## (8) 日本・ミャンマー合同ワークショップ「バイオインダストリーの発展」講演抄録

### (8)-1. Policy and Strategy on Biotechnology

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Biotechnology is highly multidisciplinary and in essence it implies the use of microbial, animal or plant cells or enzymes to synthesis, breakdown or transform materials. Biotechnology is not something new but represents a developing and expanding series of technologies dating back thousands of years. It is only relatively recently that these processes have been subjected to rigorous scientific scrutiny and analysis; even so, it will surely take some time for modern scientifically based practices fully to replace traditional empirism. For biotechnology to be commercially successful and exploited there is a need both to recruit a specialist workforce and also for the technology to be understood and applied by practitioners in a wide range of other areas including law, patents, medicine, agriculture, engineering, etc. Different countries have taken different institutional and strategic approaches to stimulating biotechnology. The institutional framework that is possible or desirable for a country depends on the size of the country, the strength of its science and technology sector, and its existing research infrastructure. Myanmar is currently developing a suitable national framework for biosafety. They are based on existing national regulatory systems and internationally agreed upon biosafety guidelines. All developing countries, including Myanmar when implementing the biotechnological techniques, should act according to the phrase "Think global but act local" taking into account the defects that could be caused by advanced technologies.

#### Introduction

Biotechnology is highly multidisciplinary; it has its foundations in many fields including biology, microbiology, biochemistry, molecular biology, genetics, chemistry and chemical and process engineering. While biotechnology has been defined in many forms, in essence it implies the use of microbial, animal or plant cells or enzymes to synthesise, breakdown or transform materials.

However, it should be recognised that biotechnology is not something new but represents a developing and expanding series of technologies dating back (in many cases) thousands of years, to when humans first began unwittingly to use microbes to produce foods and beverages such as bread and beer and to modify plants and animals through progressive selection for desired traits.

For biotechnology to be commercially successful and exploited there is a need both to recruit a specialist workforce and also for the technology to be understood and applied by practitioners in a wide range of other areas including law, patents, medicine, agriculture, engineering, etc.

The implementation of the new techniques will be dependent upon their acceptance by consumers. In the report of Advisory Committee on Science and Technology, it has been stated that 'Public perception of biotechnology will have a major influence on the rate and direction of developments and there is growing concern about genetically modified products. Associated with genetic manipulation are diverse questions of safety, ethics and welfare'.

Public debate is essential for new biotechnology to grow up and, undoubtedly for the foreseeable

future, biotechnology will be under scrutiny. Public understanding of these new technologies could well hasten public acceptance.

### Biotechnology and developing countries

Biotechnology has a dualistic character. On the other hand, it offers developing countries new ways of solving a number of major constraints and it also can contribute to their economic independence. On the other hand, its application or use can cause social, economic and ecological problems. Some of the developments in this field which could have negative effects on developing countries are substitution of traditional commodities, industrialisation of agriculture, and privatization of knowledge and technology. Most of these potentially negative developments have more to do with the world balance of power in technological advances than with biotechnology itself. However, the risks of genetically modified organisms (GMO's) are directly related to biotechnology.

The problems faced by several developing countries are essentially similar: lack of trained personnel, poor access to up-to-date information on new concepts and techniques, and weak infrastructure. In Asia, it is critical to ensure that export crops can compete with biotechnology - derived substitutes and that small farmers are not displaced by new technology.

Genetic modification (GM) of crops has other, more practical problems as well, because GM crops affect the environment by altering the genetic flow between species and changing insect species by introducing resistance genes. These issues can have a huge impact on our global community. Therefore, they must be studied extensively to determine the policy our governments should create regarding GM crops.

### Effects on people and the environment

Biotechnology can affect people and the environment everywhere, both in the developed and developing countries. However, because of their weak economic position and the absence of legislation, the developing countries are very apt to feel some effect particularly strongly. In many cases the application of biotechnology will involve the introduction of new or modified organisms into areas where they were not found in the same form or to the same extent before. The effects of this might include the following.

(1) disease in people, animals or plants;
(2) disturbance of ecosystems, e.g., elimination of natural populations, changes in natural cycles and in interactions between them;
(3) transfer of new genetic properties to other species;
(4) decrease of genetic diversity

Different countries have taken different institutional and strategic approaches to stimulating biotechnology. The institutional framework that is possible or desirable for a country depends on the size of the country, the strength of its science and technology sector, and its existing research infrastructure. The following are the major conditions for productive biotechnology programs:

(1) Close collaboration between new biotechnology and conventional agricultural research (especially plant breeding), to ensure that new techniques are taken through to new products and field application;

(2) Minimal duplication of expensive equipment and services;
(3) An effective working environment for well-trained scientists and adequate financial resources (Komen and Persley, 1993)

The possible institutional arrangements include:

(1) Establishing a national biotechnology agency to coordinate and fund biotechnology within existing institutions and to determine national policies;
(2) Stimulating research at designated centres of excellence;
(3) Creating a national biotechnology institute

Myanmar is currently developing a suitable national framework for biosafety. They are based on existing national regulatory systems and internationally agreed upon biosafety guidelines.

## Environmental sustainability

For any technology to be considered sustainable it must not degrade the environment through either the overuse of resources or the creation of unbearable ecological burdens.

All environmental biotechnology processes and products can have negative implications and such risks must be balanced against ensuring benefits. While such processes must always be put through risk assessment, it is clear that, in the light of legislative awareness and technological realism, a great amount of existing and forthcoming environmental biotechnologies should be capable of achieving maximum environmental safety.

The ecosystem must be protected from the adverse environmental effects associated with increased urbanisation and industrialisation. This will involve creative management of effluents and emissions, reducing waste generation and overall producing reliable and clean technologies where possible. Thus, there is now an increased awareness that rather than attempt to remediate after the process the problem should be tackled at source.

