FSBA Course description

FOOD SECURITY AND BIOTECHNOLOGY IN AFRICA

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Description of the modules of the Master course in Food Security and Biotechnology in Africa

Preambule

This document was discussed and adopted in its entirety by all project members during the FSBA kick-off meeting at the University of Eldoret, Kenya from 25 to 29 November, 2013.

Introduction

The main objective of the EDULINK-FSBA project is to work at the sustainable introduction of biotechnology in African agriculture by addressing biosafety and biosecurity concerns from the viewpoint of all stakeholders: from small holders and consumers to policymakers. In reaching this objective it is aimed to follow a co-evolutionary approach in which scientific, technological, societal and institutional developments and conditions are considered as being tightly interwoven and are thus to be addressed in an integrative way. Biosafety and food security are related to food sovereignty, a concept that stresses the right of peoples to define their own agricultural production systems.

So, one may conclude that the sustainable introduction of biotechnology should take into account besides the issue of biotechnology itself, related topics such as agricultural systems, social resistance against (bio)technologies, risk perceptions, regulation and governance, ethics, stakeholder involvement, and mechanisms of interaction between science, technology and society. Based on these considerations, the following 6 modules are proposed:

1. Food security, agricultural systems, and the use of technology
2. Biotechnology; history, state of the art, future
3. Societal responses to the rise of biotechnology
4. Regulation and policy approaches to biotechnology
5. Ethics and world views in relation to biotechnology
6. Tailoring biotechnology: towards societal responsibility and country specific approaches

We propose that the 6 course modules, which are to be developed by the FSBA project, elaborate on these themes. We would like to invite the FSBA project partners to give their views on the proposed modules. The overall learning objective of the set of course modules is to equip students with knowledge and skills on these topics, so that they will be able to contribute in their professional career, to realizing truly sustainable practices and uses of biotechnology.

Module 1. Food security, agricultural systems, and the use of technology

Africa faces the challenge of meeting food security as its growing population is currently reaching, or will soon reach, the number of one billion people. The issue of food security is strongly related to the area of prerequisites for (societal) sustainability and public health. Biotechnology is considered as one of the promising factors (besides others) in realizing food security and enlarging the agricultural potential of the continent. However, successful and socially accepted introduction of biotechnology must take into account physical and societal preconditions of African countries and should also overcome biosafety and social concerns. It is therefore important to outline in this course module, the physical and social peculiarities and conditions of current African agricultural systems, as well as their production potential.

From this point of view, it is helpful to understand why the Green Revolution was very successful in increasing the food production capacity in Asian and Latin-American countries, but did not really succeed in sub-Saharan Africa. It appeared that especially the infrastructural conditions (such as transport facilities, weather conditions, research capacity, etc.) were not favourable for the Green Revolution to take place in Africa. However, in countries where the Green Revolution was successful, many unexpected side-effects also occurred. One may think of environmental pollution, new pests, disruption of local social structures, loss of indigenous knowledge, and of loss of local crop varieties. Especially the fact that Green Revolution technologies (such as the use of hybrid varieties, irrigation techniques, pesticides, artificial fertilizers, etc.) were actually developed outside the areas where they were used, may be considered as a failing factor as it did fit in existing practices. In general, a gap between the conditions that come with a new technology (such as socioeconomic and physical infrastructures) and the actual physical and socioeconomic conditions in the area where the new technology will be introduced, must be considered as a receipt for failure or even worse, for a disruptive impact on local communities. In other words, we need insights in how new technologies can be tailored to the requirements of local contexts, and the other way round: which societal developments are needed for the successful introduction of new technologies.

In addition, it is useful to reflect on what is meant by the term “food security”. Food security according to the FAO "exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (http://www.fao.org/economic/ess/ess-fs/en/). Others have criticised this concept as it may also be realized by large-scale non-community-based agriculture or by food importation, thus making people dependent on external, nonself-controllable factors. Instead of food security, the concept of food sovereignty has been proposed which is defined as “the right of peoples to healthy and culturally appropriate food, produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems.”http://www.foodsovereignty.org/Aboutus/WhatisIPC.aspx Clearly, this latter concept has a political meaning and impact. However, we should realize that neglect of the issue of sovereignty in the concept of food security is also a political choice.

