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Transgenic Plants for Food Security in the Context of Development

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Including a Statement of the Study Week,
endorsed unanimously by the Participants in 16 Languages
and all Presentations given during the Study Week

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Scientific Contributions (Authors in Alphabetic Order)

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Agricultural biotechnologies, and especially transgenic crops, have the potential to boost food security in developing countries by offering higher incomes for farmers and lower priced and better quality food for consumers. That potential is being heavily compromised, however, because the European Union and some other countries have implemented strict regulatory systems to govern their production and consumption of genetically modified (GM) food and feed crops, and to prevent imports of foods and feedstuffs that do not meet these strict standards. This paper analyses empirically the potential economic effects of adopting transgenic crops in Asia and Sub-Saharan Africa. It does so using a multi-country, multi-product model of the global economy. The results suggest the economic welfare gains from crop biotechnology adoption are potentially very large, and that those benefits are diminished only very slightly by the presence of the European Union’s restriction on imports of GM foods. That is, if developing countries retain bans on GM crop production in an attempt to maintain access to EU markets for non-GM products, the loss to their food consumers as well as to farmers in those developing countries is huge relative to the slight loss that could be incurred from not retaining EU market access.

Apel, A. (2010). “The costly benefits of opposing agricultural biotechnology.” New Biotechnology **27**(5): 635-640.

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Rigorous application of a simple definition of what constitutes opposition to agricultural biotechnology readily encompasses a wide array of key players in national and international systems of food production, distribution and governance. Even though the sum of political and financial benefits of opposing agricultural biotechnology appears vastly to outweigh the benefits which accrue to providers of agricultural biotechnology, technology providers actually benefit from this opposition. If these barriers to biotechnology were removed, subsistence farmers still would not represent a lucrative market for improved seed. The sum of all interests involved ensures that subsistence farmers are systematically denied access to agricultural biotechnology.

Arber, W. (2010). “Genetic engineering compared to natural genetic variations.” New Biotechnology **27**(5): 517-521.

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By comparing strategies of genetic alterations introduced in genetic engineering with spontaneously occurring genetic variation, we have come to conclude that both processes depend on several distinct and specific molecular mechanisms. These mechanisms can be attributed, with regard to their evolutionary impact, to three different strategies of genetic variation. These are local nucleotide sequence changes, intragenomic rearrangement of DNA segments and the acquisition of a foreign DNA segment by horizontal gene transfer. Both the strategies followed in genetic engineering and the amounts of DNA sequences thereby involved are identical to, or at least very comparable with, those involved in natural genetic variation. Therefore, conjectural risks of genetic engineering must be of the same order as those for natural biological evolution and for conventional breeding methods. These risks are known to be quite low. There is no scientific reason to assume special long-term risks for GM crops. For future agricultural developments, a road map is designed that can be expected to lead, by a combination of genetic engineering and conventional plant breeding, to crops that can insure food security and eliminate malnutrition and hunger for the entire human population on our planet. Public-private partnerships should be formed with the mission to reach the set goals in the coming decades.

Beyer, P. (2010). “Golden Rice and ‘Golden’ crops for human nutrition.” New Biotechnology **27**(5): 478-481.

http://www.sciencedirect.com/science/article/B8JG4-5033Y3B-2/2/c8c360e84a3b8b067ddc19b173ba05b3 AND http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Beyer-Peter-PAS-Golden-Rice-Crops-20101130-publ.pdf

Micronutrients are essential for a healthy life. Humans do not produce micronutrients, and hence they must obtain them through the foodchain. Staple crops are the predominant food source of mankind, but need to be complemented by other foodstuffs because they are generally deficient in one or the other micronutrient. Breeding for micronutrient-dense crops is not always a viable option because of the absence of genetic variability for the desired trait. Moreover, sterility issues and the complex genetic makeup of some crop plants make them unamenable to conventional breeding. In these cases, genetic modification remains the only viable option. The tools to produce a number of micronutrients in staple crops have recently become available thanks to the identification of the genes involved in the corresponding biochemical pathways at an unprecedented rate. Discarding genetic modification as a viable option is definitely not in the interest of human wellbeing.