## Conclusion

Taking the discussed facts into account, all developing countries including Myanmar must be aware of advantages and disadvantages that could be caused by developing technologies and effective preventive measures should be first considered before implementing the assumed beneficial technology. In other words, the phrase 'Think global but act local' must always be in our mind and avoid the hazardous conditions faced in developed countries.

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## (8)-2. How will genome analysis contribute to the usefulness of biological resources? NITE-DOB's endeavor

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The National Institute of Technology and Evaluation (NITE) in more or less its current form was established in 1984 based on several original institutions the oldest of which was founded in late 1920s. Genome analysis was initiated as the first activity of its kind within NITE about ten years ago with an extreme thermophilic archaea *Pyrococcuss horikoshii*. Since then the genome analysis of a total of seven microorganisms has been completed and eight more are currently analyzed at NITE as shown in Table 2 .

### 1. Needs for biological resources and the establishment of NBRC

Generally speaking, it would be impossible to thoroughly understand the spatial and temporal relationship of all gene products within the living cells of any organism no matter how much molecular analysis is advanced. Also, no matter how chemical synthesis is advanced, it would be impossible to create novel substances without knowing the structure of natural compounds that can be identified in biological systems. Therefore, to collect, analyze and learn the functions of as diverse microorganisms as possible will be still very important and of high values not only for their industrial applications but also for scientific analyses.

Based on these notions and considering the importance of microbial genetic resources in the future development of related industrial sectors, the Japanese government decided to establish a central facility to maintain and exploit as wide variety of microorganisms as possible. Consequently, a biological resource center (BRC) named NITE-BRC or NBRC was established in 2002 in Kazusa, southeast of Tokyo, as an outstation of NITE. To cope with the new situation, part of NITE was reshuffled to establish Department of Biotechnology in 2003 that consists of three divisions.

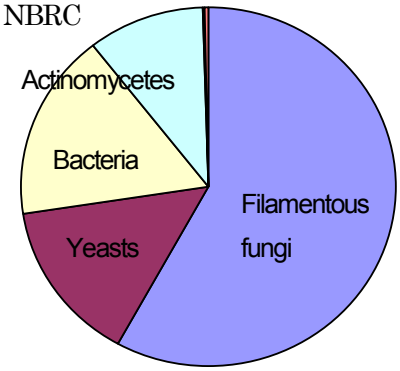
Before the establishment of NBRC, a culture collection maintained at the Institute of Fermentation-Osaka (IFO) contributed to the development of academic microbiology as well as setting the standard for various microorganisms used in industrial sectors. IFO was founded in 1957. Upon inauguration of NBRC, some 15,000 microbial strains stored at IFO were transferred to NBRC. Since then, NBRC has been putting efforts in increasing the number of microorganisms through exchanges between BRCs, deposits from individual organizations and scientists, NBRC-employees' own exploration from various natural sources including those in Asian countries, etc. Its current status can be compared with two other BRCs as shown in Table 1 with the percentages of organisms as depicted in Fig. 1.

Table 1: Comparison of three BRCs

| | NBRC | ATCC | DSMZ |
|---|---|---|---|
| Established in | 2002* | 1925 | 1969 |
| Microorganisms | P, E, V | P, E, V, Ma, Pt | P, E, V |
| Size of collection | 24,011 | 73,507 | 14,460 |
| Biosafety level | Up to 2 | Up to 3 | Up to 2 |
| Personnel | 80 | 250 | 78 |

* Its predecessor IFO was established in 1957.

Fig. 1: Classification of microorganisms maintained at NBRC




**2. Collaborations within Japan and with Asian countries in exploring novel microorganisms**

Microbial resources we plan to collect in the 1st term (FY2001-2005) are 30,000 microorganisms and 20,000 DNA clones, which will be increased to 70,000 and 30,000, respectively in the 2nd term (FY2006-2010). This is to enhance the status of NBRC to the level equivalent to that of ATCC and, at the same time, to enrich the variety and novelty of the collected microorganisms and DNA clones to meet the needs of industrial and academic researchers. At the same time, a 'virtually unified catalogue' of micro-organisms currently maintained in BRC's within Japan, in particular strains of taxonomical importance, will be constructed. Also, exploration of as many novel micro- organisms as possible in extreme environments and in less investigated habitats will be conducted.

Since 2003, we have been collaborating with Indonesian scientists to investigate and explore filamentous fungi and actinomycetes and re-located some 1,000 microbial strains in each year for further characterization that include screening of useful functions for industries. After such characterization, they will be incorporated into the NBRC collection for general distribution. Efforts will be continued with other Asian partners such as Vietnam, Myanmar, Thailand, China, etc. With the former two countries, we have started similar collaboration in this year. To pursue this line further, we have committed ourselves to play a role in the formation and administration of the 'Asian Consortium for the Conservation and Sustainable Use of Microbial Genetic Resources' or ACM in short and held the first ACM meeting on 9 October this year in Tsukuba on the occasion of ICCC-10. Delegates from Cambodia, China, Indonesia, Korea, Malaysia, Mongol, Myanmar, the Philippines, Thailand, Viet Nam and Japan participated in the meeting.

To examine the usefulness of the microorganisms thus collected and characterized at least partially, the micro- organisms will be distributed *en mass* for large-scale characterization of their functions. This will be performed on a trial basis by concluding a special contract with interested industrial companies and, if the attempt is successful, it will be expanded further in future. In this way, we are hoping to establish a BRC of multiple dimensions.

