Agricultural Biotechnology in the Greater Mekong Sub-Region

An Assessment for the Asian Development Bank

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- Institute of Agricultural Genetics, Hanoi: *Vietnam country workshop*
- Cambodian Agricultural Research and Development Institute, Phnom Penh: *Cambodia country workshop*:
- Ministry of Agriculture, Vientiane: *Laos country workshop*

Acronyms

ACIAR	Australian Centre for International Agriculture Research
ADB	Asian Development Bank
AGI	Agricultural Genetics Institute (Vietnam)
ASEAN	Association of Southeast Asian Nations
AusAID	Australian Agency for International Development
BIOTEC	National Center for Genetic Engineering and Biotechnology (Thailand)
Bt	*Bacillus thuringiensis*
CAB	Center for Agricultural Biotechnology (Kasetsart University, Thailand)
CARDI	Cambodian Agricultural Research and Development Institute
CARI	Central Agricultural Research Institute (Myanmar)
CBD	Convention on Biological Diversity
CIAP	Cambodian-International Rice Research Institute-Australia Project
CLRRI	Cuu Long Delta Rice Research Institute (Vietnam)
DALLI	Dept of Agronomy and Agricultural Land Improvement (Cambodia)
DMC	Asian Development Bank
FCRI	Food Crops Research Institute (Vietnam)
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GMO	Genetically Modified Organisms
GMS	Greater Mekong Subregion
IBAT	Institute of Biotechnology (Vietnam)
ICCP	Inter-Governmental Committee for the Cartegena Protocol on Biosafety
IEC	Information, Education and Communication
INIBAP	International Network for the Improvement of Banana and Plantain
IP	Intellectual Property
IPR	Intellectual Property Rights
IRRI	International Rice Research Institute
ISAAA	International Service for the Acquisition of Agri-Biotech Applications
ITB	Institute of Tropical Biology (Vietnam)
MAFF	Ministry of Agriculture, Forestry and Fisheries (Cambodia)
MARD	Ministry of Agriculture and Rural Development (Vietnam)

MAS	Marker-assisted selection
MIME	Ministry of Industry Mines and Energy (Cambodia)
MOA	Ministry of Agriculture (Peoples Republic of China)
MOC	Ministry of Commerce (Cambodia)
MOG	Mingladon Orchard Garden (Myanmar)
NAGM	National Authority on Genetic Modification (Myanmar)
NBC	National Biosafety Committee (Laos)
NCST	National Center for Natural Science and Technology (Vietnam)
NGOs	Non-Government Organizations
OGESA	Office of Genetic Engineering Safety Administration (PRC)
PBL	Plant Biotechnology Laboratory (Myanmar)
PDR	Peoples Democratic Republic
PRC	Peoples Republic of China
RMB	Renminbi (Currency of the Peoples Republic of China)
RUA	Royal University of Agriculture (Cambodia)
SMEs	Small and Medium Enterprises
SOEs	State-Owned Enterprises
STEA	Science,Technology and Environment Agency (Laos)
TOR	Terms of Reference
UNEP	United Nations Environment Program
US	United States
USA	United States of America
VASI	Vietnam Agricultural Science Institute
VFRDC	Vegetables and Fruit Research and Development Centre (Myanmar)
WGA	Greater Mekong Subregion Working Group on Agriculture
WTO	World Trade Organization

0.0 Executive Summary

The objective of this assignment was to undertake a rapid assessment of the current status of biotechnology, and to identify and prioritize needs in promoting biotechnology cooperation in the countries of the Greater Mekong Sub-region (GMS) that includes Cambodia, Myanmar, Lao PDR, Thailand, Vietnam, and Yunnan, PRC. This included proposing options of assistance packages for GMS countries.

The process involved a desk review of status of biotechnology in GMS countries followed by in-country workshops in selected countries to identify and prioritize the needs related to agricultural biotechnology. These workshops involved key policy planners, representatives from private sector enterprises, and non-government organizations. In addition one-to-one discussions were held with key stakeholders in each country. Finally, an inter-country workshop was held with key stakeholders to discuss the overall scope and type of support that would benefit the GMS countries.

The terms of reference (Appendix 3.3) were interpreted within a comprehensive framework of the elements required for the effective utilization of biotechnology in the region: (i) the technology itself; (ii) enterprise development and marketing; (iii) communication, outreach and public awareness; and (iv) policy related to the technology including, but not restricted to biosafety and intellectual property rights. These elements were assessed in each country with attention to the areas specified in the TOR. Each element was then assessed across the region in the same strategic manner and the assessments were then integrated to formulate recommendations for ADB investments in the region.

0.1 General Conclusions

Technology. Capacity in the GMS varies widely from second in the world (PRC) and leader among other countries in the sub-region (Thailand) to nearly non-existent for some of the less developed countries in the region. Major opportunities exist through facilitated collaboration among the countries that would benefit all countries in the sub-region.

Enterprise Development and Marketing. Every country in the region has an economic stake in working collaboratively to facilitate private investment, whether internal or international, and minimizing the harmful effects of the informal sector in the movement of propagating material, especially seed.

Communication, Outreach and Public Awareness. This is the number one need of countries at the lower end of the research and policy spectrum. They indicated (pleaded) that knowledge deficiency about biotechnology prevented the formulation of essential policies.

Policy. Joint, or consultative, policy formulation is clearly essential. Effective regulatory and quarantine procedures cannot be devised or implemented without working together. Uniform tariff policies would facilitate economic development in the sub-region.

0.2 Recommendations

Regional Recommendation #1. Because: (i) capacity to use molecular markers can be built in all GMS countries in the short to medium term; (ii) molecular markers could be used across a broad range of breeding programs in all GMS countries; (iii) Thailand and PRC could act as nodes for capacity building in this technology for the GMS; and (iv) cooperation on molecular marker technology could catalyze broader and deeper sub-regional collaboration in molecular biotechnology, it is **recommended** that a sub-regional working group be formed to plan and initiate implementation of collaborative research on molecular markers.

Regional Recommendation #2. Because of inequalities in the level of enterprise development among the countries in the GMS region, accelerated efforts on the part of Laos, Cambodia, Vietnam and Myanmar are **recommended** to develop homegrown small and medium enterprises (SMEs) and bring in partnerships with enterprises that are based in countries such as Thailand and the PRC so that the technology and trade inequities are eliminated and healthy cross country markets are created thereby preventing harmful informal flow of materials that would seriously endanger the biosafety and biodiversity in the region.

Regional Recommendation #3. Because of a need for enterprises to build sustainable business operations, extension of incentives and start-up funding to enterprises is **recommended** coupled with efforts to develop entrepreneurship through capacity building initiatives that would help to create successful bio-enterprises in these countries and through the creation of a regional venture fund that would address the technology access and funding needs of start-ups and emerging enterprises in the region.

Regional Recommendation #4. Because of lack of basic infrastructure available for emerging enterprises in some of the GMS region countries, providing access to advanced incubator facilities that are available in Thailand is **recommended**; these countries would rent space and equipment in Thailand to validate their technologies and then scale up their operations in their own countries, creating in-country incubators that, in the long run, would help to sustain the national enterprise creation initiatives.

Regional Recommendation #5. Because of the small size of markets for certain biotech derived products in some of the countries in the GMS sub-region, providing cross-country access to these products in the near term is **recommended** with a clear strategy to develop in-country enterprises over the long term, through harmonized tariff and trade policy mechanism that would facilitate this process.

Regional Recommendation #6. Because an immediate need exists to sensitize policy makers, regulatory personnel, and other key individuals in several of the GMS counties about key issues relating to agricultural biotechnology it is **recommended** that a sub-regional workshop on agricultural biotechnology be organized for this purpose.

Regional Recommendation #7. Because clear, harmonized and enforceable biotechnology frameworks and regulatory mechanisms are essential to effective, safe and

responsible development and beneficial use of modern biotechnology in agriculture and food; and because biosafety regulations are not only national but also cross-country concerns, it is **recommended** that (i) a regional initiative in the GMS on establishing biosafety frameworks and mechanisms be urgently set up and supported, and (ii) the requisite capacity for implementation by GMS countries be strengthened in all aspects, including quarantine regulations and enforcement.

Regional Recommendation #8. Because private sector participation and investment in biotechnology is deemed vital for sustained technology development, acquisition, introduction, and broader commercial use of biotechnology in agriculture and food, and that appropriate policies are necessary to stimulate and support private sector involvement, it is **recommended** that (1) the establishment of effective intellectual property protection mechanisms in GMS countries be supported; and (2) other market-oriented policy initiatives be explored for possible consideration and adoption by the emerging market economies of some GMS countries.

0.3 Investment Priorities

The lack of development in agricultural biotechnology in the GMS represents a significant hurdle for the region's economic development because of the high dependence on agriculture of many of the developing countries in the sub-region. The competitive status of agriculture in the less developed countries of the GMS may be adversely affected due to advancements in agricultural biotechnology in neighboring countries. India and the PRC may bring to these markets cheaper and superior products in the post WTO era. Economic progress in much of the GMS could be severely impaired unless support is provided to overcome technology deficiencies, lack of human resource competency and lack of appropriate policy mechanisms for the sub-region.

Priority areas for investment are listed below in approximate priority order with the first five being of critical importance. Awareness is clearly fundamental and should take precedence over other investments. The sequence of other investments depends more on opportunity than the degree of need, which is generally acute.

1. Creation of basic awareness of the benefits and risks that would flow from adoption of agricultural biotechnology. This may be achieved through in-country and intra-country workshops and stakeholder interactions with support from international Institutions of repute.

2. Development of sound agricultural biotechnology policy mechanisms in each of the countries, well integrated with agricultural and food policy and the bio-safety and regulatory mechanisms that would help to derive beneficial advantage from technologies. This may involve contracting international expertise for harmonizing country policies with that of global best practices.

3. Development of cost effective and sound research infrastructure commensurate to the level of technology application envisaged in the near term and in the medium term. This is more relevant to countries in the region other than Thailand and Yunnan, PRC. This may be attempted in two stages -- first to upgrade or establish

a center of excellence so that it becomes a catalyzing center for agriculture biotechnology research in the country, and over the medium term to develop capacity in different regions of the countries.

4. Development of human resource capability in research, technology management, commercialization, regulation and communication.

5. Creation of healthy intra-regional cooperation – quarantine, technology transfer opportunities, IP mechanisms (single registration costs for IP), knowledge sharing, trade and tariffs harmonization etc.,

6. Creation of a sound funding mechanism for nurturing bio-entrepreneurship and for the development of homegrown enterprises and collaborative partnerships.

7. Strengthening of governance in the publicly managed seed companies and publicly funded research centers.

8. Creation of marketing and distribution mechanisms for seeds and infrastructure for seed production, certification and distribution.

9. Development of outreach and communication efforts that are customized for each country, depending upon the local conditions and the level of awareness.

A need exists for contributions from international institutions, academic bodies and policy consultants who can help countries in the region to derive gains from advanced technologies in agriculture and agricultural biotechnology within a sound policy and regulatory mechanism. Appropriate investments could bring about these changes resulting in considerable economic and social impact in the region.

1.0 Background and Introduction

The TA for Promoting Partnerships to Accelerate Agriculture Development and Poverty Reduction in the Greater Mekong Sub-region was approved in June 2003. The objective of the TA is to promote dialogue and strengthen cooperation between the Greater Mekong Sub-region (GMS) countries of Cambodia, Laos, Myanmar, People's Republic of China (PRC), Thailand, and Vietnam in agricultural development. The TA activities will be implemented under the framework of the GMS Working Group of Agriculture (WGA), which was constituted in January 2003.

The WGA is a forum for identifying and realizing opportunities to increase cooperation in agriculture among the GMS countries for poverty reduction, equitable and sustained economic growth, sustainable use of natural resources for agriculture, and ensuring that benefits of GMS infrastructure projects reach rural communities. At the first WGA meeting, one priority area confirmed and reiterated was GMS cooperation in agricultural biotechnology.

The Australian Centre for International Agriculture Research (ACAR)/ADB study on agricultural biotechnology in Asia completed in May 2001 outlines a number of areas for assistance including: (i) increase public awareness raising and understanding on biotechnology issues; (ii) strengthen the policy and regulatory framework of biotechnology; (iii) expand capacity to undertake biotechnology research linked to small holders and poor farmers; (iv) address market failures and inadequate research in crops that would most likely benefit DMCs and poor farmers; and (v) maximizing private-public partnerships in biotechnology for the benefit of the poor farmers.

In order to develop concrete cooperation initiatives in agricultural biotechnology in the GMS region, the first step was to undertake a systematic assessment to determine the current status, identify and prioritize areas of assistance, and propose assistance packages for the GMS countries. To this end, ADB is supported this review of status and application of biotechnology.

1.1 Objective and Scope of the Assessment

The objective of the assignment was to undertake a rapid assessment of current status of agricultural biotechnology, identify and prioritize needs in promoting biotechnology cooperation in the GMS countries. This includes proposing options of assistance packages for GMS countries.

Agricultural biotechnology includes applications to crops and livestock[1]. Crop biotechnology can be subdivided into three technological classes on the basis of levels of accessibility (viz. complexity and cost). The first, most accessible class (Class 1) comprises such techniques as tissue culture and rapid propagation that can be used,

[1] For a full description of the various classes of agricultural biotechnology see Pew Initiative on Food and Biotechnology. 2001. Harvest on the horizon: Future uses of agricultural biotechnology. Pew Initiative on Food and Biotechnology website at http://pewagbiotech.org/research/harvest/harvest.pdf

respectively, to efficiently conserve and utilize genetic resources and mass produce healthy, high yielding planting materials.

