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A Research on the Use of Agriculture Biotechnology in Green Growth and Its Development

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Abstract – With increasing concern about the environmental, economic and social impact of chemical –dependent conventional agriculture, have led many farmers and consumers to seek alternative practices that will lead to green growth, agriculture profitability and livelihood sustainability. Increase in cost of production, inputs management etc are adding to the farmers fatigue. Another issue of great concern is the sustainability of soil productivity as land began to be intensively tilled to produce higher yields under multiple and intensive cropping systems. Groundwater table declined sharply. Recharging of groundwater has also been reduced due to severe deforestation. Indiscriminate use of chemical pesticides to control various insect pests and diseases over the years has destroyed many naturally occurring effective biological control agents.

Over recent years, biotechnology applied to agriculture has been considered a realistic alternative to improving efficiency in agricultural production. There is no doubt that the judicious use of appropriate biotechnological tools oriented to agricultural production will create positive impacts in developing countries. However, even though some promising results have been accomplished particularly for agricultural systems for domestic consumption and exports in developed countries, a solution to the problems of implementation—and technology transfer to the] countries where it is most needed—is still a long way off. There are obvious benefits in the use of modem biotechnologies, for instance in plant transformation and the improvement of introduced traits such as herbicide tolerance and resistance to insect pests, livestock husbandly7, conservation of agro-biodiversity, and decreased reliance on agro-chemicals. Yet technical, economical, and socio-political problems and lack of know-how. limit the application of agricultural biotechnology in the developing countries. There is an urgent need to establish bilateral and multilateral cooperation between the developed and developing countries aimed at enhancing adoption and utilization of these new biotechnologies for agricultural development.

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INTRODUCTION

India is mainly an agricultural country, where agriculture contributes to about 14.6 percent in gross domestic product (GDP) and support over 58 percent of nation’s population for livelihood (GOI, 2010). Promoting the organic agriculture is of paramount importance to protect biodiversity and cultural diversity of India. In most developing countries, agriculture continues to be the most important sector of the economy, accounting for the biggest proportion of employment (Båge, 2005). With increasing concern about the environmental, economic and social impact of chemical –dependent conventional agriculture, have led many farmers and consumers to seek alternative practices that will lead to green growth, agriculture profitability and livelihood sustainability(A.B., et.al.2005). The alternative organic farming is potentially a profitable enterprise, with a growing global market, already being supplied by more than 90 developing countries entrepreneurs see a market for selling food that has been grown chemical free(ADB, 2005). Local consumers in India have a fairly well-developed perception about organic produce, are interested in buying certified organic foods, and even willing to pay more for them. To gain access to this market, however, certification is a prerequisite. As such, unless effective strategies for agriculture development are successfully implemented, ending rural poverty will remain a distant goal. Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation

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and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved. Organic production is both old and new in the India. Organic agriculture is one of ecological agriculture models with the specific definition and strict standards, which is an important aspect of sustainable agriculture (Fischer G, et.al.2002). Although organic agriculture is certainly growing in popularity, there are conflicting opinions about its potential and the benefits it can offer, in particular whether organic methods can actually improve the livelihoods of smaller farmers. Similarly, questions remain about what impact organic methods have on labor, soil quality, local economies, and risk. Two areas of debate are most prominent: the local risk-benefit ratio of organic adoption and the marketability of smallholder organic products. Organic agriculture is a production system based on an agro-ecosystem management approach that utilizes both traditional and scientific knowledge (Adhikari, Dadhi, 2006).Biodiversity also supplies indirect services to humans which are often taken for granted. These include drinkable water, clean air, and fertile soils. The loss of populations, species, or groups of species from an ecosystem can upset its normal function and disrupt these ecological services. Recent declines in honeybee populations may result in a loss of pollination services for fruit crops and flowers Biodiversity provides medical models for research into solving human health problems. For example, researchers are looking at how seals, whales, and penguins use oxygen during deep-water dives for clues to treat people who suffer strokes, shock, and lung disease. India has a vast biodiversity and is a treasure house of bio-resources. India's biodiversity is the most significant in the world with 45,000 wild species of plants and over 77,000 wild species of animals have been recorded so far. India has great biodiversity mainly because of its unique bio-geographical composition(Bush M B, et.al.2004). With just 2% of the world's landmass, the country has about five percent (5%) of living resources, one third (1/3) of which are land bound.