### 3. Genome analysis to enhance the usefulness of microbial genetic resources

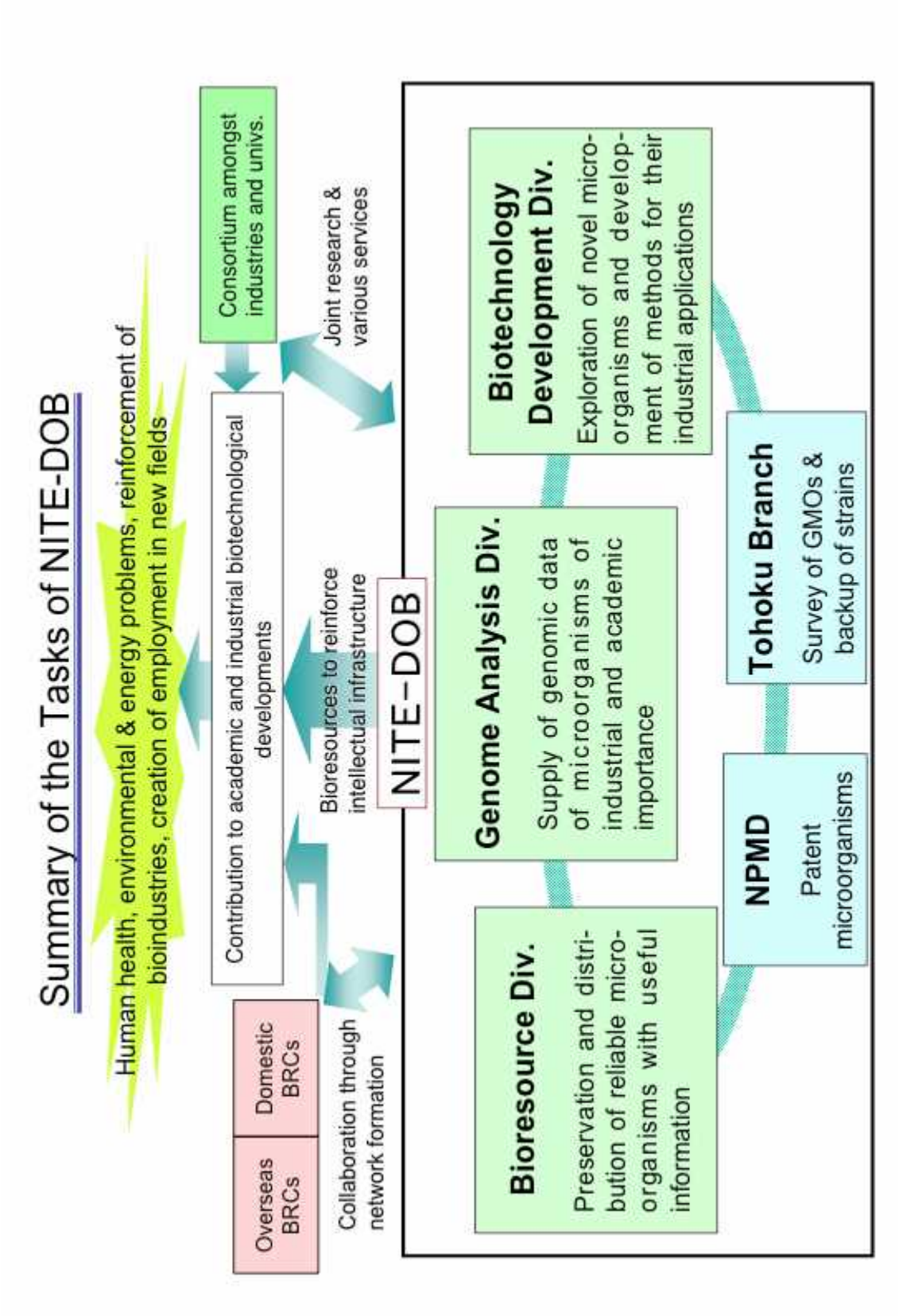
As described earlier, NITE-DOB was established on the basis of its efforts in genome analysis of microorganisms. Its main purpose has been to provide fundamental genomic information on individual microorganisms so as to enable their exploitation in many ways in the future. Until recently, the role of NITE-DOB in genome analysis has been limited to the construction of shotgun clones, their nucleotide sequencing and assembly of the sequence data obtained. Two categories of genome analysis will be conducted in parallel in the near future: namely, 'accurate analysis' and 'draft analysis'. The genomic data thus obtained will be combined with the proteomic and metabolomic data as much as possible and released to the public.

The genomes of more than 200 microorganisms have already been analyzed and several hundreds more are currently being analyzed in many institutes all over the world. By carefully scrutinizing the released data, however, it appears that those microorganisms whose genomes have been analyzed so far are taxonomically quite biased. Besides, the number of organisms that have been characterized so far is said to be less than 1 % of those in nature. Therefore, to enhance the possibility to obtain information concerning individual microorganisms so that we shall be able to exploit their functions of potential usefulness, more rapid analysis of the genomes of as many microorganisms as possible must be carried out. For this purpose, we have been seeking the way to conduct 'draft analysis' of the genomes of selected microorganisms, by investigating the steps in genome analysis so that sequence data of high quality with least statistical biases will be obtained. Table 2 shows the microorganisms the genomes of which are currently being analyzed at NITE. Except for a few gaps and/or difficult-to-read regions, many of their genomic data are more or less complete.

Table 2: Organisms whose genomes are currently being analyzed at NITE

| Organism | Size | Remark |
|---|---|---|
| *Streptomyces haemolyticus* | 2.7 | Resident on human skin |
| *Aspergillus oryzae* | 36.4 | Fermentation of sake, miso, soy sauce, etc. |
| *Brevibacillus brevis* | 6.4 | Easy to produce foreign proteins |
| *Desuolfovibrio magneticus* | 5.3 | A magnetic d-proteobacterium |
| *Rhodococcus erythropolis* | 6.5 | Resistant to organic solvents |
| *Micrococcus* sp. DC2201 | 2.7 | Can be a biocatalyst in organic solvents |
| *Rhodococcus opacus* | 8.5 | Similar to above |
| *Gemmatimonas aurantiaca* | 4.6 | A bacterium of a new phylum, involved in phosphate removal |

Based on the facts and data presented above, the activities of NITE-DOB can be summarized as schematically illustrated below.