Burachik, M. (2010). "Experience from use of GMOs in Argentinian agriculture, economy and environment." New Biotechnology **27**(5): 588-592.

http://www.sciencedirect.com/science/article/B8JG4-50393XW-1/2/4c70d58deb7a24997b939fc843b09e8f AND http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Burachik-Moises-PAS-Experience-GMO-Argentina-20101130-publ.pdf

Argentina is the second largest grower of genetically modified (GM) crops. This high level of adoption of this new agricultural technology is the result of a complex combination of circumstances. We can identify four main causes that led to this: political support (from agriculture officials), ability to solve prevalent farmers' needs, economic and environmental factors and an early implementation of effective regulations. The political willingness to study this new technology and crops as well as the recruitment of sound professionals and scientists to perform the task was crucial. These professionals, with very diverse backgrounds, created the necessary regulatory framework to work with these new crops. Farmers played a decisive role, as adopting this new technology solved some of their agronomic problems, helped them perform more sustainable agronomic practices and provided economic benefits. Nonetheless, all these advancements had not been possible without a rational, science-based and flexible regulatory framework that would make sure that the GM crops were safe for food, feed and processing.

Chassy, B. M. (2010). "Food safety risks and consumer health." New Biotechnology **27**(5): 534-544.

http://www.sciencedirect.com/science/article/B8JG4-506RD0H-1/2/2fc77e9607ee5ae9a8d7cb820aacda80 AND http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Chassy-Bruce-PAS-Food-Safety-Risks-20101130-pub.pdf

The major food safety risks are not eating a healthy diet, and failure to avoid foodborne illness. Over one billion people in the world suffer from food insecurity and malnutrition. Nutritionally enhanced transgenic crops such as Golden Rice are one potential strategy for reducing malnutrition in the world. Transgenic crops are subjected to a rigorous pre-market safety assessment. The safety of novel proteins and other products is established, and through compositional analysis and animal studies, the safety of any observed changes is evaluated. These studies provide evidence that the new product is as safe as, or safer than, comparable varieties. It must be asked, however, if this rigorous analysis is necessary, because unregulated crops produced by other breeding methods also undergo genetic changes and contain unintended effects. Golden Rice poses infinitesimally small, if any, risk to consumers whilst it has the potential to spare millions of lives each year. However, because it is a transgenic crop, it cannot be deployed without years of expensive pre-market safety review. Paradoxically, if Golden Rice had been produced by less precise conventional methods of breeding, it would already be in the hands of poor farmers. It is concluded that the hyper-precautionary regulatory process applied to transgenic crops works to the extreme disadvantage of the hungry and the poor.

Cominelli, E. and C. Tonelli (2010). "Transgenic crops coping with water scarcity." New Biotechnology **27**(5): 473-477.

http://www.sciencedirect.com/science/article/B8JG4-50T41TM-1/2/f42858b01efa4b91ab18546395fd5a06 AND http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Cominelli-Tonelli-Water-Scarcity-20101130-publ.pdf

Water scarcity is a serious problem that will be exacerbated by global climate change. Massive quantities of water are used in agriculture, and abiotic stresses, especially drought and increased salinity, are primary causes of crop loss worldwide. Various approaches may be adopted to consume less water in agriculture, one of them being the development of plants that use less water yet maintain high yields in conditions of water scarcity. In recent years several molecular networks concerned with stress perception, signal transduction and stress responses in plants have been elucidated. Consequently, engineering some of the genes involved in these mechanisms promises to enhance plant tolerance to stresses and in particular increase their water use efficiency. Here we review the various approaches used so far to produce transgenic plants having improved tolerance to abiotic stresses, and discuss criteria for choosing which genes to work on (functional and regulatory genes) and which gene expression promoters (constitutive, inducible, and cell-specific) have been used to obtain successful results.

Fedoroff, N. V. (2010). "The past, present and future of crop genetic modification." New Biotechnology **27**(5): 461-465.

http://www.sciencedirect.com/science/article/B8JG4-4Y52R7D-1/2/04c55a8ae6d670e2c660d351b18af418 AND http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Fedoroff-Nina-PAS-Past-Present-Future-20101130-publ.pdf

The introduction of science and technology into agriculture over the past two centuries has markedly increased agricultural productivity and decreased its labor-intensiveness. Chemical fertilization, mechanization, plant breeding and molecular genetic modification (GM) have contributed to unparalleled productivity increases. Future increases are far from assured because of

underinvestment in agricultural research, growing population pressure, decreasing fresh water availability, increasing temperatures and societal rejection of GM crops in many countries.

