Side events of the Public Research and Regulation Initiative at the CPB Liability meeting and the CPB-MOP2

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Table 1: Version 25. May 2005

The Public Research and Regulation Initiative aims to involve the public research sector in regulations and International agreements that are relevant for biotechnology, such as the Cartagena Protocol on Biosafety.

The Public Research and Regulation Initiative will participate as an observer in:

- **The first meeting of the Ad Hoc Open-ended Working Group on Liability and Redress under the Biosafety Protocol (Montreal, Canada, 25 - 27 May 2005)**
- **The Second meeting of the Conference of the Parties serving as the meeting of the Parties to the Cartagena Protocol on Biosafety (Montreal, Canada, 30 May - 3 June 2005).**

For more information about the participation of the Public Research and Regulation Initiative in MOP2, see www.pubresreg.org, under 'events'

The Public Research and Regulation Initiative will hold a lunch-time side event at the liability meeting and two lunch time side events during MOP2. The main purpose of these side events is to inform the negotiators what kind of activities are being carried out in public research institutions world wide, and for which purposes that work is initiated.

The following side events are scheduled:

- **May 26, "Liability and public research".**
- **30 May: Public research in agricultural biotechnology in developing countries.**
- **31 May: Public research in agricultural biotechnology through collaborations between developed countries and developing countries**
- **The side event on May 26, will have the following topics:**

1. **Overview of the public research in agricultural biotechnology for use developing countries (Dr. Christian Fatokun) 20 minutes**
2. **The impact of liability regimes on public research (Shawn Sullivan, CIMMYT) –20 minutes**
3. **Facts and misconceptions about liability and GMOs (prof. Julian Kinderlerer). – 20 minutes**
4. **Questions and discussion (30 minutes)**

The side event on May 30 will have the following topics:

1. **Overview of the public research in agricultural biotechnology for use developing countries (Machuka) 15 minutes**
2. **Public research in agricultural biotechnology in developing countries:**
    a. **Africa (Dr. Charles Mugoya) 15 minutes**
    b. **Asia (Dr. Desiree Hautea) 15 minutes**
    c. **Central and Eastern Europe (Prof. Yaroslav Blume) 15 minutes**
3. **Questions and discussion (30 minutes)**

The side event on May 31 will have the following topics:

1. **Overview of the public research in agricultural biotechnology for use developing countries (Dr. Zaida Lentini.) 15 minutes**
2. **Public research in agricultural biotechnology in developing countries:**
    a. **Latin America (Dr. Maria Jose Sampaio) 15 minutes**
3. **Examples of Public research in agricultural biotechnology through collaborations between developed countries and developing countries:**
    a. **Golden Rice Project, Danforth Centre, IPBO, (Dr. Gerard Barry) 30 minutes**

4. Questions and discussion (30 minutes).

The presentation with the overview of the public research in agricultural biotechnology for use developing countries will give a general overview of the main areas of agricultural R&D activities and the broader context of those activities, such as crops of interest, annual loss of yield, annual pesticide use etc. Table 1 gives an example.

The presentations by colleagues from Africa, Asia, CEE and Latin America will present a similar matrix, worked out per country Table 2 gives an example.

Table 1 Introductory overview of the main areas of agricultural R&D activities and the broader context of those activities

There are still about 20 projects to be included from Africa, including the scientific references, will follow in the next days.