The second, medium–accessibility, class of technologies (Class 2) includes the use of molecular markers in molecular assisted breeding (MAS). This approach could be used for some of the more complex breeding priorities in the region such as drought tolerance and durable resistance to pests and diseases. These technologies could also be used to preserve information in the GMS about existing plant breeds and preserve biodiversity,

The third, most sophisticated and least accessible class (Class 3), includes genetic engineering, genomics and bioinformatics; these latter techniques will ultimately have dramatic impact on crop improvement by allowing scientists to identify, isolate, and efficiently transfer any agriculturally important genes or groups of genes within and between crop species.

Globally, examples of the potential impact of animal biotechnology are wide-ranging and include:

- Production of medical and veterinary compounds such as monoclonal antibodies, hormones, and blood proteins;
- Bioengineering animals to produce human medical treatments for disorders or diseases, e.g. fibrinogen from sheep (blood clotting/wound treatments);
- Facilitating organ and tissue transplantation from animals to humans, e.g. modifying pigs to suppress a rejection protein;
- Spider silk production from modified goats to make ultra-strong material for bullet proof vests, sutures etc;
- Modifying fish to enhance growth, develop disease resistance (in aquaculture);
- Modifying insects to improve effectiveness of insect predators of pests, reduce virulence of insect pests, or eliminate insect-mediated transmission of human diseases (e.g. malaria) and livestock diseases.

During the country visits scientists and policy makers did not highlight animal biotechnology as a high priority. However, advances in this area could likely have substantial positive impact in the GMS once an enabling framework for biotechnology and biosafety is put in place. Developments in aquaculture may be of particular interest.

1.2 Terms of Reference

The terms of reference (TOR–Appendix 3.3) provided specified that the following issues should be addressed:

(i) Agricultural biotechnology development, acquisition, transfer and commercialization;

(ii) Investment in biotechnology to benefit small holders and poor farmers;

(iii) Institutional and regulatory framework that would ensure existence of a comprehensive bio-safety mechanism;

(iv) Human resource development initiatives that would provide quality life science personnel that would be engaged in biotechnology research, commercialization and risk assessment.

(v) Appropriate infrastructure that would provide a conducive environment within the country and regionally for carrying out research, commercialization and marketing of biotechnology derived food products.

(vi) Private sector participation to accelerate commercialization of biotechnology derived food products.

Missing from this list is the issue of public awareness and the perceptions of risk and uncertainty associated with biotechnology. Risk and uncertainty have always been a part of the human condition. Risk refers to danger (harm or loss) that can be measured or calculated while uncertainty denotes doubt, suspicion, or mistrust in the absence of data. Much of what we call biotechnology, including mass propagation through tissue culture (Class 1) and the use of marker assisted selection (Class 2) to improve the efficiency of conventional plant breeding, is known to be risk free. Technologies involving the use of bioengineered plants (Class 3) carry no known risk but uncertainty is still a factor.

When something new is introduced (bioengineered plants in the case of Class 3 technologies), uncertainty is inevitable. In the absence of communication and public awareness, uncertainty will be perceived as risk. Investments in communication, outreach and public awareness are just as essential as investments in the technology itself, or in marketing the technology.

Because of this and other considerations, the terms of reference were interpreted within a comprehensive framework of the elements required for the effective utilization of biotechnology in the region: (i) the technology itself; (ii) enterprise development and marketing; (iii) communication, outreach and public awareness; and (iv) policy related to the technology including, but not restricted to biosafety and intellectual property rights. These elements were assessed in each country with attention to the areas specified in the TOR. Each element was then assessed across the region in the same strategic manner and the assessments were then integrated to formulate recommendations for investments in the region.

2.0 Regional Assessment

The GMS is a very diverse region in many ways, including issues and concerns related to agricultural biotechnology. The PRC is second only to the United States in terms of investment (public investment is actually greater) and achievements in all classes of agricultural biotechnology, particularly Class 3 (bioengineered crops). Within the same region, however, capacity is nearly non-existent in certain countries. Clearly, many

opportunities exist for collaboration that would benefit every country in the sub-region. Every country in the region has an economic stake in working collaboratively to facilitate private investment whether internal or international, and minimizing the harmful effects of the informal sector in the movement of propagating material, especially seed. Communication and public awareness is the number one need of countries at the lower end of the research and policy spectrum. They indicated that the knowledge deficiency about biotechnology prevented the formulation of essential policies. Joint, or consultative, policy formulation is clearly essential. Effective regulatory and quarantine procedures cannot be devised or implemented without working together. Uniform tariff policies would facilitate economic development in the sub-region.

Assessments for the individual countries are reported in Appendix 3.1. This section discusses and recommends specific actions for the GMS as a whole for issues related to (1) technology, (2) enterprise development and marketing, (3) communication, outreach and public awareness, and (4) policy. It concludes by identifying specific investments that are needed in the region whether by the ADB or other entities concerned.

2.1 Technology

The three major classes of crop biotechnology were described briefly in Section 1.1. All three classes of technology are complementary and ultimately hold great promise for the GMS countries. **Class 1** technologies (tissue culture, etc) are typically inexpensive, requiring only modest human capacity development, and minimal facilities. It is usually feasible to develop such technologies at the national level. Indeed, it was observed that tissue culture and rapid propagation have already been adopted in several GMS countries. Because of the high accessibility of these technologies, and the interest exhibited by the national governments in supporting these technologies, other countries will soon follow.

In **Class 2** technologies (molecular assisted breeding, etc) different kinds of molecular markers may be involved including restriction fragment length polymorphisms (RFLPs), randomly amplified polymorphic DNA (RAPDs), amplified fragment length polymorphisms (AFLPs), microsatellites, and single nucleotide polymorphisms (SNPs)[2]. These techniques can differ greatly in their technical requirements (e.g. whether they can be automated or require use of radioactivity), the amount of time, money and labor needed, the number of genetic markers that can be detected throughout the genome, and the amount of genetic variation found at each marker in a given population. The information provided by the markers for the breeder will vary depending on the type of marker system used. Each one has advantages and disadvantages that must be weighed up carefully by the breeder.

Molecular markers are being used in Thailand and the PRC. Other GMS countries visited expressed substantial interest in adopting these technologies. Indeed, these technologies could have strong, broad impact across the breeding programs of each of the

[2] For a comparison of these molecular marker systems and the resources needed for their use see 'Electronic Forum on Biotechnology in Food and Agriculture', Background Document to Conference 10, 17 November to 14 December, 2003, FAO at http://www.fao.org/biotech/forum.asp

GMS countries and the startup costs and investments in laboratory facilities would be modest. Thus, molecular marker technology is a strong candidate for investment.

To kick-start sub-regional capacity building in this area Thailand and the PRC could share with other GMS countries their experiences in setting up and conducting the analyses and also discuss the factors to be considered when matching a specific technique to precise objectives of the breeder.

Such cooperation could have influence in the sub-region that would reach well beyond the use of molecular markers per se. It could act as an entry point for broader and deeper cooperation in molecular biotechnology in the sub-region by bringing together key scientists who could work together in addressing challenges to agricultural productivity in the GMS.

Sub-regional cooperation might well be applied to **Class 3** technologies that offer exciting longer-term possibilities to the GMS and to the world. But to develop capacity in Class 3 technologies in the GMS is a major, long-term task. Class 3 technology development will involve high startup costs and critical levels in the size of teams and laboratory and field investments. The smaller, poorer countries of the GMS will have difficulties in building their own national capacities for these technologies and could benefit from a sub-regional approach in which particular research activities are located in particular countries and results are exchanged among them.

Regional Recommendation #1. Because: (i) capacity to use molecular markers could be built in all GMS countries in the short to medium term; (ii) molecular markers could be used across a broad range of breeding programs in all GMS countries; (iii) Thailand and PRC could act as nodes for capacity building in this technology for the GMS; and (iv) cooperation on molecular marker technology could catalyze broader and deeper sub-regional collaboration in molecular biotechnology, it is **recommended** that a sub-regional working group be formed to plan and initiate implementation of collaborative research on molecular markers.

In implementing this recommendation, Thai and PRC scientists, in consultation with ADB and its biotechnology consultants, would start by jointly convening the working group and conducting an initial meeting in Thailand or the PRC. At that meeting a work plan would be prepared by the group. An important element of the work plan would likely be personalized or group lab courses for GMS scientists in Thai and PRC labs and visits of Thai and PRC scientists to labs in other countries of the sub-region.

2.2 Enterprise Development and Marketing

The role of private enterprises in transforming agriculture productivity and enhancement of market values is well demonstrated in many advanced countries such as the USA and developing countries such as China and India. The declining investments in the public research system and the market driven research approach has necessitated enhanced involvement of the private sector in development of new planting materials and high value-added food products. Intellectual property protection mechanisms have further

nurtured the interest of the private sector to thrive from a protected and prolonged return on the high investments made by them.

The existence of the private industry in many of the GMS countries is in its early stage of establishment and considerable imbalances exist in the level of enterprise penetration. While the PRC has a well established seed industry and allied enterprises that are engaged in input and output end products, Thailand has relatively early stage presence of local companies with number of multinationals waiting to expand once the policy regime facilitates their expansion. However, private enterprises in countries such as Vietnam, Laos and Cambodia are barely viable, though southern Vietnam has a few enterprises engaged in distributing seeds.

The strategies for enterprise development across the GMS region needs careful integration of these imbalances so that the technology flow and trade flow among the countries in the region does not destabilize the economic balance among the countries. Chinese enterprises have the potential to take over the whole market, though either formal or informal channels, and visible signs exist of such a possibility. The only way to prevent informal flow of biological materials and seeds into lesser developed nations in the region is to adopt accelerated measures to develop enterprises in these countries through home grown SMEs and collaborative partnerships involving large enterprises.

Regional Recommendation #2. Because of inequalities in the level of enterprise development among the countries in the GMS region, accelerated efforts on the part of Laos, Cambodia, Vietnam and Myanmar are **recommended** to develop homegrown small and medium enterprises (SMEs) and bring in partnerships with enterprises that are based in countries such as Thailand and the PRC so that the technology and trade inequities are eliminated and healthy cross country markets are created thereby preventing harmful informal flow of materials that would seriously endanger the bio-safety and bio-diversity in the region.

Development of SMEs and encouragement to start-up enterprises that would be engaged in seed production, micro propagation of plant materials, production of ingredients for the food industry such as peptides, emulsifiers and enzymes require considerable government sponsored incentives in these countries coupled with enterprise funding support through start-up capital so that enterprises are in a position to bear with inevitable lead time in development of markets in these countries. Creating awareness of the market opportunities and facilitating technology access will create enterprise development. Entrepreneurship development efforts need to be undertaken in parallel so that healthy bio-entrepreneurship is nurtured which would be essential to sustain bio-enterprise development in the region. A regional biotech venture fund that would facilitate cross-country enterprise development in agriculture biotechnology and development of seed sector would be extremely timely for the regional development.

It was observed that the enterprises engaged in seed sector are currently not adhering to a framework of intellectual property protection mechanism and plant variety recognition, which would seriously hamper organized growth of the seed sector among the countries in the region. It is essential to provide for encouragements for enterprises to comply to

these mechanisms through a system of financial and non-financial incentives to enterprises that comply with such mechanisms.

Regional Recommendation #3. Because of a need for enterprises to build sustainable business operations, extension of incentives and start-up funding to enterprises is **recommended** coupled with efforts to develop entrepreneurship through capacity building initiatives that would help to create successful bio-enterprises in these countries and through the creation of a regional venture fund that would address the technology access and funding needs of start-ups and emerging enterprises in the region.

The serious impediment for enterprise development initiatives is the lack of access to technologies that would help to incubate enterprises in the region. Because capacities do not exist immediately for technologies to be developed within the countries such as Vietnam, Laos, Myanmar and Cambodia, it would be worthwhile to provide resource support for enterprises in these countries to access technologies that are relevant for the enterprises in the region to develop products and processes. The technology access can be facilitated by strategic and technological linkages with leading Universities around the world and in the other developed countries of the Mekong region. This initiative, coupled with the incubator facilities will help significantly to create and nurture private enterprises. The commonality of the need will also help to optimize the use of technology for many countries in the region thereby minimizing the cost of technology access.

Agricultural biotech enterprises engaged in conventional biotechnology commercialization initiatives would require quality lab space and basic equipments for product development and technology validation. Once the technologies are validated at pilot scale, the enterprises will be able to scale up their operations. In order to encourage enterprises to access technologies, validate technologies and train their human resources in basic skills, access to high quality incubators will be a pre-requisite. Since it would involve considerable time and resource deployment to create incubators in each of these countries, it is essential for countries such as Thailand to provide access to the emerging enterprises in the other countries in the GMS region to avail the facilities that are available in institutions such as Biotech and CAB at concessional cost so that these emerging enterprises are able to successfully kick-start their enterprises. In the long-term plan, however, it would be essential to create incubators in each of these countries so that the enterprise development efforts can be augmented with in-country facilities.

Regional Recommendation #4. Because of lack of basic infrastructure available for emerging enterprises in some of the GMS region countries, providing access to advanced incubator facilities that are available in Thailand is **recommended**; these countries would rent space and equipment in Thailand to validate their technologies and then scale up their operations in their own countries, creating in-country incubators that, in the long run, would help to sustain the national enterprise creation initiatives.