Flavell, R. (2010). "Knowledge and technologies for sustainable intensification of food production." New Biotechnology **27**(5): 505-516.

http://www.sciencedirect.com/science/article/B8JG4-507CS31-1/2/2f9dde686fc1dcc2390c7e2106d21004 AND http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Flavell-Richard-PAS-Knowledge-Technologies-20101130-publ.pdf

Knowledge and technologies will always continue to be developed, as they have always, to bring new efficiencies to plant breeding and crop production, which suffer from many constraints and inefficiencies. These constraints need to be overcome throughout the world to help increase the rate of improvements in food production and intensify production on less land. The recent discoveries and technical innovations that are revealing the full complement of genes in crops, the ability to define genetic variation and use DNA markers to follow chromosome segments with known functions through breeding programmes are leading to new efficiencies in breeding. The ability to isolate and redesign genes and transfer them into different plants also offers the breeder solutions to several key limitations. These benefits are described together with some of the current issues associated with the use of transgenes. Generation after generation can look forward to new knowledge and technologies, many of which we cannot know at present, and thus there is no reason to be despondent about meeting future goals, if the right decisions and investments are made globally and locally. These decisions include putting optimal use of land at the top of the world agenda to sustain both the planet and an adequate quality of life for mankind. As always has been the case, more investments are urgently required into the dissemination of successful technologies in crop breeding and production, into teaching and training as well as into innovative research. Failure to invest adequately in innovative technologies will leave future decision-makers and citizens with fewer options and greatly enhance the risks for mankind and a healthy planet.

Gressel, J. (2010). "Needs for and environmental risks from transgenic crops in the developing world." New Biotechnology **27**(5): 522-527.

http://www.sciencedirect.com/science/article/B8JG4-506RN94-1/2/88f8005c772a8f846854d0d5ec6fb5fa AND http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Gressel-Jonathan-PAS-Needs-Environmental-Risks--20101130-publ.pdf

The developing world has many unique constraints to crop production and, lacking inputs, they are best overcome if solutions are seed borne. Classical breeding cannot overcome many of these constraints because the species have attained a 'genetic glass ceiling', the genes are not available within the species. Transgenics can supply the genes, but typically not as 'hand me down genes' from the developed world because of the unique problems: mainly parasitic weeds, and weedy rice, stem borers and post-harvest insects, viral diseases, tropical mycotoxins, anti-feedants, toxic heavy metals and mineral deficiencies. Public sector involvement is imperative for genetically engineering against these constraints, as the private biotechnology sector does not see the developing world as a viable market in most instances. Rice, sorghum, barley, wheat and millets have related weeds, and in certain cases, transgenic gene containment and/or mitigation is necessary to prevent establishment of transgenes in the weedy relatives.

Herring, R. J. (2010). "Epistemic brokerage in the bio-property narrative: contributions to explaining opposition to transgenic technologies in agriculture." New Biotechnology **27**(5): 614-622.

http://www.sciencedirect.com/science/article/B8JG4-506RN94-3/2/60441488d633aa3c2dded0e6700e4836 AND http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Herrning-Ronald-PAS-Epistemic-Brokerage-20101130-publ.pdf

Unlike some global contentions - abolition of slavery, or universal franchise, for example - the rift over rDNA crops is not about ultimate values. Improvement of farmer welfare and enhanced sustainability of agriculture are universally valued goals. However, means to those ends are politically disputed; that dispute depends on alternative empirical stories about biotechnology, sometimes even alternative epistemologies. Opposition revolves around two fundamental dimensions: bio-safety and bio-property. There is convergence of these dimensions around exceptional risk and vulnerability to corporate control of farmers, but these are analytically separable questions of fact. This paper concentrates on bio-property. Epistemic brokers have successfully established knowledge claims that simultaneously undermine the case for rDNA technologies as potential contributors to development and motivate opposition. Epistemic brokers command authority from their positions at junctures of networks, enabling the screening, weighting, theorizing and diffusion of contentious empirical accounts. In contentions of low information, high information costs and diffuse anxiety, these claims provide cognitive support for opposition to 'GMOs'. Specifically, claims of patents, monopoly corporate control and terminator technology have diffused to and from India in global networks. Though effective in transnational advocacy networks, these claims have proved either false or inconsistent with dynamics on the ground.

Kershen, D. L. (2010). "Trade and commerce in improved crops and food: an essay on food security." New Biotechnology **27**(5): 623-627.

http://www.sciencedirect.com/science/article/B8JG4-50CV86B-5/2/ddcedd204ee731fbd267c327a9e4bd7b AND http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Kershen-Drew-PAS-Trade-Commerce-Improved-20101130-publ.pdf

Agricultural trade between nations is a significant proportion of total international trade. Agricultural trade in transgenic crops faces extra complications due to the existence of domestic and international regimes that focus specifically on agricultural biotechnology. These specialized regimes create legal and commercial challenges for trade in transgenic crops that have significant implications for the food security of the nations of the world. By food security, one should understand not just the available supply of food, but also the quality of the food and the environmental impact of agricultural production systems. These specialized regimes for transgenic crops can either encourage or hinder the adoption of agricultural biotechnology as a sustainable intensive agriculture. Sustainable intensive agriculture offers hope for agronomic improvements for agricultural production, socio-economic betterment for farmers and environmental benefits for societies. Sustainable intensive agriculture offers particular hope for the poorest farmers of the world because agricultural biotechnology is a technology in the seed.

