TAKING STOCK – 20 YEARS OF GM CROPS – 40 YEARS OF 'GENETIC ENGINEERING'

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REPORT

Session I: The state of affairs in biosafety & risk assessment – Taking stock

In 1990, when the first GM herbicide tolerant and Bt crops were created, the expectations were high – too high, as we know now. Bt and herbicide tolerance were predicted by the makers to be either out of trade and replaced by custom-tailored plants by 2000 or just a general background of all crop varieties. In reality, we now find ourselves still stuck with the same first generation of traits in the same four GM crops: there are hardly any other traits in terms of market share. What has happened to the grand claims? Have GM crops delivered the promised yield increases? And has GMO risk assessment been reliable, is the biosafety of GM crops guaranteed?

Jack Heinemann (University of Canterbury, New Zealand) compared the performance of various crops in North America and Western Europe over long periods of time. The yield rise of maize over the last fifty years has been virtually identical in the USA (with GM) and in Western Europe (without GM). Non-GM rapeseed in Western Europe, over the same period, has always yielded much more than rapeseed in Canada, with the difference only growing after the introduction of GM rapeseed in Canada. From 1995 to 2007 in the USA, insecticide use went down 15% (without counting the Bt in the crops) and herbicide use rose 8%. In the same period in France, without GM, insecticide use fell 76% and herbicide use fell 3%.

The biosafety situation paints a far bleaker picture yet. Glyphosate is wreaking havoc on the rural Argentinian communities. Its use on GM soy in the country has increased tenfold from 1991 to 2013, reaching a staggering 6,5 kg per inhabitant per year. Two toxicologists, both now deceased, must be credited with waking the world up to the health effects of this herbicide: Andres Carrasco and Alicia Ronco. People living near or working on the soy fields have significantly higher rates of cancer, rheumatoid arthritis, asthma, hypothyroidism and other diseases, as well as birth defects and abortions. They have come to be called "the fumigated people". Their fate has become the focus of attention of the network of physicians "Doctors of fumigated towns", founded by **Medardo Avila Vazquez**. Glyphosate spraying, causing cancer mortality, has been recognised as a crime in a lawsuit brought against Monsanto by many non-governmental organisations and scientists from several countries; but the government is not taking any action to limit the damage yet. GM soy is the big pillar on which the Argentinian economy rests. However, the building of a new Monsanto plant in Cordoba was effectively prevented by demonstrations of angry citizens.

Research by **Damian Marino** of the National University of La Plata has shown that glyphosate is found in all environmental compartments, even far away from the sites of application and even in rain, where its levels are higher than in any other natural water. He has also found it in cotton wool, cotton gauze and other cosmetic products of cotton. The study in cotton raised many concerns all around the world and was replicated: most cotton used for various means, including medical uses, contains glyphosate at levels that are several times the maximum allowed one. **Delia Aiassa** from the University of Rio Cuarto has shown that glyphosate damages DNA in mice to such an extent that it blocks the process of natural cell death, which may explain the increased cancer observations. Glyphosate also alters neuronal development and axon growth, which may explain the lower IQs and other neurological alterations found in some people exposed to glyphosate.

Another mechanism of action by which glyphosate may cause health effects was suggested by **Jack Heinemann**. The collective microbes living on and in our bodies, houses, farms, plants, animals and elsewhere, are increasingly found to play an important role in sustaining health and life. Antibiotics threaten the existence of these 'microbiomes', but so do many chemicals, notably pesticides and in particular the most used herbicides: dicamba, 2,4-D and glyphosate, all three used with resistant GM crops. These herbicides easily find their way into our bodies along many different routes, threatening our microbiome. In addition to killing the bacteria, it turns out that at sublethal levels, these pesticides can induce antibiotic resistance in bacteria.