Topics that will be addressed in this course module:

- Demographic developments on the African continent: what will the future bring us?
- The variability of African agricultural systems: from small to large scale
- Current production levels in African agriculture
- Successes and failures of the Green Revolution – lessons to be learned
- Food security, food sovereignty and the civil society

Module 2. Biotechnology: history, state of the art, future

In general we may consider biotechnology as the utilization of biological organisms on a scientific base. For example, according to the UN Convention on Biological Diversity, article 2"biotechnology means any technological application that uses biological systems, living organisms or derivatives thereof, to make or modify products or processes for specific use". In this context, one may consider classical breeding techniques and beer brewing as examples of biotechnology. However, the term "biotechnology" is used by many in a much more narrow sense, often labeled as "modern biotechnology", i.e. the application of genetic engineering or genetic modification techniques, for making or modifying biological products or processes. In contrast to classical biotechnology, in modern biotechnology genes from other species are introduced into a species' gene pool. From this perspective one may consider the hybrid variety technology, which was a leading technology during the Green Revolution (see module 1), as an example of classical biotechnology. In contrast, the development and introduction of genetically modified crops in recent decennia should be considered as an example of modern biotechnology or modern breeding. However, the distinction is not sharp because modern biotechnological techniques such as marker-assisted selection are nowadays frequently used within the context of classical breeding practices.

The first applications of modern biotechnology were announced in the early 1970s and were applied to micro-organisms. In the 1980s, the first plant applications were introduced. However, it was only in 1996 when the first applications were commercialized. Since this introduction the cultivation area of genetically modified crops has gradually increased. Main applications are herbicide tolerance and pest resistance (especially Bt-applications) or combinations of these two. Nearly all commercialized plant applications concern only 4 crops: cotton, soybean, maize, and canola. In 2012 around 81% of all cotton and soybean worldwide was genetically modified. For maize and canola these percentages were 35 and 30 percent respectively.

In the 1990s, the first animal applications were introduced, especially in the field of medicine production, e.g. the production of ATryn in the milk of genetically modified goats. More recently a food application of animal biotechnology was developed in the United States: a genetically modified salmon species for the fish farming industry. It is expected that cloning of animals, which is also considered as a form of modern biotechnology, will be introduced in the food industry, although it will not necessarily involve genetic modification.

Biotechnology is a rapidly developing field of science and technology. Whereas genetic engineering initially focused on the level of DNA, nowadays the whole genome (genomics), the whole set of proteins (proteomics), and metabolic pathways (metabolomics) are increasingly important fields in biotechnology research. In addition, it is expected that synthetic biology, the science of the genetic design, nanotechnology, and information technology will affect the life sciences and agricultural technologies in the near future. Moreover, these new techniques and insights will find their way in existing and more classical technologies, blurring the boundaries of what has been labeled as classical and modern biotechnology. As indicated above, marker-assisted breeding is increasingly applied in classical breeding. Other developments are cis-genesis and reversed breeding. Cis-genesis is genetic engineering within the same species, thus without passing the species boundaries and in that respect similar to classical breeding. Reversed breeding is a technique where genetic engineering is applied for producing homozygote plants out of heterozygote plants in order to use them subsequently for hybrid breeding. It is interesting to know how these new developments will affect African agriculture and if and how they can contribute to food security and food sovereignty.

Topics that will be addressed:

- What do we mean by biotechnology and what kind of applications have been developed since its introduction?
- How do current applications of biotechnology relate to the most important agricultural systems in Africa?
- Which new developments can be expectedin biotechnological sciences and applications?