Krattiger, A. (2010). "Intellectual property, commercial needs and humanitarian benefits: must there be a conflict?" New Biotechnology **27**(5): 573-577.

http://www.sciencedirect.com/science/article/B8JG4-504JYNT-3/2/5b969a530e276c6988288e416274b156 AND http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Krattiger-PAS-Intellectual-Property-20101130-publ.pdf

"By far the best proof is experience", wrote Francis Bacon. Given the experience of countries - both developing and developed - that have used intellectual property (IP), IP protection and IP management to stimulate innovation, there is ample proof that good IP management has benefited multitudes of people around the world with new technologies, products and services. Innovations in health and agriculture have greatly enriched lives. But does this experience apply to all countries? If the best proof is experience, then what can be said authoritatively about the effects of using IP systems wisely in developing countries?

Martin, M. A. (2010). "First generation biofuels compete." New Biotechnology **27**(5): 596-608.

http://www.sciencedirect.com/science/article/B8JG4-50CV86B-6/2/f14937d456074fdd384f36b1aa8c66bd AND http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Martin-Marshall-PAS-First-Generation-Biofuels-20101130-publ.pdf

Rising petroleum prices during 2005-2008, and passage of the 2007 U.S. Energy Independence and Security Act with a renewable fuel standard of 36 billion gallons of biofuels by 2022, encouraged massive investments in U.S. ethanol plants. Consequently, corn demand increased dramatically and prices tripled. This created a strong positive correlation between petroleum, corn, and food prices resulting in an outcry from U.S. consumers and livestock producers, and food riots in several developing countries. Other factors contributed to higher grain and food prices. Economic growth, especially in Asia, and a weaker U.S. dollar encouraged U.S. grain exports. Investors shifted funds into the commodity's future markets. Higher fuel costs for food processing and transportation put upward pressure on retail food prices. From mid-2008 to mid-2009, petroleum prices fell, the U.S. dollar strengthened, and the world economy entered a serious recession with high unemployment, housing market foreclosures, collapse of the stock market, reduced global trade, and a decline in durable goods and food purchases. Agricultural commodity prices declined about 50%. Biotechnology has had modest impacts on the biofuel sector. Seed corn with traits that help control insects and weeds has been widely adopted by U.S. farmers. Genetically engineered enzymes have reduced ethanol production costs and increased conversion efficiency.

McGloughlin, M. N. (2010). "Modifying agricultural crops for improved nutrition." New Biotechnology **27**(5): 494-504.

http://www.sciencedirect.com/science/article/B8JG4-50KC70Y-2/2/bd3997c80934ea4d03029055d7df0f8f AND http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Newell-Martina-PAS-Modifying-Agricultural-Crops-20101130-publ.pdf

The first generation of biotechnology products commercialized were crops focusing largely on input agronomic traits whose value was often opaque to consumers. The coming generations of crop plants can be grouped into four broad areas each presenting what, on the surface, may appear as unique challenges and opportunities. The present and future focus is on continuing improvement of agronomic traits such as yield and abiotic stress resistance in addition to the biotic stress tolerance of the present generation; crop plants as biomass feedstock for biofuel and "bio-synthetics"; value-added output traits such as improved nutrition and food functionality; and plants as production factories for therapeutics and industrial products. From a consumer perspective, the focus on value-added traits, especially improved nutrition, is undoubtedly one of the areas of greatest interest. From a basic nutrition perspective, there is a clear dichotomy in demonstrated need between different regions and socioeconomic groups, the starkest being inappropriate consumption in the developed world and under-nourishment in Less Developed Countries (LDCs). Dramatic increases in the occurrence of obesity and related ailments in affluent regions are in sharp contrast to chronic malnutrition in many LDCs. Both problems require a modified food supply, and the tools of biotechnology have a part to play. Developing plants with improved traits involves overcoming a variety of technical, regulatory and indeed perception hurdles inherent in perceived and real challenges of complex traits modifications. Continuing improvements in molecular and genomic technologies are contributing to the acceleration of product development to produce plants with the appropriate quality traits for the different regions and needs. Crops with improved traits in the pipeline, the evolving technologies and the opportunities and challenges that lie ahead are covered.