## (8)-3. Japan's Bioindustry - Current Trend and Future Prospect

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What is JBA?

Japan Bioindustry Association (JBA) is a non-profit and public organization dedicated to the promotion of bioscience, biotechnology and bioindustry in both Japan and the rest of the world. Established through the support and cooperation of industry, academia and government, JBA is the only organization of its kind in Japan. JBA's roots date back 60 years to the establishment of the Japanese Association of Industrial Fermentation. Today, like its predecessor organizations, JBA functions as a think tank and platform for communication between scientists, technologists, policymakers and corporate managers.

The Japan's bioindustry market

In 2003, the bioindustry market in Japan was worth Japanese Yen (JY) 1,660 billion (approx. US$ 15 billion). It was a 15 % increase over the previous year. If conventional biotechnology products such as beer and sake were to be included, the market size would be four times larger (1). The bioindustry market has grown approximately eight-fold over the past 14 years since 1989 (Fig 1). Noteworthy is such a sustained growth that took place in the period during which Japan had been experiencing a prolonged economic recession.

In 2003, pharmaceuticals account for 33%, agro-products and foods for 26%, and chemicals (including enzymes) for 26% of the market. A number of the market segments that grew noticeably in 2003 include the following; biodegradable plastics (53 %); functional foods (24 %); and transgenic crops (23 %); and R&D support services (13 %) (2).

Pharmaceutical industry

The size of the Japanese pharmaceutical market in 2001 was US$46.2 billion which is 13% of the world market, which is the second largest in the world after that of the US (45%) (3).

Japanese pharmaceutical industry has been facing a number of challenges to their future development. To exemplify four of the main challenges; firstly, the Ministry of Health, Labor and Welfare (MHLW) has been continuing to lower official drug prices regularly to slow the increase of the medical budget deficit. Secondly, ICH guidelines that harmonize international pharmaceutical regulations have intensified competition within the Japanese market, because of intensified sales efforts by multi-national pharmaceutical companies. Thirdly, new good clinical practice guidelines have made it more complicated to conduct clinical trials in Japan. And fourthly, pharmaceutical companies have been obliged to increase their R&D expenditures dramatically since the advent of genomics.

Pharmaceutical companies in Japan have been coping with these challenges. They have been strengthening their R&D and sales capability at home and abroad through merger, acquisition, and other type of partnerships. They are steadily increasing their R&D expenditures. In 2003, the ratio of foreign to domestic sales substantially increased for companies like Takeda, Eisai and Fujisawa. All these trends seem to reflect a current outcome of the efforts by Japanese pharmaceutical industry to increase its

international competitiveness.

Agro-Foods Industry

In December 2002, Prime Minister Koizumi announced in Tokyo that the completion of the sequencing of the rice genome (japonica cultivar 'Nipponbare' variety). This signifies that a high-quality sequencing of the rice genome was achieved as part of the International Rice Genome Sequencing Project. The ceremony commemorating this event was attended not only by the 10 countries/regions of the consortium, but also by representatives of private companies (Monsanto and Syngenta). Japan contributed to the Project by analyzing 55 % of the main part of the genome (4).

Importation of recombinant crops (soybeans, corn, rapeseeds and cotton) to Japan has been increasing steadily. In 2003, JY 298 billion (approx. US$ 2.7 billion) worth of these recombinant crops were imported mainly from North America.

Functional foods are items such as cooking oil that is less fattening, foods that activate the immune system, and foods that help prevent cancer. Biotechnology has a potential to revolutionize the food industry by contributing to R&D of functional foods. Japanese consumers have been getting increasingly health conscious, and, in the light of this trend, the functional foods sector seems to have a bright future in the Japanese market.

Bioprocesses and environmentally friendly products

Japanese companies have strengths in commercializing microorganism- or enzyme-based bioprocesses for chemical, food and other industries. Noteworthy is that the market for industrial biodegradable plastics have recently started exponentially growing in Japan, particularly since 1998. Biodegradable Plastics Society (Tokyo, Japan) worked persistently for almost 15 years to lay the groundwork. The present market is mainly composed of poly (butylene succinate) (PBS), poly (lactic acid) (PLA), and starch blended with biodegradable plastics. Recently, Toyota Motor Co. started using PLA for the floor mat and the cover case for spare tires in their cars. Mitsubishi Chemical Co. and Ajinomoto Co., Inc. recently announced that they would synthesize their PBS from succinic acid derived from renewable resources.

In 2002, the ministry of agriculture, forestry and fisheries (MAFF) unveiled its BIOMAS JAPAN strategy outline. MAFF's immediate goals are to; 1) develop a system for the efficient production and collection of various types of biomasses, 2) provide assistance to the construction of advanced facilities and infrastructure, 3) explore ways in which to boost demand through early implementation by government agencies and other public organizations, 4) prepare for a smooth implementation of the Japan's Renewable Portfolio Standard Law, 5) standardize various types of biomasses, and consider methods for classification labelling, and 6) assess biomass risks and conduct demonstrations of model cases.

Biotechnology start-ups

Biotechnology-related start-ups are called 'bioventures' in Japan. The number bioventures in Japan has been steadily increasing according to JBA surveys. As of November 2003, 387 bioventures were operating in Japan. In regional distribution, the highest concentration (50.1 % of the national total) was in

Kanto district (Tokyo metropolitan area and the neighbouring prefectures), followed by Kinki district (Osaka, Kyoto and Kobe and the vicinity) (14.2 %) and Hokkaido (11.6 %). Kanto is home to the nation's highest concentration of companies. It is noteworthy that approximately one-third of all the bioventures are located in Tokyo.