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Topic		**Main crops of interest**	**Relevant aspects and considerations (e.g. current loss of yield, current pesticide use, health aspects, potential yield gain etc)**
General			There are many websites dealing with biotechnology in the developing world, Here just a small selection: http://www.fao.org/biotech/index.asp?lang=en FAO, many sites http://www.isaaa.org/ ISAAA, many useful sites included http://www.cgiar.org/impact/genebanksdatabases.html CGIAR: many sites http://www.ifpri.org/themes/biotech/panders.pdf IFPRI, many sites, here a sample http://www.ipgri.cgiar.org/index.htm IPGRI: many sites http://www.cimmyt.cgiar.org/ CIMMYT many sites http://www.icrisat.org/web/index.asp semiarid tropics seed science, supported by CGIAR http://www.oecd.org/home/ many sites http://www.redbio.org/ many sites ref to South America and the Caribbeans http://www.ids.ac.uk/ids/env/biotech/pubsPolproc.html Institute of Development Studies,many hints http://www.isp.msu.edu/CRSP/tcmembers.htm Bean/Cow Pea Collaborative Research Support Programm http://www.academicjournals.org/AJB/ online available African Journal of Biotechnology http://www.agbioworld.org/links/index.html a really useful list of links to biotechnology activity worldwide **Please add more links, send to klaus.ammann@ips.unibe.ch**
Drought resistance general			The semi-arid tropics are characterized by unpredictable weather, limited and erratic rainfall and nutrient-poor soils and suffer from a host Of agricultural constraints. Several diseases, insect pests and drought affect crop productivity. Developing stress-resistant crops has been a worthwhile activity of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). Mandated crops of ICRISAT, including groundnut. pigeonpea, chickpea, sorghum and pearl miller, are the main staple foods for nearly one billion people in the semi-arid tropics. Genetic transformation provides a complementary means for the genetic betterment of the genome of these crops.[1, 2]
Drought		- Wheat	Wheat yields are reduced by 50–90% of their irrigated potential by drought on at least 60 million ha in the developing world [3-10]

resistance crop by crop			A better understanding of the mechanisms of water uptake by plant roots should be vital for improving drought resistance and water use efficiency. the water uptake ability of wheat roots was strengthened from wild to modern cultivated species during evolution, which will provide scientific evidence for genetic breeding to improve the WUE of wheat by genetic engineering [11]
		- Maize	Maize (known as 'corn' in the USA) requires wetter conditions than are typical in most dryland areas. However it is an important food across Africa and a good market opportunity for dryland farmers located along the transition zone to wetter areas. Breeding research is making significant advances in increasing the drought tolerance of maize, particularly by reducing the anthesis-silking interval so that more seeds are able to successfully pollinate despite drought stress [2] Future work will probably consist in developing genotypes appropriate to precise drought scenarios, rather than in finding a unique genetic solution for drought resistance.[12]. Drought Tol Maize: Kenya: CIMMYT [13]
		- Rice	Traditional breeding efforts are expected to be greatly enhanced through collaborative approaches incorporating functional, comparative and structural genomics. Potential benefits of combining genomic tools with traditional breeding have been a source of widespread interest and resulted in numerous efforts to achieve the desired synergy among disciplines.[14]
		- Sorghum	*Piet, please double check whether drought resistance in sorghum is being engineered. The crop is already quite drought tolerant.* Quantitative trait locus (QTL) studies with recombinant inbred lines (RILs) and near-isogenic lines (NILs) identified several genomic regions associated with resistance to pre-flowering and post-flowering drought stress. [15, 16]
		- Potato	The TPS1 (Gene encoding for an Ezyme for Trehalose byosynthesis in yeast) transgenic potato plants showed significantly increased drought resistance. [17]
		- Groundnut	South Africa, experimental phase FAO-BioDeC Groundnut is an important food and cash crop in the semi-arid tropics but drought and subsequent seeds pre-harvest aflatoxin contamination are the main constraints to crop productivity and quality. Since genetic engineering techniques are available and genetic mapping proves unfruitful, research is now focused on functional genomics. The objective is to provide new molecular tools to assist breeding programmes for the resistance to these two complex traits. [18]
		- Cowpea	Cowpea cultivar and germplasm are developed by the Bean/Cowpea Collaborative Research Support Program (CRSP) which was funded by the United States Agency for International Development for a period of about 20 years. Drought-adapted, pest and disease resistant cultivars 'Mouride', 'Melakh' and 'Ein El Gazal' were developed for rainfed production in the tropical Sahelian zone of Africa. Cultivars 'CRSP Niebe' and 'Lori Niebe' which have seed and pod resistance to cowpea weevil and some disease resistance were developed for rainfed production in the tropical Savanna zone of West Africa. [19]
		- Water Melon	Tissue culture and biotechnology have been used for the genetic improvement of watermelon and provide suggestions for future application of these methods to facilitate further genetic improvement. [20]
		-	
Disease Resistance	Fungus resistance	- Banana – black sigatoka	Yield loss 50% or more, fungicide application responsible for 15%-20% of final retail price of bananas (www.apsnet.org/education/feature/banana/Top.html) [21]
		- Yam Anthracnose	Causes 70 percent or more tuber yield loss especially in Dioscorea alata. This fungus also affects other cultivated yams adversely and the pathogen mutates frequently. No known source of resistance to this fungus has been found in the yam gene pool. [22]
	Virus resistance general	-	Developments in plant tissue culture, plant transformation and regeneration, and improvements in techniques to isolate and manipulate viral genes have led to the exploitation of the concept of 'cross protection': turning the virus onto itself and controlling it with its own genes. By introducing and expressing genes of viral origin in crop plants, scientists have engineered resistance to several plant viruses. Some of the approaches, used singly or in combination, include expression of viral-coat protein, untranslatable sense or antisense RNA, satellite RNA, virus-specific 'neutralizing' antibody genes, plant viral replicase, protease or movement proteins and defective, interfering RNA. All of these approaches have resulted in manifestation of virus resistance to varying degrees in several commercially important crop plants. This review summarizes the recent advances in engineering virus resistance using the above approaches, and lists specific examples of their use in cultivated crop plants of economic importance. [23] Viruses are significant threats to agricultural crops worldwide and the limited sources of natural resistance warrant the