Module 3: Societal responses to the rise of biotechnology

Right from the beginning, biotechnology was criticized for many reasons. After the announcement of the first so-called recombinant DNA experiments, scientists warned for the risk of a outbreak of new diseases. This concern was based on genetic engineering of human cancer genes into the genome of the bacteria Escherichia coli and led to an international, voluntary moratorium on such biotechnology research. The moratorium was lifted after the Asilomar conference in 1975 where security measures were formulated and approved by the international scientific community. Later on, in the 1980s, a big international societal controversy rose because of the introduction of patent rights on genetically modified applications making high investments by private companies possible in the then new field of biotechnology. Especially developing countries feared that they had to pay high prices for products, such as medicines, that were based on genes from organisms taken from their own countries. As a result in 1994, under the administration of the World Trade Organization (WTO) an international agreement on Trade Related Aspects of Intellectual Property Rights (TRIPs) was established in which minimum standards for intellectual property (IPr) regulation were agreed. However property rights are still a controversial issue as it provides much economic and scientific influence to the ones owning these rights.

Another issue that has arisen is the safety of the introduction of genetically modified organisms (GMOs) in the environment. The term "bio-safety" refers to the possible risks of the introduction of GMOs with respect to public health and the environment. Public health may be affected by e.g. the occurrence of toxic or allergic substance in food produced with help of modern biotechnology. Environment damage may occur by disturbing effects of GMOs on ecosystems. For example, GMOs may have negative effects on wild species or may even interbreed with natural varieties. Especially European citizens have a hostile attitude towards biotechnologically modified food products, probably based on a number of food scandals such as the BSE affair (mad cow disease). Bio-safety regulation systems with respect to experiments, commercial growing, and importation of genetically modified food have been implemented in the European Union, the USA and many other countries (see module 4).

Most biosafety approaches focus on health and environmental consequences of modern biotechnology. However, much resistance against the introduction of modern agricultural biotechnology is based on another issue, i.e. the expected impact upon local socioeconomic structures and traditions. Especially, the fact that current main applications often focus on cash crops in a value chain where big international corporations dominate, worries many people. Here the concept of food sovereignty comes in and the challenge is to develop biotechnologies that strengthen local farmers and situations.

Not all resistance against biotechnology is based on bio-safety or socioeconomic consideration. Especially in Europe but also in many other countries in the world, public concern raises from principal ethical considerations. Genetic engineering is considered by some people as a technology overruling natural boundaries and natural orderings by an unacceptable extent. Such objections relate to religions, worldview and traditions (see also module 5). It is important to know if such objections play a role in the African context as, in general, immaterial drives and considerations may have an large impact on the acceptance or rejection of biotechnology.

Topics that will be addressed:

- What are the health effects of modern biotechnology in the African context?
- What are the possible ecological effects of modern biotechnology in the African context?
- Which socioeconomic effects of modern biotechnology in the African context?

Module 4. Regulation of and policy approaches to biotechnology

Regulation of biotechnology focuses on health and environmental safety aspects of genetically modified products and processes. Regulations systems are different in different countries and continents. For example, the EU considers a product as a GMO if during the production process modern biotechnology was applied, whereas the USA considers something a GMO only if the product itself is genetically modified. Such differences have already led to trade conflicts between the EU and the USA.An important difference between the EU and the USA (and Canada) is that the EU also considers ethical aspects in its regulation. It applies the so-called pre-cautionary principle, i.e. it does not allow GMOs if there is not sufficient scientific evidence that it is safe to use. Moreover, the EU requires labeling of genetically modified foods in order to give citizens the possibility to reject the use of these products. As a result of the stricter regulation in the EU and the hostile attitude of EU-citizens, hardly any genetically modified human food product can be found in the EU. On the other hand much life stock in the EU is fed by genetically modified feed usually based on GM soybean from Latin America. Because the EU is an important export country for developing countries the stricter EU regulation also affects these countries.

Countries that have not developed a regulation framework for genetically modified organisms are bound (if they have ratified) by the Cartagena protocol on Bio-safety, which is an international agreement on bio-safety and a supplement to the UN Convention on Biological Diversity. Also the Cartagena protocol follows the pre-cautionary principle.