But modern agri-business are only starting to recognize the benefits of obtaining organic certification, which will give them access to external markets and higher returns for their products. There are some differences in the existing organic agriculture standards; however all of organic farming practices share common characteristics in fighting against "energy agriculture, modern industry agriculture", like using chemicals such as fertilizer, pesticides and additives etc.

The organic agriculture in the nutshell concerns about human health, environment and sustainable development. Organic agriculture can help address many of the challenges facing the region. Organic agriculture emphasizes sustainable farming methods that enhance the health of ecosystems and produce safe, nutritious food. Farming methods such as slash and burn and heavy use of fertilizers and pesticides damage the long-term productivity of the land, undermine the sustainability of food production systems and will not support increasing populations as land availability decreases. Organic agriculture takes place in diverse environments that host a high level of biodiversity. However, many ecosystems are vulnerable and under pressure from increasing populations and higher levels of pollution and non-degradable waste. Organic agriculture protects and enhances biodiversity and soil and water conservation, and minimizes the impact of agriculture on downstream activities and aquatic ecosystems such as mangroves and coral reefs. Organic practices can also reduce the production of greenhouse gases from agriculture by rejecting the use of fossil-fuel and chemical inputs and encouraging carbon sequestration in soils.

Biotechnology involves making changes to the cellular and molecular structure of organisms. The application of biotechnology by way of genetic modification and selection to increase agricultural productivity is not new. However, modern genetic engineering—as a form of biotechnology—is different from traditional means of manipulating the biology of plants and animals, because it allows for the movement of functional genes from one organism to another.

Genetic engineering or modification facilitates the development of characteristics not possible through traditional breeding techniques. In this study, the term "biotechnology" refers to a collection of techniques used by biological scientists to modify genes within an organism or to transfer specific genes between organisms. Also, the terms "biotechnology," "bioengineering," and "genetic engineering" are used interchangeably, and refer to the use of modern genetic techniques to obtain "genetically modified" or "transgenic" plants and animals.

The purpose of this analysis is to examine tradeoffs involved with agricultural biotechnology at the farm level and from a public policy perspective. A discussion is provided of economic costs, benefits, and risks associated with the use of agricultural biotechnology within farm and food systems driven by domestic and international consumer demand. Also presented is an analysis of how agricultural production, consumer demand, and rural areas are potentially affected by policy choices associated with the use of agricultural biotechnology.

Agricultural biotechnology has been practiced for a long time, as people have sought to improve agriculturally important organisms by selection and breeding. An example of traditional agricultural biotechnology is the development of disease-resistant wheat varieties by cross-breeding different wheat types until the desired disease resistance was present in a resulting new variety. In the 1970s. advances in the field of molecular biology provided

scientists with the ability to manipulate DNA (the chemical building blocks) that specify the characteristics of living organisms at molecular level. This
technology is called genetic engineering. The technology allows transfer of DNA between more distantly related organisms than was possible with traditional breeding techniques. Today, this technology has reached a stage where scientists can take one or more specific genes from nearly any organism, including plants, animals, bacteria, or viruses, and introduce those genes into another organism. An organism that has been transformed using genetic engineering techniques is referred to as a transgenic organism, or a genetically engineered organism.

Advances in molecular biology, genetics, and bacterial metabolism have contributed to the development of biotechnologies, particularly through the use of mutation and the selection of more effective and higher yielding strains. Since the mid-1970s. the breakthrough consisting of the discovery of endonucleases (restriction enzymes),
ligases, and of gene-cloning techniques (see also - Methods in Gene Engineering), as well as the production of monoclonal antibodies by the hybridoma technique, paved the way for a "biotechnological revolution". These new techniques, known as genetic engineering or recombinant DNA techniques, not only contribute to a better knowledge of gene regulation and expression in procaryotic and eucaryotic cells, but also generate applications in many fields, including health, agriculture, improved nutrition, and animal health. In addition to conventional breeding through hybridization and crossing within the same species or between different species, recombinant DNA techniques can produce transgenic organisms (microbes, plant and animals) which contain new genes coding for useful substances or for desired new traits.