			development of novel resistance sources. Several methods of transgenic protection have been successfully applied, including protein- and RNA-mediated approaches. Increased understanding of the molecular biology of virus infection is starting to bear fruit, enabling specific strategies to be designed for virus resistance in crops [24, 25]
	Virus resistance	- Cassava Mosaic Virus	Cassava mosaic virus is a serious problem in sub-Saharan Africa. The EACMV-Ug causes loss of cassava worth $60 million annually in Uganda. Different species of the virus develop frequently thus making breeding for resistance by conventional methods not able to keep pace. Bioengineering seems to be an attractive approach to containing the resistance in cassava. [26, 27]
		- Cassava Brown streak virus	Cassava brown streak virus causes up to 100 percent tuber yield losses in East African countries. Breeding for resistance has not been possible because the mode of disease transmission is not understood. Bioengineering will be an attractive tool to use in developing clones with resistance to this virus for quick results. [28, 29]
		- Banana Streak Virus	Banana streak virus causes yield losses especially in plantain, which has the ABB genome. The virus integrates into the genome of the crop thus making it difficult to control. Bioengineering is being used to contain this disease in plantain at IITA. [30-32]
		- Yam Mosaic Virus	The yam mosaic virus (YMV) genus potyvirus causes significant tuber yield losses in sub-Saharan Africa. No known source of resistance to this disease has been found. [33-35]
		- papaya ring spot virus	Up to 100% loss in infected fields, farmers adopted within a few years a transgenic papaya resistant to the papaya ring spot virus [36]
	Bacterial resistance	- rice (against *Xanthomonas oryzae*, Bacterial blight)	Bacterial blight is a major disease in tropical Asian countries where high-yielding rice cultivars are often highly susceptible to it. It is a vascular disease resulting in tannish-gray to white lesions along the leaf veins. In severely infested fields, bacterial blight can cause yield losses up to 50%.. Development and mapping of markers linked to the rice bacterial blight resistance gene Xa7 is under way [37]
		- Cassava: Bacterial Blight	Bacterial blight disease causes heavy losses in cassava especially in the more humid areas of sub-Saharan Africa where the bulk of the crop is grown. [38-41]
		- Banana bacterial wilt	The banana xanthomonas wilt is currently devastating banana in Uganda, Ethiopia and parts of Democratic Republic of Congo where it can cause up to 100 percent yield loss. None of the genotypes tested so far shows resistance to this disease. [42]
Pest resistance in general		-	Pestyield loss in maize and beans in the Kenya highlands is studied using farmer elicited information. Total losses due to pests in maize and beans were estimated at 57 and 42%, respectively. As a group, insectpests were more important than disease pests. [43], Methodology: [44] Regression methods were used to test the relationship between crop yield loss and short- and long-term pest control practices. For maize, the short-term control, use of certified seed, was positively associated with yield loss, while labour availability was negatively associated. [43] Transgenic crops that produce insecticidal toxins from the bacterium Bacillus thuringiensis (Bt) grew on >62 million ha worldwide from 1996 to 2002. Despite expectations that pests would rapidly evolve resistance to such Bt crops, increases in the frequency of resistance caused by exposure to Bt crops in the field have not yet been documented. in laboratory and greenhouse tests, however, at least seven resistant laboratory strains of three pests (Plutella xylostella [L.], Pectinophora gossypiella [Saunders], and Helicoverpa armigera [Hubner]) have completed development on Bt crops. In contrast, several other laboratory strains with 70- to 10,100-fold resistance to Bt toxins in diet did not survive on Bt crops. [45]
Pest Resistance	Pests in the field	- Cow Pea general	Breeders at IITA have developed a number of cowpea varieties with resistance to pests such as aphids, and storage weevils. The most cosmopolitan pest of cowpea in sub-Saharan Africa is the legume pod borer (Maruca vitrata) which can cause extreme grain yield losses of up to 70 percent or more if not controlled with insecticides. Scientists at IITA and other collaborating institutions have screened over 12,000 accessions and none showed desired level of resistance to this pest. Hence IITA decided to use genetic engineering to incorporate the Bt gene into cowpea for resistance to this major pest. [46, 47] Cowpea (*Vigna unguiculata*) farmers from diverse geographical areas in northern Cameroon selected breeding lines from on-station trials for their own fields and explained their reasons (criteria) for making the selections. The average selection intensity employed by farmers varied from 6 to 17% and was similar to that employed by plant breeders. [48, 49]
		- Pod borer in cow	The pod borer, *Helicoverpa armigera*, attacks nearly 200 crops including cotton, beans, cereals, vegetables, and fruits. Global