Bt crops are characterised by sweeping claims about their specificity and safety, supported by referring to the history of safe use of the native Bt insecticide using the soil bacterium *Bacillus thuringiensis*. However, the Bt toxin in GM Bt crops is a modified, activated version of the native crystal protoxin, as **Angelika Hilbeck** (Swiss Federal Institute of Technology) explained. While the latter is only sprayed locally when necessary, Bt crops produce high doses in all plant parts from planting to harvest, independently of whether the target pest turns up at all. Also, the majority of studies on the mode of action of Bt proteins have only been done on a small subset of herbivorous insects from one or two taxonomic orders. With the rise of Bt crops, no more integrated pest management rules were followed, no thresholds, no scouting, no monitoring. Hilbeck listed 19 scientific reports of detrimental nontarget effects, most on terrestrial and aquatic insects and one each on snails and cray fish. However, the mode of action of Bt toxins is still poorly understood. Smaller cleavage products of the toxins are also found in the GM Bt crops, but the significance of these remains unknown. Very little is known about the human health effects of Bt crops. In the US, one nontarget insect, the western bean cutworm, has even developed into a pest on Bt crops: first a secondary one, now a primary pest. Production volumes of Bt cotton are falling across the globe this year for the first time. And still, very little is known about the human health effects of Bt crops. (Some preliminary assays have been done by Mexican scientist, Dr. Revilla, who showed that the Bt protein causes a stronger antigenic reaction in humans than colera; see also citations in the letter sent by Dr. David Schubert to the Mexican President.) In summary, Bt crops are far away from the "cornerstone of modern agriculture" that they were called in 2003.

Session II: Emerging and existing GE techniques and the concepts behind them

Ignacio Chapela (UC Berkeley, USA): GMOs, historicised

GMOs have a 40 year history, so we have had time to collect real evidence about them. The balance is one where "risk vs benefit" has now changed to become real damage vs unfulfilled promises. Much of this history began in the San Francisco area – from Berkeley to Silicon Valley. The wishful Valley mindset permeates current GMO promotion. For instance, Soylent's GM products (e.g. nutrition bars) promote a lifestyle, but far from becoming the Microsoft of food they have become a source of real digestive chaos, and a business disaster. Companies like Solazyme and Amyris that made big promises for GM biofuels to save the world, now make huge losses as they scale back their claims down to irrelevant products that are challenged at every turn. Law and government, however, have become complicit in protecting this industry despite its track record of proven failures.

This is a broken fiction — not a technology — with few benefits, if any. In agriculture, six countries, four crops and two traits is all that was ever new for at least two decades now. Meanwhile, unaccountable but real consequences are imposed by GMO interventions on a world of living organisms that we hardly understand at all.

Hartmut Meyer (ENSSER): Legal framework for GMO risk assessment: excluding public science?

A brief overview of legislative changes in the EU after 20 years of GM crops and 40 years of GE was given. Already in 2010, the EFSA guidance for environmental risk assessment (ERA) of GM plants was published. While it contains several improvements with regard to scientific and technical issues as e.g. suggested by ENSSER during the consultations, EFSA introduced a new decision making step as a prerequisite to initiate the various steps of the ERA. Applicants are allowed to run a "comparative safety assessment" before the ERA – a step that is not covered by the EU GMO legislation. Instead of basing its guidance on the 5 established principles as given by the Directive 2001/18/EC, EFSA replaced three of them to be able to base ERA in the EU on the obsolete concept of familiarity. This concept has been coined by a 1993 OECD publication but since than rejected as a concept for ERA during the negotiations of the Cartagena Protocol and in the development of the EU Directive 2001/18/EC. ENSSER demanded that this fundamental change of EU ERA through the backdoor must be reverted. ENSSER also like to underline, that this 2010 example clearly demonstrates how EU laws on the protection of the environment and consumers based on the precautionary can be made toothless by changing the implementing rules through EU institutions – one of the hot topics in the discussions on TTIP.