For some of the products, since each country markets would be small, it would be good to have cross country market access, instead of creating unviable enterprises in the beginning until the markets develop for such products. Proving cross country access for such products would involve careful indexing of such products with harmonized tariffs

that would encourage cross country flow of materials in the near term and development of in-country enterprises in the medium to long term.

Regional Recommendation #5. Because of the small size of markets for certain biotech derived products in some of the countries in the GMS sub-region, providing cross-country access to these products in the near term is **recommended** with a clear strategy to develop in-country enterprises over the long term, through harmonized tariff and trade policy mechanism that would facilitate this process.

2.3 Communication, Outreach and Public Awareness

Communication, outreach and public awareness were identified as major needs in the region. In fact, a number of workshop participants, beginning with those in Yunnan, ranked this as the top priority need. This is not surprising considering that the capacity of stakeholders (local scientists, regulators, journalists, extension workers, farmers, retailers, religious groups and consumers, among others) to make informed decisions related to biotechnology products will be dependent on access to quality information.

Communication efforts are needed throughout the region based on a general strategy of targeting key stakeholders and opinion leaders and a specific effort aimed at policy makers:

- Identification of the communication partners, key policy makers, and opinion leaders in relevant stakeholder groups (an opinion leader is an influential member of a community that tends to be more informed about scientific development, who exercises a key influence on other community members as far as scientific development and other innovations are concerned, and who is an entry point to other communities);
- Identification of information channels most used by policy makers and opinion leaders;
- Analysis of information related to agricultural biotechnology available to policy makers and opinion leaders;
- Development of educational materials and related activities specifically tailored to policy makers and' opinion leaders, using potential new products as the main focus of discussion.

Although policy makers and opinion leaders are important communication partners, the development of broader outreach activities should take place simultaneously. Such development should follow a relatively standard information, education and communication (IEC) model, tailored to country specificities. These include developing informational materials intended to inform public discussion accurately, whether through journalism, regional and local discussions, or other venues. The model should be put in place in close collaboration with organizations involved in agricultural biotechnology related outreach activities such as ISAAA. This plan should include: (1) implementation of regional research focused on public understanding and awareness of agricultural biotechnology and the issues surrounding it; (2) development, based on research

outcomes, of communication messages, outreach activities, and related materials for each audience; (3) selection and utilization of appropriate communication channels; and (4) evaluation and correction when necessary.

Finally, it should be emphasized that even more broadly focused communication activities need to take participatory considerations into account. In most cases, we feel that messages need to emphasize the need for a locally driven and participatory process of development.

Regional Recommendation #6. Because an immediate need exists to sensitize policy makers, regulatory personnel, and other key individuals in several of the GMS counties about key issues relating to agricultural biotechnology it is **recommended** that a sub-regional workshop on agricultural biotechnology be organized for this purpose.

2.4 Policy

The GMS countries share many common needs and concerns on biotechnology. In the policy area, a common need is the early establishment of national regulatory systems that will allow the timely, effective and responsible testing and adoption of transgenic crops and their products. This requires urgent attention because it is a prerequisite for the testing and adoption of GM crops their products, and is an initiative that can lend itself to sub-regional cooperation.

The coming-into-force of the Cartagena Protocol on Biosafety marks a cornerstone for the regulation of trans-boundary movement, handling and use of GMOs/LMOs. Parties to the Protocol have to take necessary and appropriate legal, administrative and other measures to implement their obligations under the Protocol, and it is essential that countries in the GMS be prepared to meet these new challenges. While the science of biotechnology has advanced in some of these countries, notably the PRC and Thailand, expertise in risk assessment and risk management of GMOs however has been lacking. Moreover, as trade in GMOs is expected to increase in the near future, including intra-sub-regional trade on GMOs and GM products, concern for safety of GMOs to human and animal health and the environment should be to be taken into account. Thus, it is important to immediately build capacity in biosafety regulations in the sub-region as a whole.

Currently, the GMS countries are in various stages of establishing their respective biosafety regulatory frameworks. A sub-regional approach can help make this process less difficult by helping to build harmonized biosafety regulatory mechanisms in the GMS sub-region. An urgent need exists to develop a corps of national experts that can provide highly credible, objective, scientific, and responsible oversight in the development and deployment of transgenic crops. This will not only contribute to capacity building in biosafety in the region but will also enhance networking in biosafety, information sharing and increased public awareness of biotechnology and products of biotechnology.

A significant constraint encountered by private sector technology developers and others in transferring biotechnology applications to developing countries, including the GMS countries, is the fact that while almost all usable plant biotechnology applications are proprietary the effective protection of intellectual property rights on biological materials is inadequate in most developing countries. This is despite the fact that many developing countries are already members of the WTO and are required to provide appropriate intellectual property rights protection, thus limiting the unauthorized use of proprietary technology. On the other hand, developing countries are increasingly asserting their rights the relevant base plant material, so that they too have an intellectual property stake in the matter. Usually, no release of plant materials can occur without permission of owners of technology IP owners. Sometimes even when initial releases in a given country are possible (due to the lack of patents rights), export of products may raise additional intellectual property issues.

As the private sector is the principal developer, provider and disseminator of most important biotechnology applications and products, it is essential that appropriate policies and incentives be established that will encourage active private sector participation in the development, introduction and deployment of biotechnology.

Regional Recommendation #7. Because clear, harmonized and enforceable biotechnology frameworks and regulatory mechanisms are essential to effective, safe and responsible development and beneficial use of modern biotechnology in agriculture and food; and because biosafety regulations are not only national but also cross-country concerns, it is **recommended** that (i) a regional initiative in the GMS on establishing biosafety frameworks and mechanisms be urgently set up and supported, and (ii) the requisite capacity for implementation by GMS countries be strengthened in all aspects, including quarantine regulations and enforcement.

Regional Recommendation #8. Because private sector participation and investment in biotechnology is deemed vital for sustained technology development, acquisition, introduction, and broader commercial use of biotechnology in agriculture and food, and that appropriate policies are necessary to stimulate and support private sector involvement, it is **recommended** that (1) the establishment of effective intellectual property protection mechanisms in GMS countries be supported; and (2) other market-oriented policy initiatives be explored for possible consideration and adoption by the emerging market economies of some GMS countries.

2.5 Investment Priorities

The lack of development in agricultural biotechnology in the GMS represents a significant hurdle for the region's economic development because of the high dependence on agriculture of many of the developing countries in this region. The competitive status of agriculture in the less developed countries of the GMS may be adversely affected due to advancements in agricultural biotechnology in neighboring countries. India and the PRC may bring to these markets cheaper and superior products in the post WTO era. Economic progress in much of the GMS could be severely impaired unless support is provided to overcome technology deficiencies, lack of human resource competency and lack of appropriate policy mechanisms for the sub-region.

Priority areas for investment are listed below in approximate priority order with the first five being of critical importance. Factors considered in determining these priorities are shown in Table 1. Awareness is clearly fundamental and should take precedence over other investments. The sequence of other investments depends more on opportunity than the degree of need, which is generally acute.

1. Creation of basic awareness of the benefits and risks that would flow from adoption of agricultural biotechnology. This may be achieved through in-country and intra-country workshops and stakeholder interactions with support from international Institutions of repute.

2. Development of sound agricultural biotechnology policy mechanisms in each of the countries, well integrated with agricultural and food policy and the bio-safety and regulatory mechanisms that would help to derive beneficial advantage from technologies. This may involve contracting international expertise for harmonizing country policies with that of global best practices.

3. Development of cost effective and sound research infrastructure commensurate to the level of technology application envisaged in the near term and in the medium term. This is more relevant to countries in the region other than Thailand and Yunnan, PRC. This may be attempted in two stages -- first to upgrade or establish a center of excellence so that it becomes a catalyzing center for agriculture biotechnology research in the country, and over the medium term to develop capacity in different regions of the countries.

4. Development of human resource capability in research, technology management, commercialization, regulation and communication.

5. Creation of healthy intra-regional cooperation – quarantine, technology transfer opportunities, IP mechanisms (single registration costs for IP), knowledge sharing, trade and tariffs harmonization etc.,

6. Creation of a sound funding mechanism for nurturing bio-entrepreneurship and for the development of homegrown enterprises and collaborative partnerships.

7. Strengthening of governance in the publicly managed seed companies and publicly funded research centers.

8. Creation marketing and distribution mechanisms for seeds and infrastructure for seed production, certification and distribution.

9. Development of outreach and communication efforts that are customized for each country, depending upon the local conditions and the level of awareness.

A need exists for contributions from international institutions, academic bodies and policy consultants who can help countries in the region to derive gains from advanced technologies in agriculture and agricultural biotechnology within a sound policy and regulatory mechanism. Appropriate investments could bring about these changes resulting in considerable economic and social impact in the region.

Table 1. Factors analyzed in the assessment of agricultural biotechnology in the GMS.

Factors of Analysis	Thailand	Cambodia	Vietnam	Yunnan, PRC	Myanmar	Laos
Need for policy and regulatory mechanisms	High	High	High	Low.	High	High
Need for technology access	Needs access for advanced technologies only.	High for elementary technologies	High for application technologies	Low as they have access to global and domestic technologies.	High for elementary technologies	High for elementary technologies.
Need for private enterprise development	Existing, but needs support for commercialization of products	Non-existent. Needs high focus for enterprise development.	Existent in rudimentary form. Needs focus for consolidation	Policy shift to encourage multinationals would enhance enterprise development.	Non-existent. Needs high focus for enterprise development.	Non-existent. Needs high focus for enterprise development.
Need for increased public awareness	High awareness among limited stakeholders and complete lack of awareness among others.	Low awareness. Strong urge to initiate communication efforts for better awareness.	Low awareness. Strong urge to initiate communication efforts for better awareness.	Opportunity exists for organized communication efforts to achieve wider economic and social gains	Low awareness. Strong urge to initiate communication efforts for better awareness.	Low awareness. Strong urge to initiate communication efforts for better awareness.
Need for developmental assistance	Significant potential for collaborative investments exist in the private sector.	Very high.	Very high.	Significant potential for collaborative investments in the private sector.	Very high.	Very high.
Ability to support other countries in the region.	Very High.	Very limited.	Very limited.	High	Very limited	Very limited

3.0 Appendices

3.1 Country Assessments

3.1.1 Cambodia

Situated in the Southeastern Asia, on the Gulf of Thailand, between Thailand, Vietnam, and Laos the Kingdom of Cambodia is an independent country with a population of 12 million. Geographically, Cambodia is a wide basin surrounded by highlands. The country is divided into 20 provinces and is rich in resources, forests, rubber, gems, and fish. It also has significant potential in tourism.

Cambodia's economy slowed dramatically in 1997-1998 due to the regional economic crisis, civil violence, and political infighting. Foreign investment and tourism fell off. In 1999, the first full year of peace in 30 years, progress was made on economic reforms and growth resumed at 5.0 percent. Despite severe flooding, GDP grew at 5.0 percent in 2000, 6.3 percent in 2001, and 5.2 percent in 2002. Tourism was Cambodia's fastest growing industry, with arrivals up 34 percent in 2000 and up another 40 percent in 2001 before the September 11, 2001 terrorist attacks in the US. Even given these encouraging growth estimates, the long-term development of the economy after decades of war remains a daunting challenge. The population lacks education and productive skills, particularly in the poverty-ridden countryside that suffers from an almost total lack of basic infrastructure. Fear of renewed political instability and corruption within the government discourage foreign investment and delay foreign aid. The government is addressing these issues with assistance from bilateral and multilateral donors.

Agriculture is a fundamental sector of Cambodian economy and is a top priority for the country's development program. Eighty per cent of the population lives in rural areas; most of these people are engaged in farming. Key agricultural produce of Cambodia includes rice, rubber, corn, and vegetables. Rice accounts for over 80 percent of the GDP. Next in importance are rubber and palm.

Most Cambodian farmers are poor and face many production and marketing constraints. Major problems in crop production are lack of high yielding high quality varieties and, depending on the season and the geographical location, severe drought and flooding. Brown planthopper is a significant pest of rice. This is probably due to the overuse of pesticide cocktails that kill the natural predators of the pest. Rice diseases are not perceived as a problem.

3.1.1.1 Technology

Target crops of the 3 year (2004-2006) research plan at the Cambodian Agricultural Research and Development Institute (CARDI) include rice, maize, legumes, sesame, sweet potatoes, vegetables (tomato, chili, and mushroom), mango, bananas and watermelon. Current crop improvement research involves conventional breeding. This focuses mainly on developing rice varieties through mass selection and pure-line selection. All generated crosses involve at least one traditional rice variety as parent. Grain yield, maturity, grain quality, tolerance to drought and submergence, and resistance

to brown planthopper are the key selection criteria. For most other crops, including vegetables, the approach is to introduce improved varieties.

Yield has increased slightly for most crops due to introduction of improved technology. The most dramatic improvement has been to double rice yield and production due to a research program led by the Cambodian-IRRI-Australia Project (CIAP), which collaborated with DALLI.

In addition to crop improvement, Cambodia conducts programs in: (i) crop management on rice, maize, legumes sesame, sweet potatoes; (ii) crop protection on control methods for disease, insects and weeds (rice, tomato, chili, mushroom); and (iii) post-harvest technology (rice, maize, legumes, sesame and sweet potatoes).

