Agricultural Biotechnology in Vietnam

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The Vietnamese government views agricultural biotechnology as an essential and important prerequisite to achieve national goals for food, feed and fiber production. Present activities which are quite limited due to lack of funding, facilities and human resources include tissue culture for micropropagation, virus elimination, somaclonal variation and anther culture. For livestock and poultry, diagnostics and vaccines are produced to detect and prevent diseases while embryo transfer has been utilized to improve breeds. Plans of the national government include investment of US$60 million (M) for the major institutions (Institute of Biotechnology and United Agricultural Laboratory) $20 M to strengthen other training and research centers, $2.5 M for overseas training, and 25 B DVN for R & D programs and 2 B DVN for information and libraries. Among the priority researches identified concern genetic modification of important crops such as rice, maize, potato, sweet potato etc for pest/disease resistance, abiotic stress tolerance etc., to help achieve food security in the future.

Introduction

One of the greatest achievement that served as the basis of economic transformation in Vietnam has been the phenomenal increase of research-based agriculture productivity. From 1990 to 1995, production of food crops, including paddy/rice, maize, sweet potato, cassava, and potato, in paddy equivalent, increased from 21.98 million tons to 27.55 million tons, posting an average annual growth rate of 4.3 percent. This growth rate far exceeded the population growth rate of 2.2 percent during the same period and led to significant increase in per capita food availability as well as surplus for export. The excellent performance of the agriculture sector in this period had set a firm base for obtaining a 4.5 - 5.0 percent annual growth to 2000 and higher to 2010 (Fig.1).

Many of the opportunities for opening new agricultural technologies to cultivation have already been exploited. This is especially true for Vietnam, where there is already very little uncultivated land left to bring under the plough. Among the applied technologies, biotechnology has made a significant contribution and has been judged as critical for increasing crop production to satisfy the increasing domestic needs, to meet new export market demands, and, to a certain extent, conserve natural resources by developing improved and more sustainable agricultural systems.

The role of biotechnology in agriculture development has been marked by many efforts from the governmental and ministerial levels to the policymakers and scientists. A National Council on Biotechnology was established under the chairmanship of the head of the Department of Fundamental Sciences of the State Committee for Sciences in 1991. In addition, a national program on agro-biotechnology was established to: (1) improve and produce biomaterials for agriculture; (2) improve quality and productivity of

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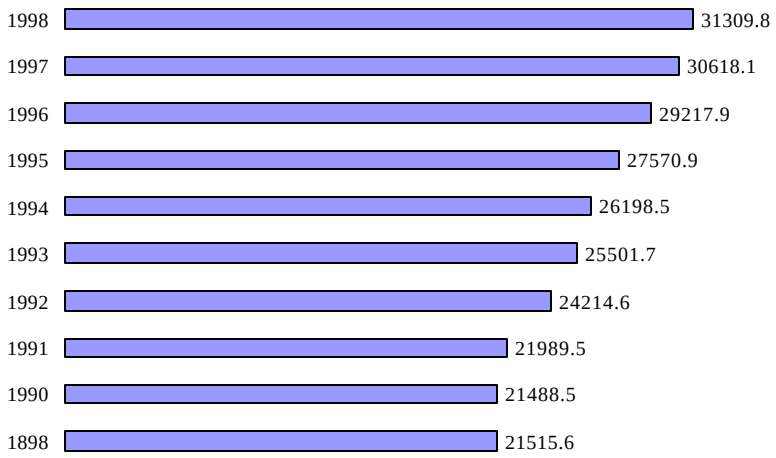
crops and livestock husbandry; and (3) conserve biodiversity and protect the environment. Specifically, the program recognizes the need for genetic engineering, plant cell technology, and DNA recombination techniques as prerequisite technologies for agricultural productivity.



Data source: Socio-economic statistical data of 61 provinces and cities in Vietnam (Statical Pubishing house, 1998)

Figure 1. Agriculture production (in thousand tons).