Miller, H. I. (2010). "The regulation of agricultural biotechnology: science shows a better way." New Biotechnology **27**(5): 628-634.

http://www.sciencedirect.com/science/article/B8JG4-50G06H6-2/2/baec44822399aaf56f2b8fe58d560c28 AND
http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Miller-Henry-PAS-Regulation-Agricultural-20101130-publ.pdf

National and international regulation of recombinant DNA-modified, or 'genetically engineered' (also referred to as 'genetically modified' or GM), organisms is unscientific and illogical, a lamentable illustration of the maxim that bad science makes bad law. Instead of regulatory scrutiny that is proportional to risk, the degree of oversight is actually inversely proportional to risk. The current approach to regulation, which captures for case-by-case review organisms to be field tested or commercialized according to the techniques used to construct them rather than their properties, flies in the face of scientific consensus. This approach has been costly in terms of economic losses and human suffering. The poorest of the poor have suffered the most because of hugely inflated development costs of genetically engineered plants and food. A model for regulation of field trials known as the 'Stanford Model' is designed to assess risks of new agricultural introductions - whether or not the organisms are genetically engineered, and independent of the genetic modification techniques employed. It offers a scientific, rational, risk-based basis for field trial regulations. Using this sort of model for regulatory review would not only better protect human health and the environment, but would also permit more expeditious development and more widespread use of new plants and seeds.

Morandini, P. (2010). "Inactivation of allergens and toxins." New Biotechnology **27**(5): 482-493.

http://www.sciencedirect.com/science/article/B8JG4-50DYHB8-1/2/1a62001700632583af489b7a83ccc9a6 AND
http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Morandini-Piero-Inactivation-Allergens-20101130-publ.pdf

Plants are replete with thousands of proteins and small molecules, many of which are species-specific, poisonous or dangerous. Over time humans have learned to avoid dangerous plants or inactivate many toxic components in food plants, but there is still room for ameliorating food crops (and plants in general) in terms of their allergens and toxins content, especially in their edible parts. Inactivation at the genetic rather than physical or chemical level has many advantages and classical genetic approaches have resulted in significant reduction of toxin content. The capacity, offered by genetic engineering, of turning off (inactivating) specific genes has opened up the possibility of altering the plant content in a far more precise manner than previously available. Different levels of intervention (genes coding for toxins/allergens or for enzymes, transporters or regulators involved in their metabolism) are possible and there are several tools for inactivating genes, both direct (using chemical and physical mutagens, insertion of transposons and other genetic elements) and indirect (antisense RNA, RNA interference, microRNA, eventually leading to gene silencing). Each level/strategy has specific advantages and disadvantages (speed, costs, selectivity, stability, reversibility, frequency of desired genotype and regulatory regime). Paradigmatic examples from classical and transgenic approaches are discussed to emphasize the need to revise the present regulatory process. Reducing the content of natural toxins is a trade-off process: the lesser the content of natural toxins, the higher the susceptibility of a plant to pests and therefore the stronger the need to protect plants. As a consequence, more specific pesticides like Bt are needed to substitute for general pesticides.

Paarlberg, R. (2010). "GMO foods and crops: Africa's choice." New Biotechnology **27**(5): 609-613.

http://www.sciencedirect.com/science/article/B8JG4-50J4MRM-4/2/ee89aab886396233495a761254ecd29a AND
http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Paarlberg-Robert-PAS-GMO-Foods-Africa-20101130-publ.pdf

There is a scientific consensus, even in Europe, that the GMO foods and crops currently on the market have brought no documented new risks either to human health or to the environment. Europe has decided to stifle the use of this new technology, not because of the presence of risks, but because of the absence so far of direct benefits to most Europeans. Farmers in Europe are few in number, and they are highly productive even without GMOs. In Africa, by contrast, 60% of all citizens are still farmers and they are not yet highly productive. For Africa, the choice to stifle new technology with European-style regulations carries a much higher cost.

Parrott, W. (2010). "Genetically modified myths and realities." New Biotechnology **27**(5): 545-551.

http://www.sciencedirect.com/science/article/B8JG4-506RN94-2/2/41a40cb121ad20dd44db6f76d34f1bd5 AND
http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Parrott-Wayne-PAS-Genetically-Modified-Myths-20101130-publ.pdf

Myths abound when it comes to GE crops. At their worst, myths play an active role in discouraging the use of GE to solve problems that afflict humankind, such as malnutrition and birth defects. Of all the various myths, two have been particularly important in preventing the use of GE maize in its areas of origin. The first is that transgenic maize will contaminate and destroy land races, thus destroying biodiversity and its associated cultural traditions. This myth totally ignores the fact that the gene flow that has taken place between maize and its progenitor, between the land races, and between land races and modern hybrids, has not led to any dire consequences. The second myth is that crops are natural and have not been modified by humans, or if they have, that plant breeding does not alter DNA. This myth ignores the fact that for the most part, it is impossible to alter the appearance of crops without changing the DNA. In fact, DNA movement within the crop genome is normal and its movement leads to double-strand DNA repair, with results like those found around transgene insertion sites. In addition, plants have ways to create novel genes. These changes help plants adapt to evolution and to human selection. The net result is that changes similar to what happens during the production of engineered plants takes place anyway in plant genomes.

