biotechnologies in nature. Today it is more important than ever that the dissemination of biotechnology information be shared with the public. Would it be helpful for citizens to encourage scientists to share this information?

6.8 Inputs from University of Ghana, Ghana

Juliana Mariama Vangahun and Kwabena Asare Bediako

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The role of agricultural biotechnology in sustainable food systems and nutrition

Biotechnology can meet the growing demand for food due to rapid population growth and consequences of climate change on agricultural production. Biotechnology offers an opportunity to develop new plant varieties with beneficial genetic traits for high yield, pest and disease resistance, improved nutritional value, and tolerance to drought, salinity and herbicide to adequately meet the growing population and conserve our biodiversity.

Conventional breeding approaches have been used by scientists to improve plants and animal for human benefit for over decades. However, conventional breeding through crosses takes 7–10 years to breed a new variety.

With biotechnology, modern crop breeders can identify and move gene(s) conferring a specific trait into another plant with ease and precision, selecting for the most beneficial traits. These tools also allow plant breeders to overcome cross-ability barriers. Beneficial traits such as high yield, high beta-carotene and high iron can have great impact on sustainable food production and nutrition in our systems. The advent of biotechnology increases job opportunities for men, women and youths and reduces the labour involved from production to processing along the food value chain. Consumption of biofortified food developed through biotechnological means, can reduce nutritional deficiency in the vulnerable population in Africa.

Despite all the benefits of agricultural biotechnology, gaps exist in Africa regarding gender issues, capacity building, technology transfer and genetically modified products. We believe that providing solutions to concerns raised below will address challenges facing Africa in agricultural biotechnology.

1. Why is technology transfer from West to Africa slow?
   There is weak collaboration between the western world and Africa in such a way that available technologies are not accessible to Africans. This increases the dependency of biotechnology application on the western world and retards the development of Africa in the area of biotechnology.

2. How do we deal with the poor adoption of GMOs in Africa?
   The adoption of biotechnology is limited by low levels of education of stakeholders, lack of biotechnological facilities and commercialization of the GM products. The beneficiaries of the technology are not well informed of its benefits and risks. This gives rise to misconceptions which implant fear in beneficiaries leading to low adoption of the technology. Additionally, limited job opportunities in Africa render biotechnologists ineffective in knowledge transfer.

3. What are the policies governing the introduction and use of GM products in Africa?
   There is fear that the introduction of GM varieties will result in loss of landraces which will eventually put our poor farmers at the mercy of multibillion companies with unaffordable cost on GM products. In this regard, there should be regulations to effectively conserve our landraces with the introduction of GM varieties and control the price of GM products.

4. What opportunities exist for youth in Africa as next generation policy-makers?
   Youths in Africa have received little consideration regarding biotechnology. By exposing the youth to biotechnology activities as next generation policy-makers, the youth can institute measures that will improve and promote biotechnology in Africa. Additionally, the youth can also engage in training and public sensitization for people to appreciate the benefits of biotechnology to subsequently reduce the controversy on the use of GMOs in Africa.

5. How do farmers benefit from biotechnology?
   The larger portion of the world's poorest and hungry population is the small-scale farmers, the majority of whom are in Africa. Major limiting factors to food production in Africa include: land issues, disease and pests, drought, poor soils and poor quality seed. Biotechnology can effectively contribute to mitigating some of the above issues in Africa, for example: increased productivity and reduction in production costs, improvement of farmers' health by enriching staple food with more nutrients such as essential vitamins, reduced effects on environment, reduced poverty and increased income.

6.9 Inputs from Wageningen University, the Netherlands

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First and foremost, thank you for including this student session as part of the agri-biotechnology symposium. We feel extremely privileged to share Wageningen University's students' perspectives on biotechnology.

The current and future problems in food insecurity and agriculture globally are complex, and have been extensively talked about during this symposium. We believe biotechnology can be one of the potential solutions to eradicating hunger through an integrated approach. To begin, we would like to start with input of Wageningen students in the form of three points of discussion.

First, we believe it is essential to employ public debates to raise awareness and insight on biotechnology. This has not been sufficiently addressed; people must be informed to develop proper opinions. These debates should be transparent and not based on assumptions.

Second, we have heard from many pro-GMO speakers that current regulations on GMO technology take too long. Multiple independent studies have shown that GMOs do not have adverse effects. However, as Professor Louise Fresco said: no evidence of risk is not proof that there is no risk. Thus, we strongly recommend that while shortening current regulations, the quality of the regulation and the quality of the decisions should be strictly maintained.

Finally, we suggest an integration of both agroecology and biotechnology and not to consider these as completely different fields of study. We sincerely hope, as Professor Gunter Pauli has shown, that multiple approaches are seen as feasible, and that a multidisciplinary approach is preferred. The world hunger problem is more than simple technical and financial issues, and we believe that investments in science in the broadest way possible are needed. These investments are not necessarily the same techniques in which the big companies are investing – where public demand has already been established. A narrow view could potentially lead to lost opportunities of finding solutions, as Professor Pauli has demonstrated to us in using the example of a whole-chain approach.

In sum, we recommend biotechnology as a systems approach – an integration of the best of both worlds. We would suggest to organize a symposium bringing both fields of study which could potentially lead to even better solutions than a symposium on biotechnology alone. We would appreciate the opportunity to participate as students and scientists in this potential event.

Questions:

1. Local knowledge, needs and social dialogue are said to be important in biotechnology innovations, but in which phase of the innovation process are they needed – at the moment of setting the agenda for research and development or at the point of implementation?
2. In your opinion, can the world hunger problem be solved by investing in agroecological approaches, and, if so, why do you believe we need to invest public budgets in biotechnology?
3. In solving world hunger with biotechnologies, are we not overlooking the fact that a huge share of the arable land is now used to produce feed for livestock animals, instead of feeding the hungry people?
4. How can a good knowledge infrastructure be established in poor countries in which investments will not be one-sided, but distributed over the diverse fields of knowledge?