As a follow up of this fundamental change of the EU ERA, which was tolerated by the European Commission and was obviously not noticed by many Member States, the European Commission in 2016 published an amendment of the Directive 2001/18/EC. The aim is to change the Annexes of the Directive to adapt the environmental risk assessment – if it is undertaken at all – to the principles of chemical risk assessment. The core change is to only accept data for ERA which were produced by laboratories accredited according to the Good Laboratory Practices (GLP) as developed by the OECD and adopted by the EU in 2004. Being used in chemical risk assessments for e.g. Bisphenol-A, it became clear that measure to guarantee certain technical standards to prevent fraud in data production o the side of the industrial applicants has much profounder effects. GLP is an industrial technical standard, which is mainly adopted by laboratories run by companies. Public scientific institutions as university that engage in established independent research and producing results relevant for risk assessment are in general not GLP accredited. The planned amendment of the Directive will effectively exclude the results of scientific research of public science institutions published in peer-reviewed journals from ERA. EU ERA will almost exclusively be based on data from corporate research commissioned by, planned with or convened the applicants. On top of this exclusion of public science from risk assessment, this approach as documented well in the case of Bisphenol-A will introduce a fatal bias in the set of data for ERA. It is evident and documented by several scientific publications that results from corporate science are much more likely to claim safety for the scrutinised chemical – or GMO in future – than results from public science. The exclusion of a vast body of scientific research – in many cases funded by EU institutions – and the introduction of a bias in favour of the commercial aims of the applicants contradicts the spirit and provisions of the Directive 2001/18/EC. ENSSER demands that EFSA is required by the law to take into account peer-reviewed research from public science and suggests that the Directive contains explicit provisions on this issue.

Ricarda Steinbrecher (Federation of German Scientists): CRISPR and gene drives – the implication of extinction technologies and population-scale engineering

The first generation of GM crops (classical genetic modification) resulted in random integration of inserted DNA sequences, often linked to mutations at the insertion site and additional mutations throughout the genome. This is partially due to the type of tissue culture used. The new generation of GM crops is making use of specially designed "molecular scissors" (nucleases), which are enzymes that cut the DNA at specific places and that can be programmed to cut at predetermined target sites. They allow for targeted alterations of the DNA, often referred to as genome "editing", which gives the impression of precision, predictability and safety. Nonetheless, they still give rise to off-target effects and unpredictable "on-target" effects, as well as process related mutations. The same problem exists with latest genome editing tool called CRISPR/Cas9, which is easy to use, cheap and has a high efficiency rate of altering the DNA at the target site. The idea of "precision" in this context wrongly focuses on the level of the DNA (nucleotides) only, which is the bottom layer. What is missing is the contextualisation into next levels, ie the genome, epigenetics, the organism, ecosystems and socio-economic conditions.

Most recently CRISPR/Cas9 is being used to create "Gene Drives". These are designed to override the Mendelian rules of inheritance, which gives both parents a 50/50 chance. Instead the designed trait is passed on to every member of the next generation, thus rapidly spreading through a population.

The ability to release a gene drive organism with the intention to alter or eradicate a wild population or a whole species is a very powerful tool to hold. It has the potential to alter whole ecosystems, their functions and services.

No species lives in isolation, all are part of various networks and foodwebs. What is an alien invasive species or a pest in one context is an integral and valulable part of ecosystem functions and services in another context.

In order to fully understand and accurately predict the consequences of the release of a gene drive organism, we would need to understand fully the role this organism (species) has in different ecosytems, habitats and environments. We also need to understand what domino effects could result from altering this species or taking it out of the web of life.

Presently, we simply do not have the knowledge or the capacity to address these issues or predict the outcomes of intentional or accidental release. What does this mean? No releases – intentional or accidental - should take place until we can ascertain the consequences. The risks are simply too high. We need to follow the precautionary principle and have a moratorium to give us the time to perform all the necessary tasks.

Jonathan Lundgren (Ecdysis Fdn. and Blue Dasher Farm Initiative, USA): RNAi and nontarget effects
This is a new form of pesticide in GM crops for which risk assessment is hard. The next generation of pesticide expressing crops will likely involve RNAi – Monsanto has already made one. For an animation search YouTube for Cable Hardin RNAi.

It could halt pest attacks, make plants unattractive to a pest or increase the specificity of a herbicide so it only attacks certain weeds. It could be a powerful tool – but we have to be sure it's safe. So how do we select species for risk assessment? We need indicator species to represent a particular group of organisms. We need to use community ecology to make bioinventories of the community networks in agroecosystems, e.g. the food web of the European corn borer.