Potrykus, I. (2010). "Lessons from the 'Humanitarian Golden Rice' project: regulation prevents development of public good genetically engineered crop products." New Biotechnology **27**(5): 466-472.

http://www.sciencedirect.com/science/article/B8JG4-50K5T51-1/2/469242a5ba1f0f71050d51e2bfd25b38 AND http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Potrykus-Ingo-Lessons-Humanitarian-Golden-Rice-20101130-publ.pdf

Compared to a non-Genetically Engineered (GE) variety, the deployment of Golden Rice has suffered from a delay of at least ten years. The cause of this delay is exclusively GE-regulation. Considering the potential impact of Golden Rice on the reduction in vitamin A-malnutrition, this delay is responsible for an unjustifiable loss of millions of lives, mostly children and women. GE-regulation is also responsible for the fact that no public institution can deliver a public good GE-product and that thus we have a de facto monopoly in favour of a few potent industries. Considering the forgone benefits from prevented public good GE-products, GE-regulation is responsible for hundreds of millions of lives, all of them, of course, in developing countries. As there is no scientific justification for present GE-regulation, and as it has, so far, not prevented any harm, our society has the urgent responsibility to reconsider present regulation, which is based on an extreme interpretation of the precautionary principle, and change it to science-based regulation on the basis of traits instead of technology. GE-technology has an unprecedented safety record and is far more precise and predictable than any other 'traditional' and unregulated breeding technology. Not to change GE-regulation to a scientific basis is considered by the author 'a crime against humanity'.

Potrykus, I. (2010). "The private sector's role in public sector genetically engineered crop projects." New Biotechnology **27**(5): 578-581.

http://www.sciencedirect.com/science/article/B8JG4-50J4MRM-5/2/b25d03d8d135f1ce871ce16f02aa1522 AND http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Potrykus-Ingo-PAS-Private-Sector-20101130-publ.pdf

There is widespread interest within academia to work on public good genetically engineered (GE) projects to the benefit of the poor, especially to use GE-technology to contribute to food security. Not a single product from this work has reached the market. The major cause is GE-regulation, which prevents use of the technology for public good beyond proof-of-concept (Potrykus, I. (2010) Lessons from the Humanitarian Golden Rice project: Regulation prevents development of public good GE-products (these Proceedings p.446ff)). There is, however, another key problem responsible for the lack of deployment of public good GE-plants: the public sector is incompetent and disinterested for work beyond proof-of-concept, and has neither capability nor funding to develop GE-plant products and introduce them to growers and consumers. The private sector has the expertise for both and in the right circumstances can be ready to support the public sector in public good enterprises. Public-private-partnerships are the best solution so far, to advance exploitation of GE-technology to the benefit of the poor. Public-private-partnerships are viable, however, only, if there is mutual interest from the private sector and initiative and funding from the public sector.

Qaim, M. (2010). "Benefits of genetically modified crops for the poor: household income, nutrition, and health." New Biotechnology **27**(5): 552-557.

http://www.sciencedirect.com/science/article/B8JG4-50JHC4K-2/2/935a355edcace7ede62ecdbed21d6ac7 AND http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Qaim-Matin-PAS-Benefits-Geneitcally-Modified-20101130-publ.pdf

The potential impacts of genetically modified (GM) crops on income, poverty and nutrition in developing countries continue to be the subject of public controversy. Here, a review of the evidence is given. As an example of a first-generation GM technology, the effects of insect-resistant Bt cotton are analysed. Bt cotton has already been adopted by millions of small-scale farmers, in India, China, and South Africa among others. On average, farmers benefit from insecticide savings, higher effective yields and sizeable income gains. Insights from India suggest that Bt cotton is employment generating and poverty reducing. As an example of a second-generation technology, the likely impacts of beta-carotene-rich Golden Rice are analysed from an ex ante perspective. Vitamin A deficiency is a

serious nutritional problem, causing multiple adverse health outcomes. Simulations for India show that Golden Rice could reduce related health problems significantly, preventing up to 40,000 child deaths every year. These examples clearly demonstrate that GM crops can contribute to poverty reduction and food security in developing countries. To realise such social benefits on a larger scale requires more public support for research targeted to the poor, as well as more efficient regulatory and technology delivery systems.