AGRI BIOTECHNOLOGY

The present level of agricultural production has not reached the optimal stage because of series of hurdles. Major bottlenecks among them, are lack of resources such as water nutrient and good quality planting material, improper management of pests and diseases and poor harvest management of the produce. Biotechnology have acted as a major pillar in the development and modernization of agriculture.

With natural bio-based organic agriculture now gaining momentum , biotechnology has a lot to offer in this field also. For crops where fertiliser application is very low, bio-fertilizers can fix atmospheric nitrogen and provide micro-nutrients useful to plant growth. Use of blue-green algae has also been beneficial to rice crop. Microbes such as mycorrhizae have been helpful to overcome the stress from drought and diseases. Biotechnology also has tremendous scope in plant protection. Biotechnological application has a maximum role for the Organic Input providers. It includes the products ranging from those used in maintaining and increasing soil fertility, in pest management, veterinary feed additives or supplements and nutraceutical products.

APPROACH FOR ORGANIC FARMING IN INDIA

For promotion of organic farming identification of potential areas and crop is crucial. As regards crops, the Government of India's priority is for fruits, vegetables, spices, medicinal plants, oilseeds, pulses, and cotton, wheat and basmati rice. Priority zones have been identified as potential areas. One of these zones includes the areas where fertilizers and other agrochemicals consumption is very low. These areas are in Assam and other north-eastern states, Jharkhand, Odisha, J & K, Himachal Pradesh, Karnataka, Madhya Pradesh, Chhatisgarh and Rajasthan. Organic farming needs to be started with low volume high value crops like spices and medicinal aromatic plants .A holistic approach involving integrated nutrient management, integrated pest management enhanced input use efficiency and adoption of region specific promising cropping systems would be the best farming strategy for India. The above approaches of potential area and priority crops are well suited to the state of Jammu and Kashmir, with default organic agriculture already at a promising rate in the state.

AGRICULTURAL PRODUCER CONSIDERATIONS

Costs and benefits associated with adopting biotechnology in agriculture are not only important from a policy perspective, but also for individuals interested in applying the new technology. Similar to other participants in the food and fiber system, agricultural producers respond to economic incentives and will produce those products providing them with the greatest expected returns (described, for example, by Makki, Somwaru, and Harwood, 2001).

In the case of crops, those produced using biotechnology may possess traits different from those of conventionally produced crops. Hence, crop producers would be prudent to consider currently existing genetically modified crops as products with value-enhanced traits and not treat them strictly as commodities. Producers should also manage the

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genetically modified crops differently than agricultural commodities.

In considering whether or not to switch from growing conventional to genetically modified crops, producers need to understand costs and benefits associated with growing the new crops. A comparison should be made between the net revenue per acre from producing and marketing the new crop and the net revenue of a conventional commodity. The expected gross revenue obtained from growing and marketing the modified crop would include a price premium or discount, multiplied by the yield (accounting for any yield drag). On the cost side, technology fees would need to be added and inputs no longer necessary would need to be subtracted. If the expected net revenue associated with producing the crop which utilizes the new technology exceeds that of a traditionally produced commodity, an incentive to change to the genetically modified crop exists.

Marginal analysis provides an initial assessment of whether or not switching to genetically engineered crops is financially worth considering for crop producers, but it may need to be supplemented with other considerations. First, producers do not need to adopt new technologies if they do not want to. Second, blindly adopting the new technology may create previously nonexistent operating problems. Third, producers who consider contracting their crop may have to identify alternative markets for the crop before finalizing their contract, in case of a harvest shortfall and subsequent inability to meet contract obligations.

Fourth, a genetically modified crop which does not meet the delivery specifications committed to in futures or cash forward contracts may generate price risk management difficulties for producers. Even if the crop would be acceptable to buyers, its value may not fluctuate consistently with commodity prices, resulting in additional basis risk and reduced hedging effectiveness. Finally, local production and marketing systems may also affect producers' decisions about whether to adopt genetically modified crops. For example, if local elevators do not have handling facilities for keeping transgenic crops separate from conventional crops; farmers would need to find alternative distribution channels, resulting in additional costs.