Lundgren has compared RNAi sequences and the honeybee genome, and found some perfect sequence homology with honey bees. So RNAi sequences will find off-target binding sites in non-target organisms. There is a lot of work to be done on risk assessment.

Of course pests are a symptom, not the problem! Addressing symptoms and not the underlying problem will solve nothing. A pest says something is wrong. Pest problems are caused by too much disturbance, ie tillage. Low diversity also causes pest problems. A good balance of species as well as species diversity, and their interactions within that community – all these are vital. Research supports these conclusions.

See Ecdysis foundation and Blue Dasher farms, working on regenerative farming systems.

Veronica Villa and Silvia Ribeiro (ETC Group): Synthetic biology and its socio-economic impacts on local communities
Synthetic biology imitations of vanilla, vetiver, stevia, artemisina and saffron among many others aim to substitute the botanical ingredients that are mostly produced in rural communities by millions of peasants and indigenous peoples around the planet and are an important source of income. They grow in forests or mountains and are central to the local livelihoods not only because they generate income but also because they need healthy ecosystems to thrive on and a strong social fabric that enables each person in the community to perform very specialized techniques to

harvest and process those crops.

The theories of the peasant economy show that the activities of local communities cannot be seen in terms of profits only. As an example the communities that still cultivate vanilla in Mexico don't do it in the hopes of big revenues but because vanilla is subject of specific care that extends to the whole forest and the moment of manual pollination is also when the communities renew important political commitments.

Nonetheless the market values of these products could be very important if processed and marketed at large scale. Synthetic biology aims at achieving the functional version of the active ingredients that are so valuable for the flavors and fragrances market. Those crops and species could be the foundation of community self-sufficiency if their social, economic, cultural and biodiversity importance are acknowledged instead of being reduced to profitable chemical compounds.

What is pushing gene drives and why? The explicit goal is to eradicate invasive species, reintroduce susceptibility to agrotoxics, eliminate vectors of illnesses – and produce bioweapons (or so called biodefense). There are many uncertainties– we cannot predict what will happen as a result. It is very probable that gene drives will not function as planned by their promotors. But even if they do, the release of organisms engineered to aggresively disseminate a GM trait is a big risk and poses a spectrum of biosafety, security and sovereignty challenges. The impacts on the environment can´t be predicted, but will most probably cause new imbalances in the ecosystems. The Precautionary Principle should be applied.

Health claims are a distraction - most applications will be for agriculture and military uses. Even if they were successful (which is very far from reality), they seek to eliminate vectors but not the causes of disease or the context that causes disease. Partial elimination of some vectors could actually endanger human health by weakening the resistance that the most affected populations have. We do not need silver bullet technologies, we need access to basic health systems and better living conditions.

The work on mosquitos implies changing the food chain – opening niches for invasive species or to other vectors that are more difficult to control. Gene drives can also be used with hostile intent – to attack crops or displace small farmers.

The proposals to use gene drives to extinguish invasive species for "conservation" were widely rejected at the 2016 World Conservation Congress of IUCN.

More than 150 civil society and peasant organizations, along with concerned scientist, are calling for an immediate moratorium on the experiments with and releases of gene drives. CBD COP13 will be an opportunity to establish such a moratorium (www.synbiowatch.org).

Session III: … and they do spread – About GMOs out of place

Spain is the only country in the European Union to grow GM crops (Bt maize MON 810). In 2009, the emergence of a new weed has continued to baffle farmers, scientists and the authorities. As **Rosa Binimelis** explained, this case has raised more questions than answers, as well as providing an illustrative example of what might be anticipated should gene flow occur and whether action to curb this would be effective.

In 2014, the regional authorities acknowledged the presence of teosinte (the ancestor of maize) as a weed in maize fields in Navarra, Aragon and Catalonia in the Northeast of Spain. Some of the fields were highly infested, resulting in total yield losses. Control is difficult as even after glyphosate applications, a high level of infestation persists. The 'Spanish teosinte' is an annual, and has characteristics of an aggressive weed, e.g. it produces many seeds which can live for many years in the soil. Its identity and origin are unknown, as well as how it got into farmers' fields. The government believes it is *Zea mays* spp *mexicana;* independent analysis is being conducted to check if this is correct.