Raven, P. H. (2010). "Does the use of transgenic plants diminish or promote biodiversity?" New Biotechnology **27**(5): 528-533.

http://www.sciencedirect.com/science/article/B8JG4-50P4NC3-2/2/47f55f594690a1387d302aa94ba250ee AND http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Raven-Peter-PAS-Tansgenic-Plants-Biodiversity-20101130-publ.pdf

The protection of biodiversity and of ecosystem services ought to be a top priority, taken into consideration in the course of all human activities, because we depend on it fully now and for the future. In this context, we note that the ecological problems related to the cultivation of GE crops fail to differ in any fundamental way from the ecological problems associated with agriculture in general, except that they usually involve the application of much lower quantities of chemicals and thus tend to leave the environments in and adjacent to where they are grown in better condition than do the conventional ones. Higher productivity on cultivated lands, which is one outcome of growing GE crops, protects biodiversity by sparing lands not intensively cultivated, whereas relatively non-productive agriculture practice is highly destructive to biodiversity, since it consumes more land in an often destructive way, even though more biodiversity may be preserved among the crops themselves than in industrialized, large fields, especially if hedgerows and woodlands are not encouraged in near proximity. The major preservation of biodiversity, however, does not take place among crops! If weeds are present that are closely related to the crops, they may acquire immunity to the effects from which the crops were protected and be more difficult to control among them. The production of super-weeds as a result of hybridization between cultivated crops and their wild relatives is essentially a myth. The definition of 'organic' production in the U.S. and elsewhere unjustifiably rules out GE crops, often in such a way as to damage the environment more than would be the case otherwise. Unless the definition of 'organic' is a problem, or close relatives to the crops are weedy among them, there seems to be essentially no ecological risk involved in growing GE crops.

Skryabin, K. (2010). "Do Russia and Eastern Europe need GM plants?" New Biotechnology **27**(5): 593-595.

http://www.sciencedirect.com/science/article/B8JG4-50R236T-1/2/cc9a8f2c4fec9e281c022353502f176d AND http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Skryabin-Konstantin-PAS-Russia-Eastern-Europe-20101130-publ.pdf

Russia, Ukraine and Kazakhstan are the leading agricultural producers, especially for potato, sugar beet and sunflower. The cumulative effect of adverse climatic conditions, high weediness and losses related to viruses and pests (without any insecticide and herbicide treatments) led to losses amounting to 40-80% of potential production in the Russian Federation and other mentioned countries. We have used new biotechnology methods to obtain several crops (potato, sugar beet, sunflower and others) tolerant to abiotic and biotic stresses. For the first time - on the basis of domestic varieties bred by Russian scientists - GM potato varieties have been obtained, resistant to Colorado beetle. These GM potato varieties were recognized as being as safe as traditional ones and have been registered for food use. Using this technology, new biotechnological sugar beet lines tolerant to herbicides were also obtained.

Swaminathan, M. S. (2010). "Achieving food security in times of crisis." New Biotechnology **27**(5): 453-460.

http://www.sciencedirect.com/science/article/B8JG4-50S2RHV-2/2/675892bf586b447d35d9d258790f3542 AND http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Swaminathan-MS-PAS-Achieving-Food-Security-20101130-publ.pdf

In spite of several World Food Summits during the past decade, the number of people going to bed hungry is increasing and now exceeds one billion. Food security strategies should therefore be revisited. Food security systems should begin with local communities who can develop and manage community gene, seed, grain and water banks. At the national level, access to balanced diet and clean drinking water should become a basic human right. Implementation of the right to food will involve concurrent attention to production, procurement, preservation and public distribution. Higher production in perpetuity should be achieved through an ever-green revolution based on the principles of conservation and climate-resilient farming. This will call for a blend of traditional ecological prudence with frontier technologies, particularly biotechnology and information communication technologies.

Van Montagu, M. (2010). "Challenges and responsibilities for public sector scientists." New Biotechnology **27**(5): 641-644.

http://www.sciencedirect.com/science/article/B8JG4-50W1TS4-3/2/a7df878e2b29e50eed51d4b3ee0e1cff AND http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/vanMontagu-Marc-PAS-Challenges-Responsibilities-20101130-publ.pdf

Current agriculture faces the challenge of doubling food production to meet the food needs of a population expected to reach 9 billion by mid-century whilst maintaining soil and water quality and conserving biodiversity. These challenges are more overwhelming for the rural poor, who are the custodians of environmental resources and at the same time particularly vulnerable to environmental degradation. Solutions have to come from concerted actions by different segments of society in which public sector science plays a fundamental role. Public sector scientists are at the root of all the present generation of GM crop traits under cultivation and more will come with the new knowledge that is being generated by systems biology. To speed up innovation, molecular biologists must interact with scientists from the different fields as well as with stakeholders outside the academic world in order to create an environment capable of capturing value from public sector knowledge. I highlight here the measures that have to be taken urgently to guarantee that science and technology can tackle the problems of subsistence farmers.