Programs also exist in land resource management including mapping of soil and crops (rice and non-rice crops), and identifying constraints to crop multiplication. Farming systems research is being conducted on options for rice-mungbean cropping systems, on inter-cropping systems under rainfed condition, on feeds derived from crops, and on animal source for production.

Social sciences research is being conducted on: (i) the impact of rice varieties and of trap barrier systems; (ii) constraints for non-rice upland crops; (iii) traits required by the market for rice; (iv) determining market demands for agricultural products; and (v) gender issues.

Capacity in biotechnology research in Cambodia does not exist at this time. No scientists are actively involved in biotechnology research because little or no human resources capacity building has been conducted in this area and facilities are not available in which to conduct biotechnology research. However, facilities are being built at CARDI to house a tissue culture laboratory that would focus on banana genetic resources conservation. This is to be conducted in collaboration with the International Network for the Improvement of Banana and Plantain (INIBAP).

Other plans for biotechnology research include characterization of agro-biodiversity and molecular characterization and allele mining of germplasm collections; CARDI has conserved 3457 rice accessions and 1097 wild rice in gene bank, 89 banana samples.

CARDI also plans to conduct germplasm enhancement using modern marker systems in segregating populations developed from identification of allelic variation in germplasm collections (e.g. drought tolerance and other traits with low heritability that are difficult to select through phenotype selection).

Plans are in place to develop micropropagation for bananas, ornamentals and other crops and to diagnose diseases with biotechnological screening techniques.

Cambodia Recommendation #1. Because of the demand for biotechnology in Cambodia, its current lack of capacity, and the existence of high quality infrastructure and knowledge delivery mechanisms in other countries in the GMS such as Thailand,

Vietnam, and PRC, it is **recommended** that Cambodia request such countries to help build its own human capacity in biotechnology.

This could involve seeking opportunities in other GMS countries for study leaves in the case of Cambodian professionals and advanced degree courses for students.

Besides the anticipated banana work, no national priorities have been set for biotechnology. In fact, only minimal priority setting has been conducted for agricultural research and development in the broader sense. One exception is that a policy decision has been made to diversify research beyond work on rice (see below under 'Policy').

Cambodia Recommendation #2. Because of the absence of clear priorities in agricultural research and development as a whole, it is **recommended** that Cambodia conduct an agricultural research priority setting exercise as soon as possible, followed closely by a priority setting exercise on agricultural biotechnology to determine the specific ways in which biotechnology might be used to complement conventional approaches.

Several government and university scientists and administrators have some awareness of the potential for biotechnology in crop improvement. For example, CARDI scientists can foresee an important role for molecular markers in their current or anticipated breeding programs on rice (e.g. flood tolerance, drought tolerance, brown planthopper resistance, photoperiod insensitivity and earliness), mango (flavor improvement), banana (yield and quality), and tomatoes (heat tolerance and virus resistance).

But, of the three to four hundred agriculture students who graduate in Cambodia each year from Royal University of Agriculture (RUA) and Maharishi Vedie University, none have taken a class in biotechnology. No postdoctoral students have gone abroad to be trained in molecular biology and no researchers have received any training on this or other biotechnology topics.

Cambodia Recommendation #3. Because of the urgent need for education and training of Cambodian students or practicing researchers in biotechnology, it is **recommended** that a few top-level students/researchers be supported to study in established biotechnology laboratories in the GMS and beyond.

3.1.1.2 Enterprise Development and Marketing

In the agricultural sector, enterprise development and marketing are in urgent need of attention. Dissemination of seed around the country is almost entirely through informal means. There is only one private seed company in Cambodia and, at present, there are no initiatives underway to encourage the creation of others. It is unclear even to scientists and administrators at CARDI, RUA and from MAFF how seeds get to market. Unless enterprise development is strongly encouraged and an organized marketing chain is created, there will be minimal utilization of improved crops, whether they are developed by conventional or biotechnology approaches.

Cambodia Recommendation #4. Because of the rudimentary status of the seed sector in Cambodia, it is **recommended** that support be provided to the Government to (i) develop policy mechanisms that would help domestic and foreign seed companies to operate profitably and (ii) initiate actions that would impose some control on the informal spread of seed.

Mechanisms by which this could be achieved might include providing lines of credit to potential investors. Meanwhile, it would be essential to develop intellectual property and plant variety protection mechanisms to protect the investments made by entrepreneurs.

3.1.1.3 Communication, Outreach and Public Awareness

Stakeholders in agricultural technology, including policy makers, scientists, farmers, and the public have very limited access to information that would form the basis for informed decision making. The seriousness of this issue is illustrated by the fact that information flow to farmers, even on safe and effective pesticide use, is almost non-existent. Consequently, over-use of chemicals is routine. Internet access is very limited even within the research community. CARDI does have access but this is an unusual case.

Public awareness programs do not appear to exist for any aspect of agriculture. Extension services are weak although some is conducted by radio and by written materials. About 40 percent of the rural population owns a battery operated radio and people tend to share their knowledge.

Cambodia Recommendation #5. Because of the need to improve communications, outreach and public awareness it is **recommended** that support be provided to design and implement a program to help all stakeholders in Cambodia to understand the benefits and risks associated with biotechnology.

3.1.1.4 Policy

Specific policy elements of the Ministry of Agriculture, Forestry and Fisheries (MAFF) are to: (i) ensure food security through expansion in production of rice and other food crops; (ii) contribute economic growth and foreign earning through exports; (iii) improve income opportunities for households, particularly those headed by women, by diversifying crop production; (iv) add value to crop and livestock production by developing agro-processing industries; and (v) manage and conserve natural resource and the environment in a sustainable manner

For several years Cambodia's rural development policy has focused on food security. As rice is the staple diet for all Cambodians the government's objective has been to increase national rice yield and develop marketing and distribution infrastructure. Although in some areas food security is a major issue, the nation has produced a small surplus of rice over the last few years. Research conducted by CARDI and its precursor, the AusAID funded Cambodia – IRRI – Australia project, has been an important element in this achievement.

With the achievement of rice self-sufficiency the Government rural development focus is now moving towards poverty alleviation and income generation. While rice research will

remain as the highest priority for the foreseeable future, CARDI's official mandate requires it to diversify its research base and lead the research effort to enhance agricultural development in Cambodia.

Indeed, CARDI's research profile will diversify dramatically. Instead of more than approximately 90 percent of the effort being placed on rice, this will drop to approximately 60 percent to make way for research on cash crops, tree crops, vegetables and forage and livestock. CARDI recognizes that its own sustainability will depend on its ability to forge partnerships with a wide range of agencies involved in agricultural research and development and to generate some of its own income to supplement that provided by the Government and by donors. Such actions are now a cornerstone of its institutional policy.

Currently Cambodia has no policy on biotechnology and biosafety. But, this year, the institution has started to cooperate on this with the RUA, the Ministry of Environment, MAFF, the Ministry of Industry Mine and Energy (MIME), and the Ministry of Commerce (MOC) in implementing the biosafety and biotechnology.

A sense of urgency about this work now exists because Cambodia is a member of the WTO and needs to address the anticipated and unavoidable influx of GM crops into the country from other GMS countries and beyond. This is coupled with a longer-term objective of creating an appropriate policy environment for the possible cultivation of GM crops in Cambodia. Development and implementation of a biotechnology and biosafety strategy and action plan will be in compliance with the International Protocol on Biosafety.

Cambodia Recommendation #6. Because of the urgent need for immediate monitoring and control of unauthorized importation of GM crops it is **recommended** that support be provided to the Cambodian Government to formulate and implement a sound policy and regulatory mechanism for agricultural biotechnology and biosafety.

As several countries in the GMS have already developed, or are developing, such policies (e.g. Thailand, the PRC and Vietnam) and some have not (e.g. Cambodia and Laos) a sub-regional approach to capacity building might be considered. This would not only help to share experiences and address common challenges, it could also lay the foundation for harmonizing regulatory policies in the sub-region.

3.1.2 Lao PDR

Laos is a landlocked nation of approximately 236,800 square kilometers in center of the Southeast Asian peninsula, bordered by the PRC to the north, Burma to the northwest, Thailand to the west, Vietnam to the east, and Cambodia to the south. It is largely mountainous, with elevations above 500 meters typically characterized by steep terrain and narrow river valleys. While estimates vary, the population is approximately 5 million people and more than 85 percent is rural.

At least 5 million hectares of Laos's total land area of 23,680,000 hectares are suitable for cultivation; however, just 17 percent of the land area (between 850,000 and 900,000

hectares) is, in fact, cultivated, less than 4 percent of the total area. Agriculture remains the foundation of the economy and the percentage of the labor force employed in agriculture is about 80 percent. Rice accounts for over 80 percent of agricultural land and between 73 percent and 84 percent of total agricultural output of major crops. Principal non-rice crops include cardamom--sometimes considered a forestry product--coffee, corn, cotton, fruit, mung beans, peanuts, soybeans, sugarcane, sweet potatoes, tobacco, and vegetables. Coffee is the only crop produced for export in substantial quantities. Locally, it was indicated that substantial quantities of potatoes are exported to Thailand. Despite increasing agricultural output, however, Laos is still an importer of food, heavily dependent on food aid.

Statistics for agricultural production do not reflect either the nature of the subsistence agricultural economy or the importance of opium to the hill economy. Opium, legal in Laos and once even accepted as a tax payment, is a lucrative cash crop.

Government priorities for agriculture and forestry focus on 6 major areas: (i) food production, (ii) commodity production support, (iii) stabilization and reduction of slash and burn cultivation, (iv) integrated rural development, (v) agriculture and forestry research, and (vi) human resource development.

3.1.2.1 Technology

Capacity for conventional crop breeding in Laos is limited to rice and a few vegetables and the capacity for agricultural biotechnology research does not exist. It is not anticipated that such capacity will be developed in the near or medium term. Bioengineered crops will consist of those that find their way informally into Laos from the surrounding countries, particularly the PRC. Markets are not sufficient to attract the multi-national private sector.

Lao PDR Recommendation #1. Because a need exists to strengthen conventional plant breeding capacity that will, in turn, allow for the appropriate use of biotechnology in collaboration with scientists from other countries in the region it is **recommended** that priority be given to the development of human resources for this purpose.

3.1.2.2 Enterprise Development and Marketing

The government of Laos began decentralizing control and encouraging private enterprise in 1986. Despite a high growth rate (based on a low base), Laos is a country with limited infrastructure; it has no railroads, a poor road system, and limited telecommunications. Electricity is available in only a few urban areas. Subsistence agriculture accounts for half of GDP and provides 80 percent of total employment.

Since the initiation of the economic reform process in Lao PDR, an important objective of the Government has been the development of an efficient market economy. The private sector is now reported to play an important role in the distribution of agricultural inputs and in the procurement and trade of rice. In spite of these developments, however, the level of market integration and development remains low, mainly because of

enormous problems of communications and access, inadequate market information and because rice production remains largely subsistence and agricultural incomes low. Particularly amongst the rural poor, therefore, the level of market integration and response to market signals, such as prices, remains negligible. A common practice observed is the sale of seeds to NGOs who distribute it among the poor farmers for free. Biofertlizer, an alternative to expensive, imported chemical fertilizer seems to be a growing industry. The team heard complaints that export of biofertilizer to Thailand were being restricted because a "GMO-free" certificate could not be provided.

3.1.2.3 Communication, Outreach and Public Awareness

Information and public awareness related to agricultural biotechnology is insignificant in Laos. Given the nature of the population and the lack of infrastructure it seems unlikely that this situation could be remedied. On the positive side, the same constraints that limit the dispersal of information also limit the spread of misinformation. A strong desire exists among policy makers, as voiced by those attending the workshop, for reliable information related to agricultural biotechnology. Support was voiced for a sub-regional workshop that would facilitate understanding of agricultural biotechnology in the region and provide a window on developments in the various GMS countries.

Lao PDR Recommendation #2. Because of the urgent need for improved communications, outreach and public awareness it is **recommended** that support be provided to design and implement a program to help all stakeholders in Lao PDR to understand the benefits and risks associated with biotechnology.

Lao PDR Recommendation #3. Because a strong desire exists for reliable information that would contribute to the establishment of appropriate policies, regulations, and research programs it is **recommended** that a sub-regional workshop on agricultural biotechnology be organized for Lao PDR participants and their counterparts in other GMS countries.

3.1.2.4 Policy

No regulatory guidelines exist at the present time. Laos PDR is a signature country to the Convention on Biological Diversity (CBD) and plans to ratify the Cartagena Protocol on Biosafety. The Science, Technology and Environment Agency (STEA) is the competent national authority and the Director General of the Research Institution of Science is the national focal point for the Inter Governmental Committee for the Cartegena Protocol on Biosafety (ICCP). The country has joined the UNEP-GEF Global Project on Development of 100 national Biosafety Framework and hopes to set up the National Biosafey Framework in accordance with the Cartagena Protocol on Biosafety. A National Biosafety Committee is reported to have been set up, composed representatives from relevant ministries. The NBC is to draft the National Guidelines on Biosafety to be approved by Prime Ministerial Decree.

Lao PDR Recommendation #4. Because there is a need to collaborate with other countries in the region to assure that policies will be relevant and enforceable and because a region-wide regulatory framework is needed it is **recommended** that policy

makers from Lao PDR be encouraged and supported to work with their counterparts throughout the region to craft appropriate policies and develop and implement an integrated regulatory framework.