Once introduced however, the dispersal mechanism is via the sharing of machinery, as well as grazing of farm animals that move between fields. Measures have been prescribed according to the level of infestation. There are also biosafety consequences, such as the potential for hybridizations between teosinte and maize. Outcrossings conducted in the laboratory have shown that it is possible to produce Bt maize–teosinte hybrids. This raises the question of whether such hybrids can act as 'genetic bridges' to backcross with parents.

The European Food Safety Authority issued an opinion that the occurrence of teosinte in maize fields in Spain is an agronomic problem, not an environmental one, and therefore its opinions on MON 810, Bt11, TC1507 and GA21 remain unchanged. However, the European Parliament, when assessing the renewal of the authorisation for those maize events, did not agree, and asked the Commission to withdraw the proposal for renewal. One reason given was that teosinte has become a stable and persistent population.

Mesoamerica is the centre of origin of maize. **Antonio Turrent** described the various landraces that are specialised for different purposes in the large variety of agro-niches in Mexico, such as high yields, lime rock conditions, highly acidic soils and high temperatures. Close to 60 native races and millions of varieties are managed for human consumption by diverse ethnic groups, who continually develop and breed them. This is autochthonous maize breeding, or native maize breeding. Women are the steering mechanism for breeding in accordance with cultural consensus; they are in charge of selecting the ideal type of ears and seed for each use. Seed interchange and circulation are hallmarks of this system. Frequent traits of some of the native races include high quality of kernel protein, resistance to disease, plants with outstanding vigour, nitrogen-fixing capacity, antibiotic activity, and capacity to dissolve phosphorus in highly acidic soils. There are multipurpose associative relations of maize.

The nixtamalizing process, which began 2000 years ago, cooks maize in alkaline and compared to untreated grain, makes niacin (vitamin B3) available, increases the amount of calcium, decreases phytic acid and eliminates some grain mycotoxins. At present, direct consumption of nixtamalized maize grain accounts for 52% of caloric intake and 39% of protein intake in the national diet. Maize is used in 600 different dishes, beverages and tamales. Most food preparations require specific landraces. This can be done only with native maize, not improved or GM maize, which is for animal feed.

The megadiversity of the Mexican maize agroecosystem would not be served adequately by a small number of non-GM or GM hybrids. These cannot compete with native maize, in jointly satisfying the needs for food security, pluricultural uses of maize as food, and a clean ecology.

If GM maize were to be introduced into Mexico, and should it become the source of allopatric germplasm, transgenes would irreversibly accumulate in maize landraces, with largely unpredictable effects, but some will likely be detrimental. Mexican citizens have therefore made a collective demand against GM maize and initiated legal proceedings in 2013 to stop the release and commercialisation of GM maize in Mexico.

Alma Piñeyro discussed the case of transgene flow and accumulation in maize and cotton in Mexico, of which this country is the centre of origin and domestication. In the case of maize, there are different native varieties distributed all over the country, such that the whole national territory has native varieties. Biodiversity of this varietal system has been kept up in a dynamic way due to human handling by diverse cultures. Native races of maize have particular features for tolerance to grow under different temperatures, altitudes, soils and have different tastes, colours, etc. as detailed by Turrent.

In 2001, the discovery of transgenes in native maize in Oaxaca was documented for the first time. There was at the time no official release of GM maize in the country, even for field trials, as a *de facto moratorium* had been imposed since 1988, so it was not clear how the transgene escape happened. There has been a huge controversy (which pretended to be a scientific controversy but was later discovered to be a PR set up) around this issue. In 2002/2003, the Mexican government presented a series of reports confirming transgenes in native maize in Oaxaca and Puebla, and the 2004 CEC publication under NAFTA concluded that GM maize would threaten the diversity of native maize, and no viable seeds or grains of American maize or maize from other countries growing GM crops should be allowed into the Mexican territory. However, in 2005 there was a change in discourse, prompted by a publication by Ortiz et al. (from the same governmental office that had published the evidence confirming the transgenes in Oaxaca and Puebla), now saying that they could not find transgenes in native maize in Oaxaca and that if there had been any transgenes, they had 'disappeared'. The result was that the government also said: even if there is release of GM maize and transgene escape happened, it would disappear eventually. In 2005, the law on GMOs in Mexico was enacted, which is very weak.