Current Status and Constraints

Organizations

Vietnam has assigned the highest priority to agri-biotechnology. Government policy views it as an essential and increasingly important prerequisite to achieve national goals and objectives for food, feed, and fiber production. Accordingly, substantial resources have been devoted to build capacity in several national institutions. The main institute for biotechnological research is the Institute of Biotechnology (IBT) at the National Center of Natural Science and Technology, followed by two research institutions belonging to the Ministry of Agriculture and Rural Development (MARD), namely: Institute of Agricultural Genetics (IAG) and Institute of Agricultural Sciences (IAS). In the universities, new courses specializing in genetic engineering and biotechnology began to be offered. Establishment of genetic engineering research centers within the universities have also been started.

Research institutions are still scattered and are not integrated. The research works are not always coordinated. These lead to difficulties in proper planning and management of government investment in all aspects (research facilities and personal training). As a result, there is a lot of duplication of research efforts, which are wasteful.

Investment

The international benefit of biotechnology to agriculture production has drawn more attention from the government, policymakers, and scientists to the biotechnology R&D program. Even if the master program for biotechnological development has not

been approved, the Ministry of Science, Technology, and Environment (MOSTE) and related ministries and local government units have explored capital from many sources for biotechnology investment. Several plant tissue culture laboratories have been set up in many provinces to meet the requirement for quality, quantity, and productivity of vegetative crops (Table 1).

Table 1. Biotechnology investments in different provinces in Vietnam.

Provinces	Budget (USD)	Year
Laocai	30,000	1995
Caobang	30,000	1995
Nghean	30,000	1995
Thaibinh	30,000	1996
Kontum	30,000	1996
Hatinh	110,000	1996-1998

The support for basic research is also expanding. In the period 1994-1996, MOSTE has funded several activities in three research institutes (Table 2).

Table 2. MOSTE funding in three Vietnamese Research Institutions, 1994-1996.

	Institutions	Budget (USD)	Activities
1	IBT	124 000	- Genetic engineering and DNA recombination laboratories - Fermentation technology complex
2	Biotechnology Center, Vietnam National University	5 000	- Enzyme-protein technology - Molecular genetic laboratory
3	IAG	3 000	- Molecular biotechnology laboratory - Tissue culture and cell technology

Nevertheless, the government's capital investment for biotechnological research and development remains unappreciated, compared with other countries in the region. Apart from several billions of Vietnam Dong in the period 1991-1995, there is no more foreign investment for research. At present, only about one percent of the national budget is spent on agriculture research in all aspects. It hardly covers 30 percent of the total requirement. Also, there has not been adequate international support in this regard, except for purchase of equipment on a small- scale level. This leads to the inadequacy, backwardness, distraction, and un-synchronization of research facilities. The backwardness is also seen in the lack of policies and available services to meet the requirements for equipment, chemicals, information, and international relations.

Manpower

Human resources are also an important factor for facilitating technology transfer and adaptation. The government is taking the necessary steps to ensure that the target will be met, including a significant investment in human capital that will build a sustainable capacity in biotechnology in Vietnam. Local universities have opened biotechnological courses for biology and agriculture students. In recent years, we have had more than 200 scientists involved in R&D biotechnology. However, at present, there

are not enough capable scientists with adequate exposure to advanced biotechnology, especially in genetic engineering, which is a promising trend in agro-biotechnology. In addition, they lack of opportunities for interaction with national and international research scientists and organizations. Therefore, many of them remain deprived of the new basic knowledge to undertake fundamental and adaptive research. The lack of appreciation and recognition of good work does discourage the creativity of the scientists.

Research and development

Vietnamese agro-biotechnology is largely at the stage of improving technology imported from the advanced countries. The conventional technologies such as *in vitro* micropropagation, virus elimination, somaclonal variation, anther culture, and haploid lines effectively improved crop productivity over the past decade. Production of diagnostic and vaccines to detect and prevent livestock diseases and pathogens, and reproduction of domestic animals (embryo transfer) have also been applied for a better husbandry.

Gene transfer to breed disease and pest-resistant varieties, as well as plants tolerant to adverse environment conditions is being pursued. The development of transgenic crops for the potential control of viral and fungal disease is not completely developed, but already tested at laboratory levels. Various interesting genes have been cloned or imported from other countries (Table 3) and advanced techniques have been practiced extensively in research institutions (Table 4).

Table 3. Useful genes used in Vietnam's laboratories.