THE DIFFUSION OF BIOTECHNOLOGY IN AGRICULTURAL PRODUCTION

Because of the rapid growth in the use of various applications of agricultural biotechnology in crop production, few reliable estimates of global cropland used for genetically engineered field crops are available. Further, the reliability of existing data on the use of agricultural biotechnology is somewhat questionable for some nations because of the controversial nature and property rights issues involved with agricultural biotechnology. For example, Brazil does not allow the planting of genetically modified soybeans, but its farmers are widely thought to grow such soybeans.

Virtually all studies reporting data on the global spread of genetically engineered crops are based on one source, the International Service for the Acquisition of Agribiotechnology Applications (ISAAA). The ISAAA is a publicly and privately funded organization and has an international network consisting of several centers, one of which is affiliated with Cornell University.

Based on the data collected by James (2001), global cropland planted with bioengineered crops increased from 4 million acres, when the crops became commercially available in 1996, to an estimated 109 million acres in 2000, spread over 12 countries. The United States and Canada account for more than three-fourths of global cropland acres grown with genetically engineered crops. Many of the remaining cropland acres used for transgenic crops are located in Argentina. Other major producers of agricultural products, such as Brazil and China, are also expected to become major participants in growing transgenic crops (Smith, 2000).

Globally, as well as in the United States, the area planted to genetically engineered crops leveled off somewhat between 1999 and 2000. Cropland areas planted with transgenic soybeans and cotton increased from their 1999 levels, while the planted areas of genetically engineered corn and canola underwent a slight decrease from their 1999 levels.

Soybeans accounted for approximately 58% of the world's cropland acres used for transgenic crops, followed by corn with about 23%, cotton with approximately 12%, and canola with about 7%. Globally, the most prominent genetically engineered trait used in crops is herbicide resistance, accounting for 69% of the total global cropland area planted with transgenic crops in 1999. In the same year, insect-resistant crops accounted for approximately 21% of the world's cropland area sown with transgenic crops, and crops containing both herbicide-resistant and insect-resistant genes accounted for about 7%. Finally, virus-resistant transgenic crops comprised close to 3% of these global cropland acres (James, 2001).

BIOTECHNOLOGY AND GMOS

The International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) examined a wide range of agricultural knowledge, science and technologies for their potential and proven impacts on equitable and sustainable development. Of these, perhaps the most controversial were the biotechnologies. The IAASTD defined biotechnology as does the Convention on

Biological Diversity, namely as "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for a specific use. " The term biotechnology can thus include traditional and local knowledge, organic and agro ecological practices, conventional breeding, the application of tissue culture and genomic techniques, marker-assisted breeding and gene splicing. "Modern biotechnology" is defined in the Cartagena Protocol on Biosafety and is commonly understood as "the manipulation of genetic material and fusion of cells beyond normal breeding barriers," with the most common example being genetic engineering (GE) in which genes are inserted or deleted through transgenic technologies to create genetically modified (GM) organisms (GMOs). The IAASTD notes that the use of the term "modern" is by convention only, and does not in any way suggest that these techniques are more sophisticated or relevant than other biotechnologies with longer histories.

Biotechnology has made tremendous contributions to agriculture, with some biotechnologies as old as agriculture itself. Free-to-the-public technologies and extension services are important to farmers. In contrast, modern biotechnology has a poor track record of relevance to the poor and subsistence farmer and its control by a relatively small number of large multinational companies means that adopting modern biotechnologies could also require accepting significant social changes and adopting agricultural models that may not result in poverty reduction or sustainable practices, while also increasing the dependency of local farmers on technological exports from the wealthy countries.

The impacts and potential or actual contributions of GMOs to sustainable and equitable development were rigorously examined by the IAASTD. The report found conflicting evidence put forward by proponents and critics of the technology, with conflicts often dependent upon whether the potential agronomic benefits of yet-to-be developed GMOs (the '"in-the-box" design) were highlighted or whether the broader societal and environmental impacts of GMOs on social equity, livelihoods, culture, biodiversity and farmers' rights, were addressed.