Furthermore, law to corporative all the national universities took effect in April 2004, and the involvement of faculty members in entrepreneurship became deregulated. Consequently, the creation of spin-off bioventures is expected to increase nationwide in the coming years. With the number of bioventures increasing, their contribution to strengthening of R&D capability of Japanese bioindustry is likely to become more significant in the coming years.

Government initiatives

Due to a high longevity (the highest in the world) and a low birth rate, Japanese population is aging faster than other industrialized countries. The Japanese civil society has a tendency to respond sensitively to issues on safety and the environmental quality. Furthermore, Japan was experiencing a prolonged economic recession in the past decade. Under these circumstances, the Japanese government decided to put priority on biotechnology as an enabling technology to reinvigorate the nation's economy, as well as to emphasize the need for sharing enhanced common understanding of innovation processes with the civil society.

In July 2002, Japanese government launched the Biotechnology Strategy Council (BTSC). BTSC was presided over by Prime Minister Koizumi and consisted of seven Cabinet members and 12 experts from academia and industry. In December 2002, BTSC announced a comprehensive "National Strategy on Biotechnology" report containing 200-detailed action plans (5). The report specified responsible government agencies, implementation dates, and target deadlines.

While government's previous policies on biotechnology focused on science and technology, BTSC's plan addresses R&D, commercialization, and public understanding of biotechnology. Each of these three pillars of the strategy has its own action plans, which cover a wide range of issues. Under the auspices of the Life Sciences Executive Committee consisting of chairman of the Parliamentarians 'Promotion Alliance for Life Sciences', member of the Council for Science and Technology Policy – Cabinet Office, and chairman of the Japan Association of Bioindustries' Executives, 'Life Sciences Summit' has been convened every year since 2000 in order to discuss further the direction of Japan's biotechnology strategy, and to follow up on the implementation of BTSC's action plans. 500-600 participants comprised of parliamentarians, government officials, academics and industry leaders attended each summit meeting.

Future prospect of Japan's bioindustry

The industrial landscape in Japan will be quietly but steadily kept transformed by the penetration of biotechnology into existing industries, as well as by the creation of new industries that will emerge as a result of interaction between biotechnology innovations and existing technologies.

Existing industries — such as chemical, food, pharmaceutical, energy, paper & pulp, textile, information, electronics, and machinery — will become more sophisticated and environmentally friendly by incorporating biotechnology innovations. For example, the chemical industry is likely to undergo

transformation at three levels. Firstly, the industry will undergo raw material conversion from fossil feedstock to biological resources. Secondly, it will undergo process conversion from using chemical processes to using bioprocesses. Thirdly, it will undergo product conversion as it increasingly focuses on more knowledge- intensive and environmentally friendly products.

Biotechnology will revolutionize the healthcare industry. Firstly, biotechnology will help reduce the number of patients requiring acute care through advanced preventive medicine and functional foods. Secondly, personalized medicine will be able to improve health with fewer side effects and shorter hospital stays. As individuals' genetic information will play such an important role in this changing industry, developing of rules and systems is essential to ensure security and privacy protection of individuals' genetic information.

Japan has strengths in a number of areas of biotechnology, such as the sequencing of human full-length cDNAs (Japan contributed 60 % of the cDNA data) (6,7), single nucleotide polymorphisms (SNPs), glyco-chain technology and bioinformatics, in addition to industrial microbiology and enzyme engineering. Japan will have strengths in combining biotechnology with other advanced technologies, such as nanotechnology, robotics, and electronics to create a new generation of advanced technologies.

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## (8)-4. Legal and Regulatory Systems to Implement the Convention on Biological Diversity

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### Introduction

Environmental issues are global in the sense that people and nations are directly affected everywhere and environmental issue is commonly regarded as local, regional and may have international or global ramification.

Among other biodiversity provides the basis for the survival of human society and for their social and economic development. Conserving biodiversity and securing the sustainable benefits of its resources and services is an international task and essential part of global efforts for environmental protection and sustainable development.

Biological diversity is the variability of life in all forms, levels and combinations. It is not the sum of all ecosystems, species and genetic material. Rather, it represents the variability within and among them. "Biological resources" includes genetic resources, organisms or part thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity.

### Convention on Biological Diversity

Convention on Biological Diversity is a major development of international environmental law not only because it is the first treaty to deal with biological diversity *per se*, but also all the issues surrounding it in the innovative ways it approaches conservation.

Convention on Biological Diversity filled a gap in international law. It entered into force on 29 December 1993, only 18 months after it's signature, after having been ratified by thirty states as required by the convention. It's signature by 157 countries at the UN Conference on Environment and Development in Rio de Janeiro was evidence of Worldwide support for the conservation and sustainable use of genetic resources, species and eco systems and a recognition of their intrinsic value as well as other values for present and future generations/ The speed with which the Convention has entered into force is further proof of this Global concern.

The preamble to the Convention sets out the reasons for conserving biological diversity and the type of measures that should be taken to this end both for ecocentric and entropocentric purposes. It stresses that biological diversity has not only an intrinsic value, but also an ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic value benefit to present and future generations; biological diversity is necessary for the continuation of evolution and for the maintenance of the life-sustaining systems of the biosphere.

The conservation of biological diversity is therefore declared in the Convention to be a “common concern of humankind”, and the responsibility of States to conserve their biological diversity and use their biological resources sustainably is affirmed.

Article 3 outlines the three objectives of the convention: "the conservation of biological diversity, the sustainable use of its component and the fair and equitable sharing of the benefits arising out of utilization of genetic resources.”

We can see that the basic objective of the convention is threefold:

Conservation of biological diversity

Sustainable use of it's component and

Fair and equitable sharing of the benefits arising from the utilization of genetic resources.

Myanmar has ratified the Convention on Biological Diversity in 1994. Myanmar also acceded the International Trade in Endangered Species of Wild Flora and Fauna in 1997 and signed the Cartagena Protocol on Biosafety, 2000.