Lao PDR Recommendation #5. Because of the demand for biotechnology in Lao PDR, its current lack of capacity, and the existence of high quality infrastructure and knowledge delivery mechanisms in other countries in the GMS such as Thailand, Vietnam, and PRC, it is **recommended** that Lao PDR request such countries to help build its own human capacity in biotechnology.

Lao PDR Recommendation #6. Because of the rudimentary status of the seed sector in Lao PDR, it is **recommended** that support be provided to the Government to (i) develop policy mechanisms that would help domestic and foreign seed companies to operate profitably and (ii) initiate actions that would impose some control on the informal spread of seed.

Lao PDR Recommendation #7. Because of the urgent need for immediate monitoring and control of unauthorized importation of GM crops it is **recommended** that support be provided to the Lao PDR Government to formulate and implement a sound policy and regulatory mechanism for agricultural biotechnology and biosafety.

3.1.3 Myanmar

Myanmar is the largest country of the Southeast Asia mainland and has six distinct regions: the western, northern, and eastern mountain ranges; the delta area of the Ayeyarwady and Sittoung Rivers; the coastal strips; and the central plain or dry zone. The cultivable area is 17 million ha, but only 9 million ha are under cultivation. About 75 percent of the 47 million population lives in the rural area and most of the people are engaged in agriculture. The population has been growing at 2.2 percent per year.

Agriculture is the key sector of Myanmar's economy. It contributes 58 percent to the county's GDP and 48 percent of its exports. The agricultural potential is under-realized as evidenced by relatively low yields, input use, irrigation coverage despite ample water resources, and low cropping intensity in comparison with other South and Southeast Asian countries. Malnutrition pockets exist in various parts of the country despite overall national food self-sufficiency.

Rice is the single most important crop, grown on 6.5 million ha or 72 percent of the country's total cultivated area. Rice production employs 40 percent of the total labor force and consumes 70 percent of total commercial fertilizers. In turn, rice maintains its position as the main staple food crop, accounting for 97 percent of total food grain production. The importance of rice as a major foreign exchange earner has declined over time but exports are still significant and there is a desire to recover market share.

Maize is of increasing importance in the country. The area planted has increased by 47 percent to 309,000 ha since 2000 while production has increased by more than 80 percent to 660,000 mt.

Myanmar has been growing potato for many years (records date to 1890) and, before the Second World War, 30,000 tons were exported to India. Today, potato is a popular vegetable crop grown almost the year round on an area of approximately 23,000 ha. Late blight, early blight and bacterial wilt are known to cause severe damage to the crop. Late blight appears annually during July to September in the Shan State highlands inflicting yield losses reported at more than 40 percent in some years.

3.1.3.1 Technology

Agricultural biotechnology research is not significant within the country and the lack of private seed companies has limited the importation of technology. Some technology may have reached the country through informal means but this has not been verified. Given the proximity to the PRC, where technology is being rapidly generated and deployed, it seems safe to assume that farmers will soon be utilizing bioengineered varieties in certain crops. For instance, any potato cultivar, whether conventionally bred or bioengineered, that offered a production advantage would readily find its way into the hill areas.

The Myanmar representative at the regional meeting organized by this assessment reported "...some activities of plant biotechnology for crop multiplication" at 4 sites: (i) Central Agricultural Research Institute (CARI) in Yezin; (ii) Vegetables and Fruit Research and Development Centre (VFRDC); (iii) Plant Biotechnology Laboratory (PBL); and (iv) Mingladon Orchard Garden (MOG). A National Authority on Genetic Modification (NAGM) has been established. A new "Biotechnology Centre Project" has been proposed to the Chinese government to support research on vegetables and poultry. These facilities are staffed by one Ph.D. at PBL and one M.Sc. each at CARI, VFRDC, PBL, and MOG. The representative indicated that biotechnology is very new for Myanmar and that both soft and hard infrastructure are needed in order to be on par with neighboring countries. He stated that assistance from neighbors would be welcome and stated that Myanmar "calls for future engagement on activities of biotechnology."

Technologies exist or are under development in the Asian region that could be relevant to Myanmar. Bt maize has been released in the Philippines, for instance, and could probably play an important role in maize production in Myanmar. The Cornell University Agricultural Biotechnology Support Project II operating in India, Bangladesh, the Philippines and Indonesia is developing Bt eggplant and potato resistant to late blight.

Myanmar Recommendation #1. Because a need exists to strengthen conventional plant breeding capacity that will, in turn, allow for the appropriate use of biotechnology in collaboration with scientists from other countries in the region it is **recommended** that priority be given to the development of human resources for this purpose.

3.1.3.2 Enterprise Development and Marketing

A private sector seed industry does not exist in Myanmar. A few multi-nationals may import seed and engage in trading but nothing is being done to develop local capacity. Development of this sector will be important to the future utilization of biotechnology in the country.

3.1.3.3 Communication, Outreach and Public Awareness

According to an ASEAN survey implemented in Myanmar, information and public awareness are the most important needs related to biotechnology, more important than research and development.

Myanmar Recommendation #2. Because a strong need exists for reliable information that would contribute to the establishment of appropriate policies, regulations, and research programs it is **recommended** that a sub-regional workshop on agricultural biotechnology be organized for Myanmar participants and their counterparts in other GMS countries.

Myanmar Recommendation #3. Because of the urgent need for improved communications, outreach and public awareness it is **recommended** that support be provided to design and implement a program to help all stakeholders in Myanmar to understand the benefits and risks associated with biotechnology.

Myanmar Recommendation #4. Because a strong desire exists for reliable information that would contribute to the establishment of appropriate policies, regulations, and research programs it is **recommended** that a sub-regional workshop on agricultural biotechnology be organized for Myanmar participants and their counterparts in other GMS countries.

3.1.3.4 Policy

No policies exist regarding biotechnology, whether for biosafety, intellectual property, or other issues related to the topic. No regulatory guidelines exist. The quarantine system does not have the capacity to govern the introduction of technology into the country. Technologies that are apparently beneficial to farmers can be expected to move into the country through informal channels.

Myanmar Recommendation #5. Because there is a need to collaborate with other countries in the region to assure that policies will be relevant and enforceable and because a region-wide regulatory framework is needed it is **recommended** that policy makers from Myanmar be encouraged and supported to work with their counterparts throughout the region to craft appropriate policies and develop and implement an integrated regulatory framework.

Myanmar Recommendation #6. Because of the demand for biotechnology in Myanmar, its current lack of capacity, and the existence of high quality infrastructure and knowledge delivery mechanisms in other countries in the GMS such as Thailand, Vietnam, and PRC, it is **recommended** that Myanmar request such countries to help build its own human capacity in biotechnology.

Myanmar Recommendation #7. Because of the rudimentary status of the seed sector in Myanmar, it is **recommended** that support be provided to the Government to (i) develop policy mechanisms that would help domestic and foreign seed companies to operate profitably and (ii) initiate actions that would impose some control on the informal spread of seed.

Myanmar Recommendation #7. Because of the urgent need for immediate monitoring and control of unauthorized importation of GM crops it is **recommended** that support be provided to the Myanmar Government to formulate and implement a sound policy and regulatory mechanism for agricultural biotechnology and biosafety.

3.1.4 Thailand

Thailand has aimed to emerge as a regional leader among the countries in the GMS Region with an early lead in establishing some of the finest research centers for carrying out in-country sponsored, as well as internationally linked collaborative research programs, aimed at increased food productivity and enhanced quality. There is a strong focus for biotechnology research among the research centers and Universities. Some of these initiatives have incorporated biotechnology tools and applications that are comparable to the best in rest of the world. The focus of the research in major research centers is well integrated to address the needs of the farming community The developments that have taken place in Thailand relating to biotech research over the last decade are quite commendable. However, there have been significant scientific advancements elsewhere in the world for producing major crops that are very important for Thailand such as rice, maize, soybean, rubber, sugarcane and some of the important vegetables that unless the country moves rapidly to adapt these technologies, the global competitiveness of Thai agriculture would be under stress.

GM foods are one contributing factor for this and adopting other biotech tools and applications such as improved diagnostic technologies, molecular market assisted breeding, micro array based technologies for crop analysis and crop improvement strategies are other application technologies that are enhancing the crop productivity and quality. For sustaining Thai competitiveness in some of the key crops, the GM technologies cannot be ignored. For example, 51 percent of the 72 Million hectares of soybean, 9 percent of the 140 million hectares of maize and 20 percent of the 34 million hectares of cotton, grown world over (ISAAA) are produced by genetic modification incorporating features of improved productivity and product quality. The Bt maize has resulted in productivity increase of 9 to 10 percent due to improved pest control. Similar or higher gains have been recorded with respect to other crops as well. This would have considerable impact for the Thai products.

The Thai Economy is significantly dependent on the agricultural exports and the continued competitive advantage for some of the main crops of Thai agriculture would be endangered if technology improvements were not incorporated in the cropping system. Ensuring higher productivity and higher quality through molecular technologies, applying novel gene based transformation technologies that would enhance the product characteristics and control losses due to pests and creating higher post harvest value through techniques such as bio-packaging will provide Thai agriculture continued regional advantage. While Thailand has significantly progressed in initiating research projects that would help to incorporate agricultural biotechnology tools and applications, the challenge is to derive outcomes from these research projects, duly incorporating the commercialization focus to the technology development.

3.1.4.1 Technology

Several advanced research projects in developing genetically improved commercial crops such as Papaya, corn and cotton are yet to be moved to commercial exploitation due to lack of clarity of perception of the policy planners on the way they may impact the trade regime of Thailand. There is no perceived urgency in exploiting gains from such research projects due to lack of commercialization focus. While there are no clarity in policy pronouncements in this regard, the approach seem to be to encourage application of biotechnology tools and interventions that would provide enhanced product profile, without attracting EU attention for DNA technologies that would help to produce genetically modified crops. While this lack of clarity persists, there are number of experiments in development of transgenic products undertaken by the leading Universities with international technology partnerships and by private sector in undertaking field trials of GM products.

While it is true that GM technologies will help Thailand to sustain competitiveness for certain crops, there are also advantages for certain crops to be produced applying organic cropping practices that would help to fetch high value realization in export markets. Hence it is essential to adopt GM technologies for certain crops and organic approach for certain other. This will involve determining research and commercialization priorities based on the product and technology status, through a holistic approach and assessment of priorities.

Thailand Recommendation #1. Because agriculture is a vital component of Thai economy, and in order to ensure continued competitiveness of Thai agricultural products globally, accelerated efforts on the part of the Government, the public research institutions and the private sector are **recommended** to adopt an holistic approach in realizing the economic and social gains from research advancements by commercializing biotechnology applications and adopting technologies, including GM technologies that would improve food productivity and quality.

On the research front, important Thai Institutions have potential to integrate themselves very well with cutting edge research initiatives that are on-going with well known global Institutions that apply advanced genomics and proteomics technologies for agriculture research. Thai Institutions have joined some of these consortiums such as the Rice genome consortium and have contributed very well to this global research network. However, there is a need for THAI Institutions to engage more and more in such cutting edge research partnerships in order to ensure acquisition of knowledge that would help Thai agriculture to gain considerably in the medium and long term. This would call for investments in collaborative global research that would bring in gains over the longer term span rather than short term span, but provide Thailand the ability to absorb such technologies rapidly, once they are ready for commercial application.

Thailand Recommendation #2. Because Thailand has the capability to join global consortia that are focused on undertaking cutting edge research in agriculture biotechnology and because such partnerships could bring considerable long term gains to Thai agriculture by commercialization of such technologies, it is **recommended** that

Thailand invest aggressively in these long term technology partnerships by deriving long term financial support if required.

Thailand has considerable knowledge of native plant based and animal based derivatives that would provide scientifically validated nutritional and therapeutic remedies to humans. It is essential to integrate the bio-diversity with a planned re-generation of these crops, which would provide considerable opportunity in development of value-based nutraceuticals. It would be highly beneficial for Thai research institutions and the private sector to engage in native knowledge based product development that would create healthy neutraceuticals sector in Thailand.

Thailand Recommendation #3. Because Thailand has rich biodiversity and a sound knowledge of the use of native plant based resources, nurturing research and commercialization initiatives in an accelerated manner is **recommended** for the effective regeneration of these plant materials and development of a sound "nutraceutical" sector that would provide an edge to Thailand in exploiting global market opportunities.

There is significant focus on capacity building with high quality infrastructure creation in the public and private sector and high level of investment in higher education within Thailand. The Higher Education development program supported by ADB and the high quality research incubator created by CAB (Kasetsart University) and BIOTEC are some of the pioneering initiatives in this regard. Thailand's continued focus in such investments and harnessing the high quality human resource capabilities in developing commercially exploitable products with improved characteristics will provide a strong institutional mechanism for research and education not only for this country, but for the Greater Mekong region as a whole. Thailand's high quality infrastructure for research, technical services and education and the human resource capacity building initiatives can be leveraged by other countries in the GMS region by appropriate development of linkages that would provide the other countries in this region access to such knowledge and infrastructure on a mutually sustainable basis. Thailand can provide leadership to countries in this region by delivering in partnership educational programs that would enhance their capacity in agricultural biotechnology and provide them access to basic infrastructure that are vital to incorporate some of the fundamental aspects of agricultural biotechnology in their cropping programs.

Thailand Recommendation #4. Because of the existence of high quality infrastructure and knowledge delivery mechanisms in Thailand, it is **recommended** that Thailand engage itself in supporting other countries in the GMS region by appropriately partnering in providing quality education in agricultural biotechnology and by facilitating access to quality research and scientific infrastructure that would help these countries adopt to some of the basic technologies in their crop production. Specific actions that might be taken by Thailand to support other GMS countries are elaborated under 'Regional Assessment' below.