		pea	losses from pod borer amount to some US$2 billion every year. An additional US$500 million is spent annually on insecticides to control this voracious caterpillar.(http://www.futureharvest.org/news/podborer.shtml)
		- Piercing sucking insects in Vegetables	A complex of pod sucking insects (Clavigralla tomentosicollis, Anoplocnemis curvipes, Acanthomia sp. etc) attack cowpea and cause serious grain yield reduction of between 30 and 70 percent. These pests can only be controlled with the use of insecticides. Advances in understanding insecticide resistance in the peach-potato aphid, Myzus persicae (Sulzer), at the genotypic, biochemical and molecular levels have led to rapid and precise methods for the detection of several resistance mechanisms (elevated carboxylesterase, modified acetylcholinesterase or MACE, and knockdown resistance or kdr) in individual insects, and for monitoring their frequencies over space and time. This paper summarises the results of two long-term surveys of resistance dynamics in M persicae in England [50] [51] [52, 53]
		- Nematodes in potatoes	The endoparasitic root cyst nematode Globodera rostochiensis causes considerable damage in potato cultivation. In the past, major genes for nematode resistance have been introgressed from related potato species into cultivars. Elucidating the molecular basis of resistance will contribute to the understanding of nematode-plant interactions and assist in breeding nematode-resistant cultivars. The Gro1 resistance locus to G. rostochiensis on potato chromosome VII co-localized with a resistance-gene-like (RGL) DNA marker. Sequence analysis of RT-PCR products showed that Gro1-4 is expressed, among other members of the family including putative pseudogenes, in non-infected roots of nematode-resistant plants. RT-PCR also demonstrated that members of the Gro1 gene family are expressed in most potato tissues. [54]
		- Nematodes in Yams	Yams (Dioscorea spp.) are highly susceptible to nematodes especially Scutenema bradys and Meloidogyne sp. They can cause up to 30 percent tuber yield loss and there are no good sources of resistance in the yam gene pool. [55-57]
		- Nematodes in bananas	Borrowing nematodes can cause fruit yield losses in banana of between 50 and 100 percent especially when present in the soil along with banana weevils. No known source of desired levels of resistance exists within the banana/plantain gene pool. [58-60] 58±28% in one study: data from 7 different countries, intense application of nematicides to banana has been a matter of considerable concern for decades. It has both environmental consequences and implications for the health of agricultural workers. As a consequence FAO considers one of the most compelling reasons for adopting genetic transformation of banana is to reduce pesticide use.(Atkinson, 2003) [61]
		- Nematodes in vegetables	Nematodes cause widespread crop losses in both Africa and Asia. *Meloidogyne* spp has been reported to cause an estimated 25% losses overall to agriculture in W. Africa (H. Atkinson, unpublished).
		- Insect pest general	Pestyield loss in maize and beans in the Kenya highlands is studied using farmer elicited information. Total losses due to pests in maize and beans were estimated at 57 and 42%, respectively. As a group, insectpests were more important than disease pests. [43], Methodology: [44]
		- Lepidoptera Asian corn borer	While the average loss is 10 to 30%,, under heavy infestation, the yield loss can be 80 to 100% (Quemada email 2005) The biology and control of the Asian corn borer, Ostrinia furnacalis Guenee, is reviewed. This insect is distributed from China to Australia and the Solomon Islands. In northern parts of its range the moths have one or a few generations per year, but in the tropics, generations are continuous and overlapping. The caterpillars can cause severe yield losses in corn, both by damage to the kernels and by feeding on the tassels, leaves, and stalks. Survival and growth of the caterpillar is highest on the reproductive parts of the plant. Other economic plants attacked include bell pepper, ginger and sorghum. Recently, the Asian corn borer appears to have become an important pest of cotton [62]
		- Insect Pest Bt	Mexico: Four maize lines, Mp78:518 (resistant), P47S3 (intermediate to susceptible), Tz3 and Ki3 (susceptible), and three experimental hybrids, P47S3 x Mp78:518 (resistant), Tz3 x Ki3 and Ki3 x Tx601 (susceptible), were infested with 15, 30, 45 and 60 southwestern corn borer (SWCB) larvae per plant at the 6-7 fully extended leaf stage. There was a small linear increase in leaf feeding ratings on resistant genotypes (Mp78:518 and P47S3 x Mp78:518) as the number of larvae increased. On susceptible genotypes leaf feeding increased sharply at 30 larvae when compared to 15 larvae. [63, 64]
		- Lepidoptera Stem borer in maize	Maize yield loss due to stem borers can be as high as 14% and sometimes up to 20-40%, [44] Food insecurity is one of the most important social issues faced today, with 840 million individuals enduring chronic hunger and