## Biodiversity of Myanmar

The greater part of the country has a tropical climate, while the coastal areas have a temperate climate. Myanmar has a wide variety of ecosystems such as land, mountain, forest, wetland, coastal and marine ecosystems. These various ecosystems provide the country with rich biological resources.

Myanmar, since time immemorial, has always been deeply committed to forest and biodiversity conservation and, as a consequence still possesses vast and varied natural forest rich in biodiversity. The forest flora is diverse, varying from sub-alpines on the snow-capped mountains in the north, through dry and moist deciduous to tropical monsoon forests in the south with mangrove along the coastal areas and coral reefs offshore. Myanmar is also home of teak which is recognized as one of the most valued and sought-after tropical timbers of the world and it is asserted that extensive and beautiful natural teak stands can be seen only in Myanmar today.

Myanmar has a long and rich tradition of biodiversity conservation. The wildlife sanctuary at the environment of Mandalay city, decreed by King Mindon in 1859 was the earliest wildlife refuge area in Myanmar. The Government is strongly committed to biodiversity conservation. Nature and Wildlife Conservation Division was formed within the Forest Department in 1981.

Myanmar is endowed with a rich biodiversity of habitat types arising largely from its unusual ecological diversity. There are more than 7,000 recorded plant species of which 1071 are endemic, about 100 species of bamboos, 30 species of rattan and 800 species of orchids. The diverse forest ecosystems in Myanmar are home to about 1,000 bird species nearly 300 mammal species and about 360 known species of reptiles. Myanmar is, therefore, often cited as the last frontier of global biodiversity in Asia.

Forests, wetlands including mangroves, swamp, lakes, marshes and seas provide a natural habitat for this large variety of biological species. Myanmar's rivers, numerous streams, creeks, lakes and seas also provide home for a large variety of fresh water and marine fish, shrimps and prawns species.

Myanmar also has rich mineral deposits including lead, silver, gold, zinc, copper, tin, wolfram, coal, gypsum, barite, limestone as well as precious stones such as ruby, sapphire, and jade. The country also has a large potential of energy resources such as hydrocarbons and a great potential of hydropower.

## Challenges and Strategies

Although Myanmar is rich in natural resources and, environmental degradation is still minimal, some of the resources are not renewable and the growth in population, industrial and economic activities will give rise to pollution, water and energy shortages, transportation problems, waste management problems and other environmental impacts. Preventive and remedial measures will have to be taken for the increased issues of the impacts on environment.

Most of the environmental issues found in Myanmar are similar to those of the other developing countries; such as- land derogation, deforestation and loss of biodiversity. Deforestation and the subsequent loss of habitat, hunting and poaching have threatened wild life and wild plants in Myanmar.

The Government of the Union of Myanmar is committed to achieving sustainable development in the country on the one hand, and as a party to a number of international environmental conventions is also committed to implementing global sustainable objectives on the other.

Since the Earth Summit in 1992, many sustainable development endeavours have been undertaken in Myanmar ranging from poverty alleviation to combating desertification, deforestation and loss of biodiversity. These important environmental initiatives are carried out in the country with its own resources as Myanmar has received only a nominal sum of financial resources from the international community. Multilateral and bilateral financial assistance has been inadequate for implementing Myanmar Agenda 21. Apart from the financial constraint there are other constraints such as lack of technology and human resources capacity for the effective implementation of global and national sustainable development programmes.

Economic, trade and political barriers also pose as major constraint for a developing country like Myanmar in its efforts to achieve sustainable development goals

Since Myanmar considers such a rich pool of biodiversity as an important national asset, the government of the Union of Myanmar has drawn up strict regulations to protect its reservoir of biodiversity and biological resources.

Myanmar's forest management system also promotes conservation of the environment, forest ecosystems and species. It gives least disturbance to biodiversity in the context of biodiversity conservation and sustainable forest development, three strategic approaches, namely, natural system, modified natural forest system and forest plantation system are being pursued.

Natural system is the formation of a network of protected areas systems. It plays a vital role in the management and conservation of the country's biodiversity. It will bring nationally important ecosystem, endangered species and natural historic sites under protection and management. It will also serve as a genetical storehouse and life supporting system.

Modified natural forest system is a mechanism to generate the sustainable forestry developments with least disturbance to the environment and wildlife.

Forest plantation system is aimed at meeting the growing socio-economic needs of the people by planting appropriate tree species at denuded and degraded forest land to attain high yield per minimum unit area.

The forest policy of 1996 has prescribed that 5 % of the area in Myanmar should be brought within the ambit of the protected area system. Human settlement, growing of food crops and commercial logging are prohibited in all the protected area. Increasing population is also threatening protected areas and species extinction.

Existing protected areas system does not cover the whole range of variation of the ecosystems and the species of actual or potential socio-economic value. The present protected areas need to be more broad-based and representative, comprising all natural ecosystems and this gap should be filled with the missing forest ecosystems such as dry dipterocarpus forest, mountain/alpine forests and coastal island

forest. There is also a need to protect freshwater wetlands and mangrove wetlands as they are among the most highly diverse, integrated and productive ecosystems of Myanmar and the major breeding ground for most of the brackish water fish. They also provide nesting sites for migratory birds.

The wildlife legislation declares complete protection for 39 mammals, 50 birds and 9 reptile species; normal protection for 12 mammals, 43 birds and 6 reptile species; and seasonally protected species include 2 mammals and 13 bird species.

Wildlife protection statute, which provides for plants and tree species to be categorized under different protection categories, needs to be carried out. Completely protected, normally protected and seasonally protected wildlife species being classified in an ad-hoc manner hampers effective management.

Myanmar has been divided into 9 bio-units each representing a different agro/eco-climatic zone. Protected forest cover area of 2% and are made up of 3 National Parks and 16 sanctuaries. There are 40 protected areas up to July, 2004; 23 wildlife sanctuaries, 7 national parks, 1 mountain park, 5 bird sanctuaries, 1 elephant range, 1 nature reserve and 2 protected area.