von Braun, J. (2010). "Food insecurity, hunger and malnutrition: necessary policy and technology changes." New Biotechnology **27**(5): 449-452.

http://www.sciencedirect.com/science/article/B8JG4-50T9X4V-1/2/1d40d73dea96f2e1ad180a18aad8bf35 AND http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/vonBraun-Joachim-PAS-Food-Insecurity-20101130--publ.pdf

Ending food insecurity, hunger and malnutrition is a pressing global ethical priority. Despite differences in food production systems, cultural values and economic conditions, hunger is not acceptable under any ethical principles. Yet, progress in combating hunger and malnutrition in developing countries has been discouraging, even as overall global prosperity has increased in past decades. A growing number of people are deprived of the fundamental right to food, which is essential for all other rights as well as for human existence itself. The food and nutrition crisis has deepened in recent years, as increased food price volatility and global recession affected the poor. In a strategic agenda, it will be necessary to promote pro-poor agricultural growth, reduce extreme market volatility and expand social protection and child nutrition action.

Weale, A. (2010). "Ethical arguments relevant to the use of GM crops." New Biotechnology **27**(5): 582-587.

http://www.sciencedirect.com/science/article/B8JG4-511R9XC-1/2/7021a03bdd55e918b5cb0b668de93b5f AND http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Weale-Albert-PAS-Ethical-Arguments-Relevant-20101130-publ.pdf

The Nuffield Council on Bioethics (NCOB) has published two reports (1999 and 2004) on the social and ethical issues involved in the use of genetically modified crops. This presentation summarizes their core ethical arguments. Five sets of ethical concerns have been raised about GM crops: potential harm to human health; potential damage to the environment; negative impact on traditional farming practice; excessive corporate dominance; and the 'unnaturalness' of the technology. The NCOB examined these claims in the light of the principle of general human welfare, the maintenance of human rights and the principle of justice. It concluded in relation to the issue of 'unnaturalness' that GM modification did not differ to such an extent from conventional breeding that it is in itself morally objectionable. In making an assessment of possible costs, benefits and risks, it was necessary to proceed on a case-by-case basis. However, the potential to bring about significant benefits in developing countries (improved nutrition, enhanced pest resistance, increased yields and new products) meant that there was an ethical obligation to explore these potential benefits responsibly, to contribute to the reduction of poverty, and improve food security and profitable agriculture in developing countries. NCOB held that these conclusions were consistent with any practical precautionary approach. In particular, in applying a precautionary approach the risks associated with the status quo need to be considered, as well as any risks inherent in the technology. These ethical requirements have implications for the governance of the technology, in particular mechanisms for enabling small-scale farmers to express their preferences for traits selected by plant breeders and mechanisms for the diffusion of risk-based evaluations.

Zeigler, R. S. and S. Mohanty (2010). "Support for international agricultural research: current status and future challenges." New Biotechnology **27**(5): 565-572.

http://www.sciencedirect.com/science/article/B8JG4-50S2RHV-3/2/d0f1874157d49e6a7942105df9613dcc AND http://www.ask-force.org/web/Vatican-PAS-Studyweek-Elsevier-publ-20101130/Zeigler-Mohanty-Support-International-Research-20101130--publ.pdf

The success of the first Green Revolution in the form of abundant food supplies and low prices over the past two decades has diverted the world's attention from agriculture to other pressing issues. This has resulted in lower support for the agricultural research work primarily undertaken by the 15 research centers of the Consultative Group on International Agricultural Research (CGIAR). The total support in real dollars for most of the last three decades has been more or less flat although the number of centers increased from 4 to 15. However, since 2000, the funding situation has improved for the CGIAR centers, with almost all the increase coming from grants earmarked for specific research projects. Even for some centers such as the International Rice Research Institute (IRRI), the downward trend continued as late as 2006 with the budget in real dollars reaching the 1978 level of support. The recent food crisis has renewed the call for a second Green Revolution by revitalizing yield growth to feed the world in the face of growing population and a shrinking land base for agricultural use. The slowdown in yield growth because of decades of neglect in agricultural research and infrastructure development has been identified as the underlying reason for the recent food crisis. For the second Green Revolution to be successful, the CGIAR centers will have to play a complex role by expanding productivity in a sustainable manner with fewer resources. Thus, it is crucial to examine the current structure of support for the CGIAR centers and identify the challenges ahead in terms of source and end use of funds for the success of the second Green Revolution. The objective of this paper is to provide a historical perspective on the support to the CGIAR centers and to examine the current status of funding, in particular, the role of project-specific grants in rebuilding capacity of these centers. The paper will also discuss the nature of the support (unrestricted vs. project-specific grants) that will be needed for a much-desired second Green Revolution.