In 2007 and 2009, new scientific papers were published corroborating the presence of transgenes in native maize in CDMX, Oaxaca, Puebla, Yucatán and Veracruz. Independent monitoring was also conducted by civil society organizations, which also recorded instances of transgenes in native maize in some isolated locations. All these data confirm that there are transgenes in native maize but still in few locations. An official report, finally made public by INECC in 2015 due to NGOs' pressure, also corroborated transgene presence and showed the frequencies detected in several States.

It is clear that if GM crops are cultivated, the crops' biology and human management will contribute to transgene spread. Pathways for spread include grain that is imported (mainly from the US and South Africa, which grow GM maize), some of which is used as seed; illegal introduction of hybrid GM seed; contaminated legal allegedly non-GM hybrid seed; and uncontrolled trials of GM maize. In the Mexican case, there is a diversity of agricultural systems; some are based on native seeds, where seed saving and exchange are common, but there is also industrial agriculture. Data on diffusion rates in different agricultural systems suggest that transgene flow is mediated by human interaction.

Scientists have also sampled maize-derived food products and found 82.02% of food tested containing transgenes. Glyphosate residues on food are now also a concern, as glyphosate has been re-classified as a probable human carcinogen by the WHO IARC. 41% of food items sampled that tested positive for transgenes conferring glyphosate tolerance, also had residues of this herbicide and its breakdown product, AMPA.

In addition, GM cotton has been grown in Mexico since 1996, even when the country is the centre of origin and diversification of this crop and harbours wild populations. As a biosafety measure, the Mexican government created an imaginary line north of which GM cotton could be grown as there are supposed to be no wild relatives in the territory above, and south of which GM cotton couldn't be grown. However, this measure was inadequate for living plants that can spread through various means. In the case of cotton, its spread can be independent from human management. Thus, by 2011, recombinant proteins have now been detected in wild and cultivated native cotton varieties. Efforts to understand the ecology of wild, feral and cultivated cotton are being undertaken as a means to generate more accurate information about this species, inform biosafety measures and understand the venues for transgene dispersion for cotton.

In both cases, researchers dealing with the documentation of transgene dispersal into maize and cotton, respectively, have been subjected to artificial "scientific controversies" that have enabled the Mexican government to avoid taking real precautionary measures for both crops and their native/wild relatives.

Angelika Hilbeck (ETH Zurich, Switzerland) presented a talk prepared by **Christoph Then** (Testbiotech, Germany). The talk described accumulating evidence of unintended transgene flow and potential adverse effects that result. An interesting example was the discovery of GM oilseed rape plants growing in Switzerland, where there is no legal cultivation of GM plants nor any importation of GM food or feed. The source was not contaminated imports of oilseed rape, but contamination of imported wheat kernels from Canada that contained GM oilseed rape seeds. "If it can spread, it will."

This and other examples underscore the call for more discussion and evaluation of emerging 'gene drive' systems that are intended to spread transgenes and GMOs.

The enhanced capacity to decipher and then synthesise DNA sequences on large scales is also creating a new frontier for biopiracy. No longer are genetic resources physically transferred from the country of origin or discovery to the country of exploitation. Instead, it is envisioned that the sequence information is rapidly transferred across national boundaries by electronic means and then reconstructed de novo in a recipient country.

Ignacio Chapela presented a new distributive model for mapping GMOs. Currently, transgene spread is only detected, but novel technical approaches in the hands of citizens will allow for the more useful monitoring and mapping of transgene flow. This capacity will enable more sound decisions by individuals, communities and governance bodies at all levels. A distributive way of mapping GMOs requires enabling people to act in their places, as opposed to centralized, command-and-control approaches. Distributive mapping also enables modes of diffuse control and autonomous capacity to make decisions, from what to look for and map, to what to do about what is mapped.