			three billion individuals suffering from nutrient deficiencies. Most of these individuals are poverty stricken and live in developing countries. Strategies to address food insecurity must aim to increase agricultural productivity in the developing world in order to tackle poverty, and must provide long-term improvements in crop yields to keep up with demand as the world's population grows. Genetically enhanced plants provide one route to sustainable higher yields, either by increasing the intrinsic yield capability of crop plants or by protecting them from biotic and abiotic constraints. [65] Insect resistant (Bt) Maize: Kenya – IRMA project ((KARI/CIMMYT) [66, 67]
		- Banana Weevils	Banana weevils attack the plants in the field causing the plants to fall thus leading to poor yield. A trypsin inhibitor gene is being developed to be used to transform banana for resistance to this pest. [68]
		- Grain Weevils in Cowpea	Cowpea seeds are attacked in storage by bruchid (Callosobruchus maculatus). This insect can cause up to 30 percent loss in stored cowpea seeds within six months. Only low level of resistance exists in the cowpea gene pool. [69] [70]
		- Yam, general	Yams (Dioscorea spp.) constitute a staple food crop for over 100 million people in the humid and subhumid tropics. They are polyploid and vegetatively propagated. The Guinea yams, Dioscorea rotundata and D. cayenensis, are the most important yams in West and Central Africa where they are indigenous, while D. alata (referred to as water yam) is the most widely distributed species globally. The genetics of yams is least understood among the major staple food crops due to several biological constraints and research neglect. An initial c-DNA library has been constructed in order to develop expressed sequence tags (ESTs) for gene discovery and as a source of additional molecular markers. [22]
		- legume pod borer, Chickpea *Cicer arietinum* L.)	Conventional chickpea is subject to a few pests, including the legume pod borer (Helicoverpa armigera). Damage due to the insect is estimated to cost $0.5 million in the chickpea growing areas of the world, with large acreages in India and Bangladesh. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has genetically modified chickpea to be resistant to the borer, and has recently launched contained field trials for the crop at ICRISAT-Patancheru. The transgenic chickpea contains Bt genes for resistance to Helicoverpa. This transgenic chickpea crop is the third for which contained field trials have been launched. Transgenic groundnut resistant to the Indian Peanut Clump Virus has been undergoing contained field trials since 2002, while transgenic pigeonpea has been through similar trials since 2003. For more of ICRISAT see http://www.icrisat.org [71, 72]
	Storage pests	- Grain borers in maize	Yield loss up to 80%. Maize varietal characteristics were evaluated in the field and in the laboratory for their efficacy in providing resistance to storage pests, in particular Prostephanus truncatus (Horn) (Coleoptera: Bostrichidae) the larger grain borer, and Sitophilus zeamais (Motsch.) (Coleoptera: Curculionidae) the maize weevil. Resistance appeared to be associated more with the husk cover than with the grain [73] The input costs of pesticides to control biotic constraints are often prohibitive to the subsistence farmers of Africa and seed based solutions to biotic stresses are more appropriate. Plant breeding has been highly successful in dealing with many pest problems in Africa, especially diseases, but is limited to the genes available within the crop genome. Years of breeding and studying cultural practices have not always been successful in alleviating many problems that biotechnology may be able to solve. [74]
		- Tubermoths in potatoes	Up to 100% in storage (Langaoui et al., 2000). … responsible for losses of up to R 40 million per annum to the South African potato industry[75]
Stress Tolerance		- Barley	A review is presented of genetic strategies deployed in a 3-yr project on drought tolerance in barley. Data were collected on genetic, physiological and agronomic traits in non-irrigated and irrigated field trials in Egypt, Morocco and Tunisia. A wide range of barley germplasm (developed from African and European cultivars, adapted landraces and wild barleys) was tested, and positive traits were found in each gene pool. The contrasting environments of the three North African countries had major effects on plant/genotype performance. Genetic effects were also detected, as were genotype x environment interactions [76]
		- Cotton	Evolution of resistance to insecticides provides a useful model for examining fitness trade-offs associated with adaptation to stress. Here, we examined male reproductive costs in pink bollworm (Pectinophora gossypiella) resistant to an insecticidal protein of Bacillus thuringiensis (Bt) produced by transgenic cotton, using contrasts between two pairs of related susceptible and resistant strains. Without competition for access to females, no costs affecting reproductive success of resistant males were observed [77,