The National Commission for Environmental Affairs (NCEA) is the focal agency for Convention on Biological Diversity in Myanmar. For implementation of activities, the Ministry of Forestry is mainly responsible as the forest coverage is about half of the country's total area with abundance of wildlife species. Other relevant Ministries are Ministry of Livestock and Fisheries and Ministry of Agriculture and Irrigation.

Genetic diversity is the basis for all crops improvement programme. Various crop species such as rice, sesame, pulses and citrus have genetic diversities. Conservation of these genetic resources is of considerable importance for the present and future use in crop improvement programmes. The Seed Bank was established in the Central Agriculture Research Institute (CARI) in 1987.

The Forest Department under the Ministry of Forestry is responsible for biodiversity conservation in general and Wildlife Division under the Forest Department is responsible for the establishment of protected areas network and wild life management of the country in particular.

The major development in biodiversity conservation is the promulgation of the "Protection of Wildlife, Wild Plants and Natural Areas Law" in 1994. The new wildlife legislation as against the old has assumed the modern approaches in biodiversity conservation. The Law has greatly widened the scope of protection for wildlife including birds and mammals. The 1994 wildlife legislation declares complete protection for 39 mammals, 50 birds and 9 reptile species, normal protection for12 mammals, 43 birds and 6 reptiles species and seasonally protected species including 2 mammals and 13 birds. For conservation of biodiversity, mangrove ecosystems and fragile mountain ecosystem about 28 sanctuaries, 8 parks and 2 protected areas have been established in Myanmar.

**Environmental Policy and Law in Myanmar**

It is crucial that policy formulation and making of law must recognise the relationships between population resources, environment and development to achieve equitable, environmentally sound and sustainable development for the country.

Environmental law is one of the major tools for effecting environment management. It is impossible to cover all these vast areas of environment by single legislation.

The Environmental Policy

To coordinate environmental matters in the country, the National Commission for Environmental Affairs (NCEA) was established in 1990 under the Ministry for Foreign Affairs.

In accordance with its objectives, the NCEA formulated the National Environment Policy of Myanmar and the policy was proclaimed through the Gazette in accordance with the notification No 26/94 dated 5 December 1994, of the Government of the Union of Myanmar which reads as follow:-.

"With a view to establish sound environment policies in the utilization of water, land, forests, minerals, marine resources and other natural resources for conserving the environment and preventing its degradation, the Government of the Union of Myanmar here by adopts the following policy:

'The wealth of a nation is its people, its cultural heritage, its environment and its natural resources. The objective of Myanmar's environment policy is aimed at achieving harmony and balance between these through the integration of environmental considerations into the development process to enhance the quality of the life of all its citizens. Every nation has a sovereign right to utilize its natural resources in accordance with its environmental policies; but great care must be taken not to exceed its jurisdiction or infringe upon the interests of other nations. It is the responsibility of the State and every citizen to preserve its natural resources in the interest of present and future generations. Environmental protection should always be the primary objective in seeking development."

Myanmar also notified its Myanmar Forest Policy on 23 February 1996. It was issued in view of the importance of the Myanmar Forestry Sector in enhancing national socio-economic development, and formulated within the overall context of ecological balance and environmental stability, taking full cognizance of the forestry principles adopted at the United Nations Conference on Environment and Development (UNCED) in 1992.

The other ministries including the Ministry of Energy and the Ministry of Health, have also issued polices in which some provisions for protection and preservation of environment have been included.

A plan of action for sustainable development based on the Global Agenda 21 was prepared by the NCEA in cooperation with the ministries concerned, UNEP and ESCAP in 1995 and was published in 1997.

This plan of action entitled "Myanmar Agenda 21" aims at strengthening and promoting systematic environmental management in the country. The Myanmar Agenda 21 makes recommendations for the drafting and promulgation of National Framework Environmental Law, and Environmental Impact Assessment (EIA) Law for systematic integration of environmental considerations in the development process of the country.

Current laws relating Biodiversity

Myanmar has a number of sectoral laws which are related to environmental protection and conservation of natural resources. Some of these laws date back to the early 19th century. Although most of these laws were enacted for other objectives rather than for environmental protection, some provisions contain environmental elements.

(a) The Forest Law (1992)

After becoming a signatory state to the Biological Diversity Convention and the UN Framework

Convention on Climate Change, the provisions of the old Forest Act, 1902 was repealed and the Forest Law was enacted in 1992. The new Forest Law was enacted to be in line with the principles of the convention as far as possible.

The new Forest Law was enacted, *inter alia*, to implement the environmental conservation policy of the Government; to promote public participation in implementing the forest policy and environmental conservation policy of the Government; to carry out in accordance with international agreements relating to conservation of forests and conservation of environment; and to carry out simultaneously conservation of natural forests and establishment of forest plantations.

The new law deals with constitution and conservation of reserved forests and protected public forests, control and management of forest land, establishment of forests, plantations, rules and conditions for extraction and removal of forest produce, establishment of wood-based industry and matters relating to search, arrest and administrative actions. The Forest Department has been assigned by the Law to establish commercial forest plantations, industrial forest plantations, local supply forest plantations and village firewood plantations, forest plantations for environmental conversation.

Under the *Forest Law,* the Ministry of Forestry and the Forest Department are responsible for the successful implementation of the objectives of the Law. Hence, the Ministry of Forestry has already issued the Forestry Policy of Myanmar and has drawn up long-term and short-term plans for the forest sector including the plans for the greening of nine arid districts in the central region of the country.

Myanmar has also signed International Tropical Timber Agreement (ITTA) Geneva 1995 in the year 1996.

(b) The Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law, 1994

Another pertinent law is the Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law, 1994. Before the promulgation of this law, there was the Wild Life Protection Act enacted in 1936.