Crops derived from GE technologies have faced a myriad of challenges stemming from technical, political, environmental, intellectual-property, biosafety, and trade-related controversies, none of which are likely to disappear in the near future. Advocates cite potential yield increases, sustainability through reductions in pesticide applications, use in no-till agriculture, wider crop adaptability, and improved nutrition. Critics cite environmental risks and the widening social, technological and economic disparities as significant drawbacks. Concerns include gene flow beyond the crop, reduction in crop diversity, increases in herbicide use, herbicide resistance (increased weediness), loss of farmer's sovereignty over seed, ethical concerns on origin of transgenes, lack of access to IPR held by the private sector, and loss of markets owing to moratoriums on GMOs, among others.

While focusing mainly on transgenic *crops* because there are no widespread commercial applications of GM animals, the report did note that gene flow from GM fish could be of significant concern and would need to be stringently monitored, particularly given how little is understood about marine ecosystems.

MICROBIAL INOCULATION OF PLANTS

The use of bacterial inoculants and of mycorrhizae would indeed have important consequences for agricultural, horticultural, and forestry production. Microbial inoculation involves the selection and multiplication of plant-beneficial micro-organisms and applying them to plants, seed, or soil. The main uses of micro-organisms are as biofertilizers for improved plant nutrition and as biological control agents to combat pests, weeds, and diseases. The prospects for improving agriculture through the use of microbial inocula are very good. With the possibility of better yields, lower costs, and reduced dependence on chemicals, microbial inoculation of plants is likely to be of great importance, particularly in less-intensive, low-input agricultural systems in developing countries.

Nitrogen (N) is an essential and often growth-limiting plant nutrient. Crops take up N that is released to the soil solution as a result of atmospheric deposition, soil organic matter mineralization, crop residue decomposition and animal manure and inorganic fertilizer addition. Furthermore. N may become available through biological fixation.

Only inorganic N. principally nitrate (NO3 ') and ammonium (NH4 +) is available for plant growth. Nitrite (NO2 -) can be taken up but this N form is toxic to plants and is generally present in trace quantities only. A deficiency in nitrogen leads to yield declines or even a complete crop failure. An excess of nitrogen may lead to excessive vegetative growth, lodging, delayed maturity, increased disease susceptibility, low crop quality, and nitrate accumulation. Excesses may contribute to acid rain, destruction of the ozone layer in the stratosphere, the greenhouse effect, eutrophication of surface waters, contamination of ground water, and fish and other marine life kills, as well as blue baby syndrome in infants and amphibian mortality and deformations. The nitrate concentration in ground and surface waters is an important water-quality index. The U.S.

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Environmental Protection Agency (EPA) has set the Federal Standard for the maximum permitted amount of nitrate N in drinking water at 10 mg N per L or 43 mg NO3- per L. It is important from both an economic and an environmental standpoint to manage N optimally.

Microbial inocula are already used worldwide in the control of diseases and pests in intensive agriculture, and there is some scope for their use in less intensive, low-input agricultural systems in developing countries. Bacillus thuringiensis is already applied to some extent in developing countries, for example in the control of pesticide-resistant blackfly vectors of river blindness in West Africa, and for the control of cereal stem borers Busseola fusca and Chilo partellus in Kenya. The production of microbial inoculants is not very difficult: significant quantities can be produced in unsophisticated fermentors of modest volume. What is more difficult is the selection of effective strains which show consistent benefits and sustain biological activity. Quality control of the inoculants is very important and requires the development of rapid assays for biological activity (growth promotion or biological control) for use during product development and production. Furthermore, extensive regional trials would need to be conducted with the product to determine the environmental limits on biological activity, and to monitor the survival and dispersal of the inocula. Attention should also be paid to delivery systems in order to allow application by small-scale farmers.

CONCLUSION

The discussion on the merits and risks of agricultural biotechnology will require involvement by all participants in the food and fiber system, from agricultural producers to consumers of final products. Justification of biotechnology applications based on purely technical merits is a necessary condition for their successful implementation, but it is not sufficient. An additional requirement is that stakeholder concerns—including those of developing nations, environmental groups, and consumers—are addressed in an open and transparent manner.

Since the organic farming has just started in India, we need to address the production as well as marketing problems simultaneously. Also India's domestic market is quite big and if genuineness and quality is guaranteed there is no dearth of buyers; the demand for organic foods in the metros is on the increase. Organo-Agri-units set up with the technological support of biotechnology for domestic as well as global market holds tremendous scope. The extension programme targeted at the rural farmer in the state can prove to be beneficial.

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