His team has developed a small handheld device that works as a fluorometer using solar energy, is cheap to make and produce, and can be reproduced in conditions of low inputs and low technical access. The LAMP (loop mediated DNA amplification) is a complex molecular reaction that results nevertheless in a robust and simple signal used to drive this method. Five other novelties are included in the method presented, including: extraction-free sample processing, pipetting-free fluid management, refrigeration-free reagent management, toxic-free visualization and recording. Together, these qualities result in a field-abled approach that obviates the need for expensive and cumbersome equipment, facilities or trained personnel, the necessary requirements for a distributive mapping of use in real field situations. Additionally, the method complies with the "CWSS" child and wildlife safety standard, dictating that materials and methods promoted for use in remote autonomous locations should not present a risk for the most vulnerable inhabitants of those locations.

Session IV: GMOs in developing countries

A harmonic repeated on both days of the meeting was that the industrial agriculture model gripping the planet is the symptom of economic and political ideologies. Genetic engineering is an enabling technology for the symptom, but its elimination falls short of curing the problem.

Brian Dowd-Uribe presented on the reversal of Bt cotton in Burkina Faso. Field trials for Bt cotton were first conducted in 2003. In 2006, the Bt trait was backcrossed to local varieties in order to ensure quality and local adaptation to agro-climatic conditions. Bt cotton was released to farmers in 2009. It was planted primarily by small-scale farmers, around 100,000 farming households. By 2013, Bt cotton made up 70% of total cotton production. However, in 2015, a phase out of Bt cotton began, and by 2016 Burkina Faso's cotton crop was 100% conventional.

Burkina Faso has a competitive advantage in the lint quality of its local varieties: long fibres (which can be spun into high quality cotton) and high fibre efficiency (ginning ratio). This is the result of an intentional breeding program, which had its origins in the French colonialists, but has led to publicly-funded, state-led efforts. The breeding is conducted for multiple desired outcomes (not just for pest resistance as is the case with Bt cotton).

However, with Bt cotton, fibres were 1/32 inches shorter, leading to only 33% of Burkina Faso total cotton fibre classed as high quality in 2013. This is a huge decline, as in 2005, 80% of cotton fibre was classed as high quality. In addition, Bt cotton had lower cotton fibre efficiency.
It appears that the Bt varietals retained the lint quality characteristics of their Bt parent, and not of their Burkinabe parent.

The cotton companies in Burkina Faso decided on the phase out and have also sued Monsanto for $84 million; yet many farmers wish to continue growing Bt cotton. The cotton sector in Burkina Faso is vertically integrated, which attracted private sector investment into Bt cotton. The cotton companies operate regional monopolies, controlling all seed distribution, input provisioning, cotton purchase and ginning. The companies, in providing seeds and input on credit, allow for stable credit which facilitated Bt cotton adoption. The State is the sole owner of the largest cotton company, and farmers lack choice of seed varietals.

Some research points to yield and profit benefits of Bt cotton; however, in 2008/9 when Bt cotton was adopted, national data showed a national-level production decline. Based on Dowd-Uribe's research, farmers principally desire Bt cotton due to labour savings.

Private financing played a large role in the Bt cotton failure, as the product was rushed to market, without conducting the five generations of backcrossing as recommended by cotton breeders; instead this was only done over three generations. In addition, Bt cotton altered the broad public breeding effort to a singular focus – pest resistance, which serves corporate interests to the detriment of other efforts. On the other hand, there is a lack of farmer power in the cotton sector – there was no farmer input in the GM crop approval, its reversal or into breeding programmes – while power concentrated in the hands of fewer decision makers.

To conclude, the highly particular outcomes of GM crops depend on specific social and agroecological contexts. However, there has been limited scope of GM crop analyses and little is known about the suite of impacts of GM crops. Narrow indicators such as average yield and profits, neglect differential impacts. There is also a lack of longer time horizons which might reveal the emergence of secondary pests, pest resistance, and/or unintended consequences. What are required instead are multi-year, multi-metric, integrative, and multi-disciplinary studies.