While there is a need for continued investments in research facilities and scientific human resource development, Thailand needs to explore and consider rapid adoption of technologies through technology transfer. The limitation to technology transfer is due to non-existence of a sound Intellectual property mechanism. The capacity building in

research is primarily concentrated in the public system and not in the private enterprises due to this factor. The efforts of private enterprises to bring in hybrid seeds incorporating improved traits are restricted by the absence of proper plant variety protection mechanism. There is considerable interest in the private sector to introduce hybrid seeds with improved characteristics and the technology access at the farm end will be far significant, once these mechanisms are in place. There is a need to create an atmosphere that would engage private sector in carrying out application based research in agricultural biotechnology and develop mechanisms that would provide opportunity for public-private partnerships in biotech research and commercialization. Strong interest in private sector research can be created by providing access to high quality infrastructure such as technology incubators and by engaging the private sector to participate in research programs in partnership with the public sector that would address national research and commercialization priorities.

Thailand Recommendation #5. Because of current inadequacy of mechanisms that encourage private research investment, it is **recommended** that a mechanism be created that would help to accelerate private research participation by augmenting incubator facilities and encouraging the private sector to engage in public-private partnership based research initiatives that would facilitate development and commercialization of agricultural biotechnology products.

3.1.4.2 Enterprise Development and Marketing

The abundant entrepreneurship abilities in Thailand can provide excellent growth in enterprise development and commercial exploitation of technologies that are relevant for improved food production. Currently the role-played by small enterprises in development and commercialization of seeds for GM crops or disease free hybrid seeds are limited. Certain level of success has been achieved in animal husbandry and diary in small enterprises exploiting biotechnology tools and applications in product improvement. However, the advancements in farm productivity and significant gains to small farmers can be achieved, if a vibrant seed industry is created in the private sector. Currently, the seed sector is dominated by the Public seed distribution enterprises. The role of large multinational partnerships are limited due to absence of technology protection mechanisms highlighted elsewhere in this report. Thailand needs to device a framework where by local seed companies can improve their capacity and work collaboratively with those who can provide advanced technologies for improved seed production. The marketing and distribution system should be strengthened in the private mechanism for the hybrids and in the public mechanism for the varieties. In the absence of enabling mechanisms for accessing technologies and accessing markets, the private enterprise development will not progress rapidly. Thailand has potential to be one of the global sources for high quality seeds if these enabling mechanisms are created. Technology advancements flow to the farm end through high quality seeds that incorporate appropriate characteristics for target crop production. Aggressive efforts in developing home grown companies and concurrently opening the sector for foreign investments will provide Thailand an opportunity to emerge as the Asian leader and indeed as a global leader in seed production and seed distribution. Any delay in triggering appropriate actions in this direction will open up serious threats to the Thai seed sector and force

farmers to access seeds from other regions such as the PRC and India who are emerging as large suppliers of seeds to the whole world. This will also open up a major challenge to contain the spread of the informal sector.

Thailand Recommendation #6. Because Thailand is emerging as a global seed producer, it is **recommended** that the seed sector be nurtured through appropriate policy mechanisms that would help to build private seed enterprises that are domestically owned as well as foreign owned along with initiation of effective steps that would contain inappropriate seed distribution in the informal sector.

Investment in private enterprise development should be triggered by appropriate financing support through lines of credits that would provide access to low cost funds for investment in product development, technology access, technology exploitation and development of marketing channels, until such time the Thai seed industry gains global competitiveness.

In order to encourage enterprise development and to facilitate private enterprises to derive gains from their research investments, it is essential for Thailand to develop an appropriate mechanism which would encourage seed industry adhering to intellectual property mechanism and an effective plant variety protection mechanism by building incentives in such financing mechanisms that would discourage those enterprises who do not adhere to such mechanisms.

Thailand Recommendation #7. Because it is essential to encourage and develop a vibrant seed industry that would adhere to marketing high quality seeds without infringing on intellectual property ownership and the protection of plant varieties, it is **recommended** that an appropriate policy and financing mechanism be installed that would encourage seed industry compliance with such mechanisms in order to build a healthy seed sector and contain the harmful impact of the growth of the informal seed sector.

3.1.4.3 Communication, Outreach and Public Awareness

The communication and outreach efforts in Thailand that would help to derive gains from contemporary agricultural biotechnology are limited due to lack of initiatives on the part of the Government agencies, non-government agencies and the private sector. There are several signals to indicate that the GM technologies will move into the farm end not through the official channels, but in the informal sector due to the small farmers' compulsions to sustain their income. This could have long-term repercussions if such uninformed exploitation of technologies is allowed to take place. While the Scientific community and the policy planners have got together in various forums, there were no sustained dialogue through an empowered body that would analyze the risks and benefits of facilitating contemporary technology access to the farm sector. The communication efforts should be directed at all levels, educating the political decision makers, the policy planners, farmers and the consumers. The technology generators, technology managers, technology users, service providers, policy planners, educators and the media should be engaged in informed, science based dialogue that would analyze benefits and risks of technology applications.

Scientists need to bring out simple messages that would help the Politicians and policy planners to understand the gains from agricultural biotechnology applications that would help to sustain Thailand's competitive advantage in food production and exports. There is a need to create urgency in decision making process and decision support system so that the technologies that are so vital for Thailand at this moment and that are lying presently with the research institutions within the country and within the private sector can be commercially exploited for its own competitive advantage.

Thailand Recommendation #8. Because policy makers, scientists, farmers, and the public have very limited access to information that would form the basis for informed decision making, and because this limitation is exacerbated by the fact that most information related to biotechnology is in English, it is **recommended** that support be provided for the establishment and operations of a biotechnology outreach and communications program in biotechnology that would disseminate biotechnology information in the local language and help train agricultural biotechnology stakeholders in biotechnology communications.

Thailand Recommendation #9. Because a strong desire exists for reliable information that would contribute to the establishment of appropriate policies, regulations, and research programs it is **recommended** that a sub-regional workshop on agricultural biotechnology be organized for Thailand participants and their counterparts in other GMS countries.

3.1.4.4 Policy

Thai policy in adopting GM products is influenced by the negative perceptions in Europe for the GM products. Europe is one of the important export destinations for Thailand and hence the country is cautious in granting approval for the commercial release of GM crops. The consideration to go slow on the commercial exploitation of GM crops is more trade related rather than science related. However, due to the same trade related factors, the farmers in Thailand would be enticed to adopt GM crops unofficially by sourcing it from other countries in the region that are strongly supporting production of GM seeds. The farmers' compulsions to sustain his income and his inability to mitigate the damage from pests otherwise will be factors that would force him to opt for such seeds through informal channels. The Thai Government needs to adopt firm policies that would put in place a comprehensive bio-safety mechanism and permit GM crops with such safeguards as are considered appropriate. Initially, a stringent traceability can be built in until clear policy changes emerge in the European Union. To begin with, food crops may be encouraged to be commercially exploited and once the mechanisms are in place for monitoring, they can be commercialized. Thailand will be threatened by two strong countries in the neighborhood, the PRC and India, who would exploit the Thai markets, if there were no consistent policy for adoption of technologies that would help to sustain competitive edge for Thai agriculture.

The policy framework also needs to address opportunities that will bring in considerable technology access, if appropriate intellectual property protection mechanism is created.

Absence of effective plant variety protection mechanism and the intellectual property framework would significantly impair the movement of appropriate technologies to the farm end and this needs to be remedied at the earliest. In our opinion, the policy framework and the regulatory mechanism have considerably lagged behind the scientific advancements achieved by the research institutions and in a way impaired the pace of commercialization of biotechnology based applications.

Thailand Recommendation #10. Because policy and regulatory and legal mechanisms have lagged behind the pace of innovations and scientific advancements achieved by the Thai research enterprises and the private sector in agricultural biotechnology, it is **recommended** that policy planners formulate and implement a sound policy and regulatory mechanism for agricultural biotechnology research and commercialization initiatives that would bring economic gains to Thailand.

3.1.5 Vietnam

Situated on the eastern coast of the Indochina peninsula, Vietnam is a strip of land with a total land area of 329,241 square kilometers bordering with the PRC to the north, and Laos and Cambodia to the west. With the East Sea to the east, and the Pacific Ocean to the east and south, Vietnam is an important transport junction from the Indian Ocean to the Pacific Ocean. Population of Vietnam is 76.3 million (as of April 1st, 1999).

Vietnam is still largely an agricultural economy with about 76 percent of the population engaged directly or indirectly in agriculture. With abundant land and labor forces, diverse climatic conditions and a recent, more open policy to link with other countries in trade, Vietnam is gaining significant achievements in its national economy, especially in agriculture and rural development. From a food importing country, Vietnam has emerged to be a food exporting country in recent years. The agriculture sector grows at around 4.5 percent every year, contributing around 20.8 percent of GDP.

Some of Vietnam's major crops include rice, cassava, sweet potatoes, and sugarcane. In Vietnam, the most important cereal crops such as rice and maize are at the top of the list in terms of agricultural biotechnology. Fruits such as citrus, mango, longan, papaya, lychees, and vegetables such as asparagus and leafy green vegetables represent an important growth area and require improvement of quality through application of biotechnology.

3.1.5.1 Technology

In the national social economic strategy, biotechnology has been identified as a priority area, ranking only second to information technology among five prioritized areas of research and development.

Four major focus areas have been identified for the application of biotechnology in agriculture:

- Development of large-scale micro propagation technology for economical important plants;

- Application of genetic engineering and cell technology to plant and animal breeding programs, with emphasis on rice, vegetables and root crops;
- Research and technology transfer for improving crop and animal varieties and processing agricultural products;
- Development of biotechnology related to environmental protection and reforestation.

Considered as a national priority, biotechnological research and development has been receiving increased funding from the government, at the level of about $1.5-2M annually since 2001. Government support for capital construction is also provided. For example, by the years 2001-2003 the government approved to fund the Institute of Biotechnology US$3M for setting up National Key Laboratory for Gene Technology.

The biotechnology research activities in Vietnam are concentrated in several ministries and agencies, such as the Ministry of Agriculture and Rural Development (MARD), which includes the Agricultural Genetics Institute (AGI), the Cuu Long Delta Rice Research Institute (CLRRI), the Vietnam Agricultural Science Institute (VASI), and the Food Crops Research Institute (FCRI); the National Center for Natural Science and Technology (NCST) which includes the Institute of Biotechnology (IBT); and the Universities, where several Biotechnology Centers have been created.

Tissue culture techniques for crop propagation are highly developed in Vietnam and adopted extensively in various crop groups, including forest species, fruits, ornamentals, root and tuber crops, industrial crops, and medicinal plants. Micropropagation has developed into a new area of industry, with a network of micropropagation factories now set up all over the country and producing millions of quality planting materials.

Lead research institutes in the country also have adopted tissue culture techniques for crop breeding applications, such as haploid and protoplast culture as well as marker-assisted breeding, successfully.

The IBT and several national institutes of MARD implement national research programs using modern biotechnology, including the applications of GM technology. Presently, GM crops could be produced at least at four national research institutions as follows: IBT, AGI, Institute of Tropical Biology (ITB), and CLRRI.

Agronomically important genes have been introduced into many important crops such as rice, papaya, potatoes, sugarcane, tomato, cotton, and maize, and several small-scale tests of transgenics at laboratory and field trial levels have been conducted.

Vietnam has thus embarked on a concerted program on technology and product development using modern biotechnology, supported by a national policy and public investments in R and D, scientific human resource development, and research infrastructure. Commercial GM products from these efforts have yet to be successfully developed and used. As modern biotechnology will continue to be a rapidly-developing, resource-requiring, knowledge-intensive endeavor with both near-term and long-term objectives, the Vietnamese national program will require sustained investments and would also benefit from broader and long-term scientific collaborations with international

and advanced research programs and institutions dealing with biotechnology as well as with private sector technology providers.

It is also important to emphasize the need to gear GM technology and product development with a "freedom-to-operate" orientation, so that benefits from commercial exploitation of the products of ongoing GM technology R and D will be fully realized.

Vietnam Recommendation #1. Because agricultural biotechnology education, research and development, and human resource development are a strategic priority for Vietnam, the continuing government investments are **recommended** in these areas along with the enhancement of all related programs through broader and long-term international collaborations.

3.1.5.2 Enterprise Development and Marketing

As yet, a limited number of enterprises are engaged in technology and product delivery of agricultural biotechnology products in the country. The most developed enterprises are those engaged in production and distribution of micropropagated, quality planting materials through a network of factories in many provinces, as well as producers and distributors of microbial and organic fertilizers. Both government and private sectors are engaged in these enterprises.

Nonetheless, there is a trend of increasing private sector participation as gauged by the increasing trend in the number of private companies engaged in the above-mentioned enterprises. Also, most of the government-operated enterprises operate on a self-funded basis, and some are being converted into shareholder-operated enterprises.

The most important delivery mechanism for products of modern agricultural biotechnology, the seed industry, remains largely in the public sector, with the private sector still at an early stage of development. Except for a few international and local companies engaged mainly in seed production and/or importation and distribution of conventionally bred crops, mostly vegetables (e.g. East-West Seed Company, Known You Seed Company, Thang Long Seed Company, Thang Nang Seed Company, Bioseed), the major transnational seed companies dealing with field crops and GM crop products are noticeably not yet active in the country. Though there is a level of competition between the state owned enterprises and the private companies there is also co-operation illustrated by an arrangement wherein the national seed companies and many of the provincial state agencies are selling the seeds, purchased from the private seed companies, through their distribution systems- a profitable activity for the SOEs.