	Gene	Expression	Origin
i Plants			
1	Cry IA (a, b, c, d)	Insect resistance	Ottawa University, Canada
2	GNA	Bacterial resistance	John Inne Institute, England
3	Xa21	Bacterial resistance	UC, Davis, USA
4	Asp1	Increase store protein	Demegen, USA
5	Chitinase	Fungal resistance	UG, Belgium
6	P5CS	Drought tolerance	VUB, Belgium
7	OAT	Drought tolerance	VUB, Belgium
8	HAL	Drought tolerance	PUV, Spain
9	Nha	Salt tolerance	PUV, Spain
10	Bar	Herbicide tolerance	PMB, France
11	Dhpds	Drought tolerance	VUB, Belgium
12	CP	RSV resistance	IBT, Vietnam
13	ACC antisense	Increase shelf-life	IBT, Vietnam
14	Chil442	Chilling tolerance	IBT, Vietnam
15	Tps	Drought tolerance	PUV, Spain
16	myb family	Rice crop improvement	NIAR, Japan
ii) Animal and Env			
17	Growth hormone	Growth control	Berlin, Germany
18	CryIII	Mosquito larva killing	IBT, Vietnam ICGB, India

Table 4. Application of molecular biological techniques in Vietnam.

Traits	Techniques	Institution
1) *Livestock husbandry*		
Disease- resistant gene for pig	PRC	Institute of Livestock Husbandry
Milk- related genes	PCR gene, k-casein and β-lactoglobulin	IBT
Determination of cow gender	PCR	IBT
Samonella infection	PCR	Institute of Food technology
2) *Biodiversity and environment*		
Animal and plant species classification	Gene sequence analysis	IBT
Biodiversity of rice	PCR, SSR, Waxy gene comparison	Rice Research Institute (RRI) IAG
Genetic diversity of alga	Molecular marker	IBT, VNU
3) *Crop improvement*		
Rice breeding	Tissue culture, RAPD	IBT
MS of rice	Gene mapping	IAG
Salt- tolerant gene of rice	Gene mapping	IBT

Biotechnology work on rice, being a very important crop in Vietnam, using both conventional and advanced methods, has been carried out in various research institutions (Table 5).

Table 5. Rice biotechnology in Vietnam.

Technology	Institution
Anther culture for DH lines	ITB, IBT, AGI, RRI, CPRI, INSA
Somaclonal variation selection for stress tolerances	IBT, AGI
Three-line technology for hybrid varieties	HAU, INSA, AGI, CPRI, RRI
Lingage mapping for chilling and drought tolerance	IBT
Gene transformation for pest and disease resistance	IBT, AGI, ITB

Planning for 2000-2005

Strategies:

- Commit to sustainable agriculture development and protection of the environment.
- Improve international networking with applied research institutes and encourage foreign investment in agro-biotechnology to facilitate the transfer of technology.
- Improve research facilities, particularly applied research, aiming at adapting international technology to local needs.
- Rationalize the number of research institutes, improve coordination of research, and increase training staff.

With such strategies, the Vietnamese government has a plan to invest $60 million to IBT and United Agricultural Laboratories and to spend $20 million to strengthen eight training centers (H-VNU, HCM-VNU, Hanoi Technology University, HCM Technology University, HAU), $2.5 million for overseas training, 25 billion DVN for R&D programs, and 2 billion DVN for information and libraries.

The first priority during this period has been given to crop biotechnology focusing on the improvement of genetic modification of basic crops such as rice, maize, root crops and tubers, soybean, sugarcane, cotton, and fruits and vegetables (Table 6) to achieve food security in the future.

Table 6. Crop biotechnology priorities of Vietnam.

Crops	Biotechnology
Rice	Hybrid, gene transformation
Maize	Diagnosis
Potato	*In vitro* tuberization
Sweetpotato	BT transgenic plants
Casava	Propagation
Soybean	Abiotic stress tolerance, Rhizobia strains for Mekong Delta Soil
Sugarcane	Germplasm, progagation, ruster and stem borer resistance
Fruits and vegetables	PSV resistance (papaya)
Cotton	Transgenic BT plants

Conclusions

Even with limited funding, facilities, and biotechnology-experienced scientists, Vietnam has recognized the important role of biotechnology in the development of agriculture. It has started to increase the investment and encourage capable scientists to get actively involved in biotechnological research and development. So far significant results have been obtained.