			78]
Saline tolerance in general		-	About one-third of the world's irrigated land is unsuitable for growing crops because of contamination with high levels of salt. Currently more arable land is lost through salinity than is gained through the clearing of valuable forests. Most trees and crop plants are highly sensitive to salty conditions, experiencing a water deficit because of osmotic stress and biochemical perturbations due to the influx of sodium ions (Na^+). Varieties of a single plant species, such as barley or tomato, exhibit a high degree of variation in salt tolerance. This suggests that only a few mutations in several key transporter or regulatory proteins could confer salt tolerance on salt-sensitive plants. For example, the differing ability of two species of *Plantago* to withstand salty soil is due to the presence of the sodium/proton (Na^+/H^+) antiport protein in salt-tolerant *P. maritima* and its absence in salt-sensitive *P. media*. [79] Salinity in soil affects about 7 % of the land's surface and about 5 % of cultivated land. Most importantly, about 20 % of irrigated land has suffered from secondary salinisation and 50 % of irrigation schemes are affected by salts. In many hotter, drier countries of the world salinity is a concern in their agriculture and could become a key issue. Consequently, the development of salt resistant crops is seen as an important area of research. Although there has been considerable research into the effects of salts on crop plants, there has not, unfortunately, been a commensurate release of salt tolerant cultivars of crop plants. The reason is likely to be the complex nature of the effect of salts on plants [80] Soil salinity is a major abiotic stress in plant agriculture strongly, influencing plant productivity world-wide. Classical breeding for salt tolerance in crop plants has been attempted to improve field performance without success. Therefore, an alternative strategy is to generate salt tolerant plants through genetic engineering. Several species and experimental approaches have been used in order to identify those genes that are important for salt tolerance. Due to high level of salt tolerance, halophytes are good candidates to identify salt tolerance genes. [81]
Saline Tolerance		- Wheat	Salt tolerance was tested in the progenitors of cultivated cereals, wild barley (Hordeum spontaneum) and wild emmer wheat (Triticum dicoccoides) from Israel. Plants from five selected populations of H. spontaneum from the Mediterranean Coastal Plain and northern Negev desert, were grown on 250 and 350 mM of NaCl. Likewise, five populations of T. dicoccoides from the eastern Samaria steppes, Mt. Hermon and Mt. Carmel, were grown on 175 and 250 mM of NaCl. Here we report on superior genotypes of H. spontaneum, ripening at 350 mM NaCl (= 60 % sea water), and of T. dicoccoides ripening at 250 mM (= 40 % sea water). We are proceeding now with both genetical and physiological studies aimed at chromosomally-locating salt tolerant genes and unravelling the mechanism(s) of salt resistance in these wild cereals [82]
		- Maize	Salinity and soil nutrient deficiencies are the main factors reducing plant productivity in arid and semiarid areas. Among the essential elements, nitrogen is usually the most growth limiting plant nutrient in saline or non-saline soils. A pot experiment was carried out in the greenhouse to evaluate the influence of composted manure and urea as nitrogen sources on growth and mineral [nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sodium (Na)] content of maize (Zea mat's L.) under different levels of salinity [83]
		- Rice	One somaclonal family (1-23) regenerated from a salt-resistant callus, its initial cultivar I Kong Pao (IKP, salt-sensitive), the breeding line IR31785 (extremely salt-sensitive), the moderately salt-resistant cultivar Aiwu and F-3 populations derived from several crosses were exposed until maturity to a low sub-lethal (30 mmol NaCl/L) dose of salt. The agronomic performance of this material was compared with its physiological behaviour, as recorded during the vegetative growth phase. Although grain yield of 1-23 was similar to the yield of its initial cultivar IKP in both control and salt-stress conditions, a strong increase in salt resistance in terms of grain yield per plant was observed in their F-3 population derived from IR31785 x 1-23, which performed better than the corresponding parents and better even than the cultivar Aiwu in the presence of 30 mmol/L NaCl. Such improvement was due to a high number of spikelets per plant and a high spikelet fertility. [84] [85]
		- Sorghum	Grain sorghum is a potential crop for moderately saline areas, having been identified as fairly tolerant to salinity, and shown to