To encourage enterprise development, both from the domestic and international private sector, it is important to put in place appropriate policies, such as IP protection, and incentives such as financing mechanisms supportive of start-up industries, to stimulate private sector participation in biotechnology enterprises including the seed industry.

Vietnam Recommendation #2. Because the participation of the private sector is essential to the further development of the seed and biotechnology industries in Vietnam, it is **recommended** that appropriate policies be adopted to encourage the private sector,

both domestic and international, to engage in private seed and other agricultural biotechnology enterprises in Vietnam.

3.1.5.3 Communication, Outreach and Public Awareness

As with practically all stakeholders in all developing countries, the lack of ready access to relevant information and knowledge base on biotechnology is a major constraint that must be addressed in Vietnam. Credible, science-based information about biotechnology, and its implications to the broader areas of trade and markets, economic and social benefits and risks, environment, sustainability, food security, and others, are key to informed decision-making not only at the level of policy and program planners but also to technology adopters such as farmers, and the general public as consumers. A sustained and concerted initiative on communication and outreach on biotechnology, involving major stakeholders, is essential.

Vietnam Recommendation #3. Because policy makers, scientists, farmers, and the public have very limited access to information that would form the basis for informed decision making, and because this limitation is exacerbated by the fact that most information related to biotechnology is in English, support is **recommended** for the establishment and operations of a biotechnology outreach and communications program in biotechnology that would disseminate biotechnology information in the local language and help train agricultural biotechnology stakeholders in biotechnology communications.

3.1.5.4 Policy

The Government of Vietnam has a clear national policy recognizing the development role of biotechnology as enunciated in its strategic plan for 2001-2010.

The major policy gaps at present are in the formulation and adoption of related enabling policies that are deemed essential for sustained and successful development and commercial deployment of modern agricultural biotechnology products in Vietnam: particularly in the area of biosafety (and food safety) and intellectual property protection.

Vietnam has been cognizant of the importance of these policies and has initiated national processes to develop and adopt relevant biosafety and IP policies.

An inter-ministerial national drafting committee has been constituted and has already produced a working draft of the national biosafety framework, policy and regulations. The draft is still undergoing review at the present time. Vietnam is also working with the UNEP-GEF in regard to developing the national biosafety framework.

Similarly, Vietnam has initiated efforts to strengthen its intellectual property protection policies and laws and is in the process of developing a plant variety protection law.

Clearly, the need is not just for the urgent adoption of appropriate enabling legislations on biosafety and IP that conform with internationally accepted norms and standards, but to rapidly develop the mechanisms, particularly the national capacity, to implement the policies and deal effectively, transparently, and consistently with biosafety and IP issues and concerns.

Vietnam Recommendation #4. Because the enabling policy and regulatory mechanisms for research, development and commercial use of modern agricultural biotechnology are not yet established in Vietnam, a priority focus is **recommended** for the establishment and implementation of biosafety and intellectual property frameworks, mechanisms and regulations that conform with international standards that would enable and help accelerate the safe development and deployment of modern biotechnology and its products in Vietnam.

Vietnam Recommendation #5. Because of the urgent need for immediate monitoring and control of unauthorized importation of GM crops it is **recommended** that support be provided to the Vietnamese Government to formulate and implement a sound policy and regulatory mechanism for agricultural biotechnology and biosafety.

3.1.6 Yunnan, PRC[3]

Yunnan is a border province situated in southwestern PRC. It covers 3,940,000 square kilometers and has a population of 43.3 million (of which 34.6 million live in rural areas). There are more than four million hectares of cultivated land or approximately 7 percent of the country's total. Yunnan has a complex terrain comprising highlands, hills, plains and river valleys. Elevations range from 6740 meters above sea level in the northern part to only 76 meters in the parts of the south. Consequently there are diverse patterns of agricultural production within the province.

Yunnan is rich in plant and animal diversity and is a center of origin for many plants including rice and tea. The prospects for utilizing these precious resources for the GMS are enormous. The major grains in Yunnan are rice, corn and wheat. The main cash crops are tobacco, oil plants, sugarcane and tea. Livestock production focuses on pigs, cattle, sheep, poultry, and fish.

The province has given high priority to strengthening agricultural exchange and cooperation with GMS countries. The latter have become major agricultural trade partners of the province. Products imported to Yunnan include rice, tropical fruits and processed products, livestock products, and fishery products. Exported products are mainly temperate fruits, vegetables, live animals, crop seeds, and agricultural machinery.

Much emphasis has been placed on capacity building initiatives with Thailand, Myanmar and Viet Nam. According to a recent presentation by Mr. Xingqiang, Director General, Agriculture Department of Yunnan Province[4], the following areas are to be emphasized: (i) expanding trade cooperation of agricultural and other related products; (ii) collaborating on agricultural resources development; (iii) strengthening the agricultural

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[3] Much of the background material on the PRC in this section was drawn from the following working paper: 'Agricultural Biotechnology, Food Production and Food Security', Gabrielle Persley and Carlien Brenner, prepared under the Asian Development Bank's regional Technical Assistance 5918: *Study on Potential Use of Biotechnology in Reducing Poverty and Achieving Food Security in Asia,* 2001 (ISBN: 971-561-362-4)

[4] At the Workshop on Agricultural Investment and Cooperation in the GMS organized by the Ministry of Agriculture, PRC and the Asian Development Bank, Kunming, PRC, November 3-5, 2003

technological cooperation; and (iv) enhancing the cooperation on animal epidemic disease inspection and control. As PRC is a member of WTO, and given the free trade zone of PRC and ASEAN, Mr. Xingqiang noted the unlimited opportunities in Yunnan to cooperate in the agricultural sector in the GMS.

3.1.6.1 Technology

Yunnan is uniquely positioned within the GMS to engage in biotechnology research and development. As a province of the PRC it has access to enormous technical resources, both infrastructural human. Indeed, the PRC has developed the largest plant biotechnology capacity outside of North America.

In 1988, the PRC was the first country in the world to grow a genetically engineered crop commercially; a variety of tobacco, which had resistance to tobacco mosaic virus, was released in Liaoning Province. Since then there have been rapid developments in the PRC in scientific infrastructure and also research programs in biotechnology and molecular biology of various crop plants.

Infrastructural developments include the establishment of National Key Laboratories in the general areas of agricultural biotechnology and crop genetics and breeding, in north, central and south PRC. More than 2 million hectares of land is planted to transgenic crops in the PRC. The PRC had the highest year-on-year percentage growth with a 40 percent increase in its Bt cotton area, which occupied more than half (51 percent) of the national cotton area of 4.1 million ha for the first time, and benefited 5 million small resource-poor farmers. The PRC has released rice varieties resistant to three major pests and conducted field trials on GM wheat. Other GM crops on sale include pest and disease-resistant cotton, tomatoes and sweet peppers. In the pipeline are GM potatoes, rape, peanuts, cabbage, melons, maize, chilies, papaya and tobacco

More than 100 laboratories around the country have been working to integrate biotechnology in conventional agriculture in order to improve yield and quality of crop plants. These laboratories are well equipped for biotechnology and molecular biology research. In addition, there are open laboratories supported by Ministry of Agriculture, Ministry of Education and the Chinese National Academy of Sciences. These laboratories have provided good opportunities for biotechnology research.

The most important programs for biotechnology R&D are the National Program on High Technology Development (also known as the 863 program) and the National Program on Development of Basic Research (also known as the 973 program), both of which included agricultural biotechnology as a major component. The PRC has assigned high priority to: (i) Genomics of rice, maize, wheat, cotton and soybean; (ii) genetic engineering of cotton, rice, maize, tomato, tobacco, wheat, soybean, and oil rapeseed; and (iii) marker-assisted selection of rice, wheat, maize, soybean.

Significant advances have been made in the genomic studies in rice and other cereals. There has also been rapid development of molecular marker technologies and the identification, mapping and cloning of a large number of agriculturally useful genes.

Transformation technologies have also been firmly established in many laboratories for most of the crop species including major cereal crops such as corn, rice, and wheat that are often considered difficult to transform. Transgenic plants can now be routinely produced for crops such as rice, corn, wheat, cotton, tomato, potato, soybean, rapeseed, and other crops using *Agrobacterium,* particle bombardment, or other methods.

Commercial approvals have been obtained for Cotton (insect-resistance), tomato (virus-resistance and improved shelf-life), sweet pepper (virus-resistance), Petunia (flower color), and Poplar tree (insect resistance). Of these products, Bt cotton is the most important with 15 new varieties having been planted in 12 provinces and 2.6 million hectares under cultivation. Impacts of Bt cotton in the PRC include a 70-80 percent decrease in insecticide use a net benefit to farmers of RMB 2130 /ha or US $ 250/ha, and improved farmers' health due to dramatically reduced use of chemical insecticides.

Yunnan, PRC Recommendation #1. Because the PRC invests so heavily in agricultural biotechnology and has made enormous progress in even in the most advanced aspects of the field it is **recommended** that the PRC be provided support to assist other GMS countries in their own capacity building efforts through sub-regional or country workshops on specific scientific topics, by initiating scientific exchange programs, and by encouraging postgraduate students from the GMS to study for advanced degrees in PRC.

Despite the impressive advances made by PRC, there are a number of scientific and technical constraints to the application of technology in crop improvement. One is the lack of understanding of the mechanisms governing the traits important in crop improvement. Drought causes severe yield loss in the PRC, the GMS and worldwide. Drought tolerance as a trait, however, has not been well defined. It is still not clear what aspects of plant morphology or physiology are most important for drought tolerance.

There is also a need for more germplasm. Appropriate germplasm has not yet been found for a number of important traits such as resistance to fungal diseases and resistance to a number of pests in crop species (for example, sheath blight of rice, scab disease of wheat, and yellow wilt of cotton). These have become devastating diseases in the GMS and worldwide, as have borer insects of a number of crops. International collaboration, catalyzed by internationally engaged universities in the U.S.A. and elsewhere and by international agricultural research centers, may have a crucial role to play in germplasm identification, exchange, and use.

3.1.6.2 Enterprise Development and Marketing

The seed industry in the PRC is very large. At the provincial, prefecture, and county levels, there are more than 2,690 seed companies. At present the greater part of the industry follows the usual governmental administrative structure, with elements at the national, provincial, prefecture/municipal and county levels. It is essentially an input support service to farmers. Certified seed is actually produced by the county seed companies and, in general, sold to farmers within the counties of production. Seed markets are segmented and only a small percentage of seed-company production enters the seed trade outside its county of production. A small percentage of certified seed is

also produced outside this structure by state farms, mainly for their own use with a minor surplus for sale to nearby farmers.

The government recognizes the crucial role of the seed industry in achieving national targets of grain production and agriculture production goals generally. For this reason, it sees the present structure of the seed industry, that allows low productivity, low quality, unresponsive, loss-making seed producers (side by side with much more effective units) to persist, as a major constraint. There is full recognition of the need for major steps in the direction of commercialization, if only to stop the drain on the budget from the need to cover company losses.

At present the commercial structure is pre-competitive, with each county seed company attempting to produce most of the varieties of seed used by county farmers. What specialization occurs does so because of the specialization of the county farmers. Economies of scale, the gains from trade and the stimulus of competitive markets are largely missing. Moreover, prices of major grain seeds are closely controlled through mandated, impossibly thin markups over costs of production. Given the general inefficiency of seed operations, these thin markups typically result in losses and in failure to make necessary investments. In contrast to major grain seeds, vegetable seeds now have no markup controls, and seed companies have recently been expanding production; and trade in these seeds, despite seed-company resource and management constraints, have been developing.

With a number of exceptions, the physical infrastructure for storage, seed processing and packaging is old, outdated, technologically inadequate, and poorly maintained. Marketing of seeds is rudimentary with most seed sold through township seed stations/extension centers in the county of production. Seeds available through these centers are typically limited in quantity and in the range of crops and varieties. One aspect of inefficient operation of seed companies is the government requirement that they hold overly large emergency stocks equivalent to some 15-20 percent of their annual turnover. They receive a direct subsidy for this.

Public/Private collaboration in plant biotechnology is unusual in the PRC because the private sector plays a very small role in the Chinese Agricultural Input industry. There are a few public-private collaborations and also some examples of collaboration between state-owned research institutes and state-owned commercial enterprises. Both types of collaborations could grow in the future if the government allows private firms to play a larger role in the input industries, intellectual property rights on biotechnology are strengthened, and regulations on biotechnology are rationalized.

Yunnan, PRC Recommendation #2. Because the challenges facing the PRC in enterprise development and marketing are a constraint to biotechnology development in the country and also affect it's role as a potential catalyst of biotechnology in the GMS it is **recommended** that investment be made in identifying priority actions that would be needed to ameliorate the situation.

3.1.6.3 Communication, Outreach and Public Awareness

A major constraint to the utilization of bio-engineered crops is the lack of extension mechanisms to take the products of biotechnology research to farmers. The PRC once had a network system to dispense agricultural technologies, seeds, and other related materials. But with the development of a market economy, the old distribution systems are gradually losing their effectiveness and are now evolving into profit-driven seed companies undergoing privatization. This may be a good movement in itself, but it may take several years for the system to become effective because of uncertain funding. Governmental support goes mainly to research with little left to support initiatives and startups of seed companies.