The term 'regulation' is commonly understood as the employment of a set of rules, procedures and laws that deal with experiments, growth and trade of GMOs. However, this is not enough to guarantee safety or public acceptance. There is much more than the regulation of safety only. The topic of intellectual property right (IPR) is another important element of regulation. Who is the owner of a variety? Different property rights exist. Besides patent systems we may e.g. distinguish plant breeder rights and open source approaches. It is important to know what the benefits and drawbacks of the different IPR systems are for local communities and how they can be realized.

In this context, the expected introduction of so-called generic application is interesting. In the coming years the first GMO patents will expire. Theoretically, this may imply that fees have not to be paid to the patent holder anymore, making biotechnological applications cheaper and their use by farmers and local breeders less restricted. On the other hand, in many countries a permit for growing GMOs is only given for a limited period of time. After that period a new permit must by asked for. If the initial developer of the GMO has not a financial interest in continuation of the permit, it may be uncertain if the GMO will remain available. Here we see that IPRs and bio-safety regulation may affect each other.

The latter example demonstrates that biotechnology regulation is not context independent. On the contrary, effective regulation for the long term requires much more then just a set of procedures; it needs the embedment within a civil society, i.e. the existence of institutions that take care for the design, the interaction with other rules and laws, the implementation, maintenance, control, and evaluation. Even in Europe, where regulation is established within rather democratic pathways of public control, there is still a lot of distrust among the public on how bio-safety of biotechnology is regulated. So, it is very important to pay attention to the question how regulation should be set up for it to be effective. Most probably, Africa can learn from Europe on how to avoid certain errors with respect to the realization of regulation.

Topics that will be addressed:

- US, Canadian and EU regulation
- Regulation in developing countries (as far as implemented)
- Cartagena protocol
- Effects of current regulation regimes
- IP regulations and the TRIPs agreement
- New developments: generic applications
- From regulation towards governance approaches / civil society

Module 5. Ethics and worldviews in relation to biotechnology

Ethics and/or worldviews (including religion and ideologies) are important because they give sense and meaning to daily life. This is especially true for agriculture because it provides one of the most essential things to all men's life: food. Moreover, as agriculture and food are directly related to health and community traditions, technologies that affect agricultural practices also interact with ethics and/or worldviews of the people and communities involved. For the sake of smooth readability, we will use in the following section the term 'ethics' for both ethics and worldviews.

The main questions ethics aims to answer are: 'How should we live?', 'How should we act?' or 'What is right?' These are practical questions and the answers lead to a particular morality we can find within a community. However, ethics as a more theoretical enterprise tries to give answers to the question "Why should we live in this or that way?' Thus, so-called normative theories aim to give answers to the reasons that underpin particular moral behaviors. This is important in the case of biotechnology because this is a global enterprise were many different groups, traditions, countries, etc. interact, and where different perspectives on morality and ethics may meet each other. Mutual understanding of different ethical perspectives will contribute to a better societal embedment of new agricultural technologies.

Developing this module will imply the elaboration of the main ethical theories such as virtue ethics (related to communitarian ethics), utilitarian ethics (consequential is the ethics), and deontological ethics (right ethics). These normative theories predominantly focus on communitarian virtues, welfare considerations, and moral principles respectively. Although in many cases these different ethical perspectives synchronize with respect to their answers to moral dilemmas, they may also conflict with one another. For example, from a utilitarian perspective one may perhaps favor the introduction of large-scale agriculture because of food security benefits , it may however negatively affect food sovereignty of people, which is much more a right-based ethics. Because of such conflicts some ethics scholars argue a much more pragmatic approach, which still recognizes the value of dominant theories but at the same time give much more room to local and practical conditions and circumstances.

Nevertheless, it looks like that with respect to biotechnology additional approaches are needed. For example, the possible effect of biotechnology on the environment implies the attention to environmental ethics, which puts forward the value of ecosystems and natural populations. And the possible introduction of animal biotechnology implies attention to what is called animal ethics, which considers the moral status and unicity of animal species. Finally, the involvement of risk (for man, the community, the environment, animals, etc.) implies attention to risk ethics, where not the extent of a risk is the pivotal issue but rather how a risk is perceived, and why it is for someone acceptable or not.