			contain intraspecific variability for that trait. The aim of this work was to describe the responses of grain sorghum to saline irrigation, assess the responses of a set of genotypes to salinity, and to analyze the relationships between several agronomic and physiological traits and salinity tolerance [86]
		Tobacco plants	Dr. Tuteja’s group developed a transgenic tobacco plant containing the gene. Wild type tobacco plants suffered in response to high salt, but transgenic plants overexpressing PDH45 protein continued to grow. In addition, subsequent generations of transgenic tobacco plants maintained the exogenous gene and continued to resist high salt stress, suggesting that stress tolerance can be manipulated in crop plants. UNWINDING AFTER HIGH SALINITY STRESS: DEVELOPMENT OF SALINITY TOLERANT PLANT WITHOUT AFFECTING YIELD Narendra Tuteja, http://www.isb.vt.edu/news/2005/news05.mar.html#mar0505 [87, 88]
Nutrition Improvement in general		-	Because trace minerals are important not only for human nutrition but for plant nutrition as well, plant breeding holds great promise for making a significant, sustainable, low-cost contribution to the reduction of micronutrient deficiencies in humans. It may also have important spin-off effects for increasing farm productivity in developing countries in an environmentally beneficial way. This article describes ongoing plant breeding research that could increase the intake of bioavailable zinc from food staple crops in vulnerable populations in developing countries. The 3 most promising plant breeding strategies toward this goal are as follows: Ij increasing the concentration of zinc, 2) reducing the amount of phytic acid (a strong inhibitor of zinc absorption), and 3) raising the concentrations of sulfur-containing amino acids (thought to promote zinc absorption) in the plant. The agronomic advantages and disadvantages as well as the potential benefits and limitations of each approach for human nutrition are described. Research is currently underway to identify the optimal combination of these approaches that will maximize the effect on human zinc nutrition. [89]
Nutrition improvement	Provitamin A	- Rice	Recent studies found that, even under conservative adoption and consumption assumptions, introducing golden rice in the Philippines could decrease the number of disabilityadjusted life years (DALYs) lost due to Vitamin A deficiency by between 6 and 47 percent [90]. That is equivalent to an increase in unskilled labor productivity of up to 0.53 percent. Based on those findings, Anderson, Jackson and Nielsen (2004) represent these health impacts with an assumed 0.5 percent improvement in unskilled labor productivity in all sectors of golden rice-adopting Asian developing economies. Given the low nutrition levels of poor workers in Africa, and the fact that if golden rice were to be adopted in Asia and Africa then nutritionally enhanced GM varieties of wheat and other foods would soon follow, we assume the productivity of unskilled labor would rise by 2 percent following adoption of second-generation GM crops.[91] The latest figures on improved nutrition with the Golden Rice 2: Through systematic testing of other plant psys, we identified a psy from maize that substantially increased carotenoid accumulation in a model plant system. We went on to develop ‘Golden Rice 2’ introducing this psy in combination with the Erwinia uredovora carotene desaturase (crtI) used to generate the original Golden Rice1. We observed an increase in total carotenoids of up to 23-fold (maximum 37 lg/g) compared to the original Golden Rice and a preferential accumulation of b-carotene. [92]
		- Golden Mustard	For mustard (from Vibha Dhawan, presentation): • The economically weaker sections of Indian population suffer from Micronutrient and Vitamin deficiencies. • Vitamin A deficiency prevalent in all age groups with children, expecting and lactating mothers worst affected. • Lack of Vitamin A causes many disorders ranging from minor skin infections to night blindness and break down of the immune system Golden mustard advantages for India: • Vitamin A at higher doses toxic but not beta-carotene • One tablespoon of golden mustard oil is enough to meet the daily requirement of Vitamin A • The bioavailability of Vitamin A is expected to be considerably high in mustard oil as it is fat soluble Multiple delivery systems can be developed [93, 94] http://www.monsanto.com/monsanto/layout/media/00/12-07-00b.asp