The PRC has received criticism from biotechnology opponents for not paying enough attention to biosafety, the environment, consumer and food safety, and the potential impacts of biotechnology on the PRC's future agricultural trade position.

However, the above perceptions regarding the PRC's position on agricultural biotechnology lasted for only a few years. In May 2001, the PRC's State Council decreed a new rule — Regulation on Safety Administration of Agricultural GMOs. And in early 2002, the Ministry of Agriculture (MOA) issued three detailed regulations on the biosafety management, trade and labeling of GM farm products. After these events, the PRC received more criticism than support from both proponents and critics of biotechnology. For example, biotech scientists and biotech industry representatives criticized the PRC's new regulations as too restrictive to provide a favorable environment for the development of biotechnology. They called the period following 1999 as the "winter of biotechnology." Alternatively, Greenpeace and environmental agencies continuously warned the PRC of the potential risks associated with GMOs.

International trade impacts occurred for both imports and exports. New regulations required importers of GM agricultural products to apply for official safety verification approval from the PRC's Ministry of Agriculture. Pressure was also raised on the export side. The PRC was frequently asked to certify that its agricultural exports to Japan and EU markets were free of GMOs. In addition, there has been growing criticism of the PRC's financial and institutional ability to label its GM farm products.

Additionally, the media has claimed that the PRC had reversed its former enthusiastic embrace of biotechnology by imposing extra restrictions on both domestic and imported varieties of genetically modified crops. These claims stated that the PRC made a decisive shift away from its intentions to become the developing world's leader in biotechnology. After 15 years of nationwide promotion of agricultural biotechnology in the PRC, the current policy debate appears confusing to many observers. The industry wonders whether the PRC will continue to advance its biotechnology, and some scientists question how to proceed in the near future.

Yunnan, PRC Recommendation #3. Because the PRC has vividly demonstrated the positive impact of GM crops on agricultural production and can thus serve as a model to other GMS countries in that respect, it is **recommended** that investment be made in

addressing aspects of communications, outreach and public awareness that are presently causing confusion in attitudes to biotechnology within the country and abroad.

3.1.6.4 Policy

Chinese policymakers are concerned about environmental and food safety in response to the debate on the potential risks of GMOs recently raised by the Chinese media. The debate in the PRC has involved scientists, government officials, and newspaper reporters; responses and reactions vary among stakeholders and change over time as more information becomes available on biotechnology. A consensus seems to be growing in the PRC that the most important task a scientist or biotechnologist can do is to reduce the potential negative effects and demonstrate the safety of GMOs.

In November 1993, the State Science and Technology Commission of the PRC issued the Safety Administration Regulation on Genetic Engineering, which was the first law on biosafety in the PRC. Based on this Regulation, three years later, the Safety Administration Implementation Regulation on Agricultural Biological Genetic Engineering was issued in July and entered into effect in December 1996 by the Ministry of Agriculture (MOA), PRC. In the same year (1996), MOA established the office of Genetic Engineering Safety Administration (OGESA) to regulate field trials, environment releases and commercialization of transgenic organisms in the PRC. From 1997 on, OGESA started to process biosafety evaluation applications twice a year. On May 23rd 2001, the Guideline for Biosafety Management of Agricultural GMO was issued by Government of the PRC. On January 5th 2002, MOA issued three managing documents according to the guideline. They are Biosafety Evaluation Regulation for Agricultural GMO's. Import Regulation for Agricultural GMO's and Labeling Regulation for Agricultural GMOs.

A number of national institutes under the Ministry of Agriculture, the Ministry of Public Health and the State Environmental Protection Agency have launched various biosafety programs, including capacity building for biosafety management and risk assessment, research studies on environmental safety and food safety, detection technology for GMOs and GMO products, and monitoring of international practices.

One of the major constraints to development and utilization of bio-engineered crops in PRC relates to intellectual property rights (IPR). The PRC does not yet have effective IPRs for large-scale biotechnology research to develop transgenic crops. Most of the bio-engineered crop plants developed to date involve complex IPR issues. There is a major shortage of experts with knowledge and experience in dealing with IPR issues. Scientists and breeders do not fully understand IPRs, which are often not recognized and honored.

Yunnan, PRC Recommendation #4. Because the PRC is seen as a potential catalyst for GMO research and development in the GMS and can be effective in this only if it builds its own IPR capacity it is **recommended** that an IPR workshop be held in the PRC (preferably in Yunnan) for scientists and policy makers.

3.2 Composition of the Panel

Ronnie Coffman (Chair and ADB Consultant)

Ronnie Coffman serves as Director of International Programs and Chair of the Department of Plant Breeding of the College of Agriculture and Life Sciences, Cornell University. Previous positions include Associate Dean for Research and Director, Cornell University Agricultural Experiment Station; and Plant Breeder at the International Rice Research Institute (IRRI). Coffman's work has been important to the development of improved rice varieties grown on several million hectares throughout the world. He has collaborated extensively with institutions in the developing world and has served as a board member for several international institutes. His Ph.D. is from Cornell and undergraduate work was done at the University of Kentucky, his home state.

K. Vijayaraghavan

Vijay is a Certified Management Consultant (CMC) and a Fellow of the ICMCI (International council of Management consulting Institutes), USA. He did his Masters and Fellowship in Public Accounting and Management Consulting with focus on Strategic and Technology management consulting. He is the Chief Executive of Sathguru Management Consultants Pvt Ltd, a large consulting firm with its base in Hyderabad in India. Sathguru advises Government organizations, Multilateral and bilateral development institutions, private enterprises and NGOs across the Asian region in several countries. Vijay is engaged in shaping number of policy initiatives in life sciences for India and is a member of some of the important national committees constituted for this purpose. Sathguru is an Associate of Cornell-in-India and Vijay is engaged in co-directing Cornell's program in India, which covers several other countries in Asia as well. He is the regional coordinator of the Agricultural Biotechnology support project II (ABSPII), funded by USAID and managed by Cornell University. In Asia, ABSPII has its jurisdiction over India, Bangladesh, Philippines and Indonesia.

Randy A. Hautea

Randy A. Hautea completed his Ph.D. in Plant Breeding from Cornell University, and his M.Sc. and B.S. degrees in Agronomy and Plant Breeding from the University of the Philippines Los Baños. He is currently the Global Coordinator and Director of the Southeast Asia Center of the International Service for the Acquisition of Agri-biotech Applications (ISAAA). ISAAA is an international not-for-profit organization engaged in facilitating the assessment, acquisition, transfer, and management of biotechnology applications for the benefit of developing countries, and operates principally in Southeast Asia and East Africa. Prior to joining ISAAA in 1998, Randy served as Director of the Institute of Plant Breeding, Philippines. He has also consulted with various organizations, and has been involved in several program reviews and assessments of international agricultural research centers of the CGIAR (ICRISAT, CIAT, IPGRI-APO, IRRI GRC).

Peter Gregory, Ph.D.

Dr. Gregory serves as Director for Biotechnology, International Programs, in Cornell University's College of Agriculture and Life Sciences. Prior to joining Cornell, Dr. Gregory led the biotechnology practice at Novigen Sciences International, a Washington, DC–based consulting firm that specializes in food and nutrition, agriculture, and environmental sciences. Previously he was a Senior Consultant at Jellinek, Schwartz & Connolly, Inc., an environmental consulting firm in Washington. Prior to his consulting activities, he was an Advisor in the Rural Development Department at the World Bank where he provided strategic guidance at the institutional and project levels on biotechnology. Before joining the World Bank, Dr. Gregory was the Deputy Director General for Research at the International Potato Center (CIP), Lima, Peru where he led the Center's global research, training, and international cooperation activities, with emphasis on blending biotechnology with the traditional genetic improvement of root and tuber crops. Dr. Gregory started his professional career on the faculty of the Department of Plant Breeding at Cornell University. His research at Cornell focused on mechanisms of crop resistance to pests and diseases. His teaching focused on the use of biochemistry and molecular biology in crop improvement. Ph.D., Plant Biochemistry, King's College, University of London, England, 1972. B.Sc. (Honors), Botany, King's College, University of London, England, 1969.

3.3 Terms of Reference

Agricultural Policy Advisor with expertise in Biotechnology

Background

The TA for Promoting Partnerships to Accelerate Agriculture Development and Poverty Reduction in the Greater Mekong Sub-region was approved in June 2003. The objective of the TA is to promote dialogue and strengthen cooperation between the Greater Mekong Sub-region (GMS) countries of Cambodia, Laos, Myanmar, People's Republic of the PRC, Thailand, and Vietnam in agricultural development. The TA activities will be implemented under the framework of the GMS Working Group of Agriculture (WGA), which has been constituted in January 2003.

The WGA is a forum for identifying and realizing opportunities to increase cooperation in agriculture among the GMS countries for poverty reduction, equitable and sustained economic growth, sustainable use of natural resources for agriculture, and ensuring that benefits of GMS infrastructure projects reach the rural communities. At the first WGA meeting, one priority area confirmed and reiterated was GMS cooperation in agricultural biotechnology. The Australian Centre for International Agriculture Research (ACAR)/ADB study on agricultural biotechnology in Asia completed in May 2001 outlines a number of areas for assistance including: (i) increase public awareness raising and understanding on biotechnology issues; (ii) strengthen policy and regulatory framework of biotechnology; (iii) expand capacity to undertake biotechnology research linked to small holders and poor farmers; (iv) addressing market failures and inadequate research in crops that would most likely benefit DMCs and poor farmers; and (v) maximizing private-public partnerships in biotechnology for the benefit of the poor farmers.

In order to develop concrete cooperation initiatives in agricultural biotechnology in the GMS region, the first step is to undertake a systematic assessment to determine the current status, identify and prioritize areas of assistance, and propose assistance packages for the GMS countries.

Objective

The objective of the assignment is to undertake a rapid assessment of current status of biotechnology, identify and prioritize needs in promoting biotechnology cooperation in the GMS countries. This would include proposing options of assistance packages for GMS countries.

Scope of Work

To achieve this objective the expert will focus on the following issues:

(i) Agricultural biotechnology development, acquisition, transfer and commercialization;

(ii) Investment in biotechnology to benefit small holders and poor farmers;

(iii) Institutional and regulatory framework that would ensure existence of a comprehensive bio-safety mechanism;

(iv) Human resource development initiatives that would provide quality life science personnel that would be engaged in biotechnology research, commercialization and risk assessment.

(v) Appropriate infrastructure that would provide a conducive environment within the country and regionally for carrying out research, commercialization and marketing of biotechnology derived food products.

(vi) Private sector participation to accelerate commercialization of biotechnology derived food products.

The detailed process of assessment will be developed in consultation with ADB, prior to the fielding of the expert, and taking into account individual country needs and the overall needs of the Mekong region. To support the assessment the following would be undertaken:

(i) Desk review of status of biotechnology in GMS countries.

(ii) In-country workshops in select countries to identify and prioritize the needs related to agricultural biotechnology. This will involve key policy planners, private sector enterprises, non-government organizations. In addition one-to-one discussion will be held with key stakeholders in each country.

(iii) An inter-country workshop with key stakeholders to discuss the overall scope and type of support that would benefit the GMS countries.

Expected output would be a report provided to ADB summarizing the current status of biotechnology in the region, and prioritized short term and longer term needs of the countries to promote investment in biotechnology to support food production and food security, especially of poor farmers. The draft report should be submitted to ADB for comments prior to finalization. The report should be finalized within 4 weeks of receiving comments. Copies of the report will be shared with the concerned GMS countries.

Period of assessment is expected from mid- October to end- November. The final report is expected mid-December, so that it may be presented at the meeting of the Working Group on Agriculture planned for January 2004.

3.4 Chronology of the Assessment

From November 3-5, 2003 one member of the assessment team participated in the 'Workshop on Agricultural Investment and Cooperation in the GMS' in Kunming, PRC. The workshop was organized by the Ministry of Agriculture, PRC and the ADB. The primary objective was to promote dialogue and GMS regional cooperation in agricultural investment, trade, and technology. Participants included Government Officials from GMS countries, representatives from the private sector and civil society, and ADB staff and consultants. The team member made a plenary presentation on 'Crop Improvement and Biotechnology: A New Era in Science and Policy' and also led a breakout group discussion on future of hybrid rice and biotechnology in the GMS.

Between November 12 and November 21 in-country workshops were conducted as follows:

- Bangkok, Thailand November 12
- Hanoi, Vietnam November 14
- Phnom Penh, Cambodia November 18
- Vientiane, Laos November 21

In each workshop representatives from governmental agencies, research and educational institutions, and the private sector (see Appendix --- for lists of participants) presented their perspectives on the national status of agricultural biotechnology and the goals and strategies needed to maximize benefits and minimize risks. Following these presentations workshop participants engaged in discussions to establish national priorities for policy and regulatory frameworks, research and education, and commercialization.

On November 24 a sub-regional workshop was conducted in Bangkok. Participants included representatives from Thailand, Vietnam, Cambodia, and Laos - who had participated in the country workshops - and a representative from Myanmar (see Appendix for list of participants). Presentations and discussions focused upon policy and regulatory issues, research and education, and commercialization with emphasis on ways in which cooperation could be fostered among the GMS countries.

A draft report was prepared and submitted to Ms. Juri Oka of ADB for comments and suggestions in early December. Valuable feedback was received from Ms. Oka on December 8. The final report was submitted to ADB on December 31, 2003.

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