Although many of the described ethical approaches probably are relevant to the rise of biotechnology in Africa, it is also important to pay attention to specific African ethical perspectives and how they relate to the dominant ethical theories that often have a Western origin. It is important to supplement western thinking with African voices.

Topics that will be addressed:

- Ethical theories, including African ethics
- Applied ethics:
    a. Environmental ethics
    b. Animal ethics
    c. Participation ethics / ethics of fairness

Module 6. Tailoring biotechnologies: towards societal responsibility and country specific approaches

The issues addressed in the preceding modules stress the need of paying attention to the question how new technologies have to be developed and/or have to be introduced, in order to be successful. This depends on what is meant by the term 'successful'. Referring to the quotation from the FSBA project document in the introduction of this text, 'succesfull' or 'sustainable' would imply that new technologies should fit to "the viewpoint of all stakeholders: from small holders and consumers to policymakers". As assessing the viewpoints of stakeholders is part of the project activities through stakeholder meetings in the different countries, it is not possible to give here a full description of this issue. However, what we can do is highlighting the conditions for what may be labeled "tailored biotechnology". Tailored biotechnology, that may include both classic and modern versions of biotechnology, accounts for the role of the stakeholders in the process of technology development. As small farmer's agriculture is Africa's most dominant form of agriculture, and constitutes the social infrastructure for the great majority of Africa's populations, new technologies should be adjusted to the needs and customs of small farmers. Societal, health and ecological issues have therefore to be taken into account to realize such a tailoring of biotechnology.

This approach means for example that an issue such as risk should not only be considered in a technical or scientific way, but also within a perceptive framework. This is because the notion of risk involves besides the notion of chance, also the severity of a negative event, which is a social and ethical issue. In addition, the concept of tailoring implies that the stakeholders can really use the new technology within their own context and on their own conditions, and have the opportunity to fulfil the required social, financial, and other conditions for the implementation of the new technology. This means that the tailoring of biotechnology implies societal consultation through e.g. stakeholder meetings, in order to get an understanding of the stakeholders' wishes and the conditions they pose.

As described in module 3, the introduction of biotechnology has in many places met with social resistance. In general, new technologies often lead to resistance and conflict. However, it seems that the controversy around biotechnology is much more intensive as compared to many other (former) introductions of new technologies. For example, the introduction of the Green Revolution in South East Asia was not accompanied by much controversy (although it was not welcomed by everybody, especially in the later phases). Nowadays, many people easily adopt new technologies such as the mobile phone. So, if biotechnology (whether classical or modern) is to be introduced in a sustainable way, the question why biotechnology is so controversial should be dealt with. This is the reason why it is useful to consider the rise of biotechnology from the perspective of the so-called Science and Technology Studies (STS). This field of research seeks to understand the relationship between societal and technological developments and tries to find out which conditions may contribute to the smooth reception of science and technology in society. In addition, STS aim to contribute to the public engagement of new technologies in society.

STS reveal that technology development is a stratified concept that concerns several societal levels. At the micro-level, technological innovations are to be used by users (e.g. modern seeds, irrigation equipments, etc.). On a larger scale, at the meso-level, institutions are needed such as accessible markets, infrastructures, and educational opportunities. And finally on the large scale, at landscape or macro-level, yet other conditions have to be fulfilled such as effective and stable policies and financial infrastructure. Successful innovation can only happen if the conditions at the different levels are sufficiently fulfilled. On the other hand, because change at the higher levels is not easy to realize and often happens slowly, insight at these levels may indicate which technologies at the micro-level are feasible and have indeed a chance to be succeed. Different countries often have different stratifications, according to societal structure. Thus the tailoring of biotechnologies will differ among African countries.

Topics:

- Tailoring technologies: how to match new technologies to local conditions?
- What are risks, which risk perceptions, play a role?
- What are feasible participation methods, including dealing with the media?
- How can we understand the rise of biotechnology and the controversy around it from the perspective of Science and Technology Studies?