Daniel Maingi (Growth Partners Africa, Kenya) discussed the situation in Eastern Africa. Here, the central issue is securing food sovereignty, a higher level of local and democratic control of food than the narrative of food security. Kenya is leading the way with its 2010 Ownership of Indigenous Seeds law, giving claim to resources on the basis of local possession and use.

The region is under pressure from those advocating for industrial farming models, with the promise of greater profits and food security. Cotton is described as the 'white gold' in Kenya and GM β-carotene bananas as nutritional necessities for Uganda. Interestingly, though, Uganda ranks 5th in the world – well above countries such as Israel – for quality of diet, without GM bananas.

Nevertheless, under similar pressures Tanzania has repealed its strict liability laws. Ethiopia sees GM agriculture as a conduit for foreign direct investments. The ISAAA, an industry propaganda organisation, spends a great deal of money taking politicians on sanitised tours of GM cropping sites of small scale farmers in Africa. Ironically, the tours have changed countries as each farmer in turn has failed to benefit from his GM crops and stopped growing them. They have migrated from South Africa (see Mariam Mayet's talk) to Burkina Faso (see Brian Dowd-Uribe's talk) and now to India – where Bt cotton is increasingly failing small scale farmers, too. Likewise in Pakistan and Bangladesh.

Angelika Hilbeck (ETH Zurich, Switzerland) described the key failures of the GM paradigm to deliver beyond simple pest control traits. So far there is only one commercialised abiotic stress tolerance traited crop plant, a 'drought tolerant' maize called MON87460. The inserted transgene, called cspB (cold shock protein B), is taken from a bacterium. The claims for it are wishy-washy and its benefits, if real, are modest. In contrast, traditional breeding augmented by non-GE modern molecular biological tools has produced many more crop plants with high levels of drought tolerance.

This latter germplasm is provided by the public sector, but under the Gates Foundation backed WEMA (Water Efficient Maize for Africa) programme, it is being coupled with the patent protected and dubious cspB transgenes of Monsanto, leading to proprietary capture. While Monsanto is 'donating' the use of the transgene in the varieties in Africa, it will likely retain control and benefit from the high quality drought-tolerant germplasm generated via non-GM breeding in this programme.

Phil Bereano (Community Alliance for Global Justice, USA) presented a more comprehensive description of the workings of the Gates Foundation, in the broader context of philanthrocapitalism. This is the use of accumulated wealth (usually gained by avoiding taxes) to further capitalist ideology under the guise of charity. In this capacity, Gates has become the 5th largest donor to African aid, surpassing most nation states.

The Foundation is funding business-oriented, high-input agricultural systems to achieve its goals in Africa, undermining local networks and organisations, as well as community institutions, and further concentrating power in traditional 'white' societies. This comes at no particular sacrifice to the Gates Foundation, which has earned more during the years of its existence than it has ever paid out.

Nevertheless, in return Gates gets access to the political halls of power in Africa without having any particular expertise to offer regarding agriculture, poverty alleviation or any other qualifications which would be highly relevant in the field.

Mariam Mayet (African Centre for Biodiversity, South Africa) synthesised the threads and themes of the previous speakers using her experience from South Africa. She described how the financial, military and political power centres of the West continue to colonise Africa via their 'solutionist'-oriented impositions without any meaningful consultation with the affected societies in African countries. In this century, the colonisation is as much physical as it is institutional.

GM is the tool in the toolbox of the capitalist industrial agenda, not just agriculture. Displacing it might have some good. However, she envisions a future where it will just be replaced by other 'green revolution' technologies that are environmentally and socially just as damaging. Hence, unless the root cause of the problem is identified and eliminated, not much may be gained by targeting singular technological interventions.

She observes that only three of the 54 African countries are growing GM crops. They are minor in scope, but major in focus. How far and fast they spread, though, is indicative of the transfer of power away from local communities.