	Protein quality	- Maize	The nutritional advantages of quality protein maize v common maize are of a magnitude that must be exploited for the advantage of children in maize-consuming poor countries. [95] Work of World Food Prize laureates 2000 to add here
		- Potatoes	The GM potatoes are part of an anti-hunger plan, formulated in collaboration with charities, scientists, government institutes and industry, currently under consideration by the Indian government. See also [96] and [97]
		-	
	High iron	- rice	Iron deficiency is the leading human nutritional disorder in the world. Compared with other micronutrients such as vitamin A and iodine, overall progress in reducing iron deficiency has been limited. Plant foods contain almost all of the mineral and organic nutrients established as essential for human nutrition, but often these are not present in sufficient amounts. The cereal grains represent the single largest source of calories in the world and, in countries where the staple food is rice, per capita consumption is so high that even a small increase in its nutritive value would be highly significant. [98]
	High Zinc	- rice	The importance of zinc for human health was first documented in 1963. During the past 25 y, deficiency of zinc in humans due to nutritional factors and several disease states has now been recognized. The high phytate content of cereal proteins is known to decrease the availability of zinc, thus the prevalence of zinc deficiency is likely to be high in a population consuming large quantities of cereal proteins. Alcoholism, malabsorption, sickle cell anemia, chronic renal disease, and chronically debilitating diseases are now known to be predisposing factors for zinc deficiency. A spectrum of clinical manifestations ranging from mild to severe degree have now been recognized in human zinc-deficiency states. Zinc is required for many biological functions including DNA synthesis, cell division, and gene expression. It is required for the activity of many enzymes in biological systems. Recent studies indicate that zinc is needed for cell-mediated immunity. (Prasad, 1991) Synthetic hexaploid wheats (Triticum aestivum L) derived from crosses between durum wheat [Triticum turgidum ssp. durum (Desf.) Husn.] and diploid wheat (Aegilops tauschii Coss.) have been developed as a means of transferring desirable characteristics of Aegilops tauschii Coss. such as disease resistance and abiotic stress tolerance into modern bread wheat genotypes. In a growth room experiment using soil culture, we studied a group of 30 synthetic hexaploid wheat accessions together with modern wheat genotypes in order to identify new sources of zinc efficiency for further improvement of zinc efficiency in modern wheat genotypes [99]
	Low HCN content	- Cassava	Cassava tubers contain the toxic hydrocyanic acid which makes time and resource consuming fermentation and processing necessary prior to eating. Bioengineered cassava with little or no HCN has been developed which need to be tested in sub-Saharan Africa. If biosafety regulatory bodies in SSA approve the release of bioengineered cassava clones with no HCN it will save a lot of time and labour needed in processing the tubers for consumption. [100-102] [103] But some reservation seems to be appropriate: There are plenty of "sweet cassava" cultivars around that do not produce HCN. However, the cultural preference is to plant the cyanogenic types, because they suffer from less predatory damage. [104-106]
Herbicide Tolerance	Combat Striga	- maize	Multi-site, multi-season field tests demonstrate that herbicide seed-coating herbicide-resistance maize controls Striga spp. and increases yields in several African countries [107] TZB and PR7843, the two most widely grown open-pollinated (OP) varieties in West and Central Africa, were susceptible to Striga with yield losses of 68 and 79%, respectively.[108-111]) [107, 112-114]

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