This Law was promulgated to implement the policy of the Government for protecting wildlife and wild plants, and conserving the natural areas. This new law is also one of the results of follow-up action taken by Myanmar after becoming a Sate party to the environment-related U.N. Conventions. i.e. 'Convention to Combat Desertification', the 'Convention on Biological Diversity' and the 'Convention on International Trade in Endangered Species of Wild Fauna and Flora'. The 'Convention on Biological Diversity' recognizes that a fundamental requirement for the conservation of biological diversity is the *in situ* conservation of ecosystems and natural habitats and the maintenance or restoration of viable populations of species in their natural surroundings. Site-specific conservation measure, usually in the form of protected areas, are an essential tool for this purpose.

The Protection of Wild Life and Wild Plants and Conservation of Natural Areas Law 1994 was enacted containing specific provisions for the protection and conservation of wildlife and wild plants, living and non-living organisms and migratory birds; to protect wildlife and wild plants liable to the danger of extinction and the habitat thereof; to contribute towards work of natural scientific research and to protect wildlife and wild plants by establishing zoological gardens and botanical gardens.

The law provided for the formation of a National Committee for the Protection of Wildlife and Wild

Plants and Conservation of Natural Areas with representatives from the relevant government departments and experts to give necessary advice for laying down relevant policies, supervising works relating to protection of wildlife and wild plants and conservation of natural areas. There are also some penalty provisions with fine and imprisonment for the violation of this law.

Other related Laws on Biodiversity

The Territorial Sea and Maritime Zones Law which defines and determines the maritime zone, exclusive economic zone and continental shelf was enacted in 1977. The Union of Myanmar has the right to exercise general or exclusive jurisdictions over these zones and the continental shelf in respect of preservation and protection of the marine environment, its resources and prevention of marine pollution.

Myanmar has ratified the United Nations Convention on the Law of the Sea on 21st May 1996 and International Convention for the Prevention of Pollution from Ships (London) 19731n 1988

In the Livestock and Fisheries sector, there are four existing laws
Law Relating to the Fishing Rights of Foreign Fishing Vessels (1989),
Myanmar Marine Fisheries Law (1990),
Fresh Water Fisheries Law (1991) and
Aquaculture Law (1989).

These laws were enacted to ensure sustainable use of marine resources. These Laws were enacted to regulate and control fishing in marine and fresh water fisheries in general, and to prohibit or prevent from doing the following acts in particular:
fishing by using explosives, poisons, chemicals or dangerous materials of like nature;
using prohibited fishing implements and fishing methods;
fishing of prohibited species and size;
disposing from aboard the fishing vessel, of living aquatic creatures or any material which may cause pollution of water and damage to fishes and marine organisms;
obstructing navigation and flowing of water or polluting the water; and
cutting undergrowth or setting on fire causing damage to habits of fish.

Myanmar Marine Fisheries Law enacted in 1990 is salient among the four fisheries laws enacted in Myanmar. The Department of fisheries, under the Ministry of Livestock and Fisheries, administers the implementation of the law. It also supervises fishing activities in Myanmar waters to prevent extinction of fish and for the sustainable use of fish and marine product. It is necessary to apply for license from the Department of Fisheries to carry out catching, breeding, exploring, research, seeding, propagating, processing, transporting, sorting and selling of fish etc. on a commercial scale. Inspectors of the department are authorized to inspect the fishing industries and fishing vessels for the compliance of licensee's conditions. Section 39 of the law provides:

"No person shall dispose of living aquatic creatures or any material into the Myanmar Marine Fisheries Waters to cause pollution of water or to harass fishes and other marine organisms."

The punishment for the violation of this section is kyats 10,000 confinement or imprisonment which may extend up to 1 year.

Aquaculture Law was enacted in 1989 to promote aquaculture systematically, Myanmar has ratified

Agreement on Networks of Aquaculture Centres in Asia and Pacific (BKK) 1988 in1990.

**Promoting environmental education public awareness and training**

Since 1993, under the aegis of the NCEA, nation- wide World Environment Day celebrations have been held, aiming at promoting public environmental conservation programmes. Environmental management training workshops and environmental seminars are frequently organized by the NCEA to disseminate environmental information and environmental management techniques in the country frequently organized by the NCEA to disseminate environmental information and environmental management techniques in the country.

Moreover University of Yangon has conducted two international conferences in the year 2002 and 2003. Some Universities in Myanmar are offering the degree of Environmental Studies at undergraduate and postgraduate level. At all Department of Laws of Universities offering the Environmental Law course as an elected course for undergraduate students.

The promotion of public environmental awareness among women is also being actively carried out by the Women and the Environment Subcommittee formed under the Myanmar National Working Committee for Women's Affairs. Women and the environment groups are formed at various levels from the central down to the village level. These groups are actively engaged and promoting environmental awareness and educational in the country.

**Conclusion**

Nature protection has been recognized as an urgent strategic task by Myanmar which has made clear that environmental protection and maintenance of the cycle of ecological equilibrium is one of the basic policies of its social and economic development.

Review and systematic analysis of the proposed protected area needs to be carried out to include the representation of ecosystems of the country for the preservation of biodiversity.

There is also a need to guarantee the permanence of existing and future protected areas and the improved administrative and management mechanism of such areas. Capacity building and manpower development in terms of skills, number and logistic support is also required.

Myanmar has ratified the Convention on Biological Diversity in 1994. Myanmar also acceded the International Trade in Endangered Species of Wild Flora and Fauna in 1997 and signed the Cartagena Protocol on Biosafety, 2000, Myanmar has promulgated

The new Forest Law in (1992) and The Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law, 1994 to be in line with the conventions.

The other 60 environment related sectoral laws are also existing in Myanmar even though they may not be directly concerned to the conservation of the living resources.

Most of these sectoral laws have been enacted for various purposes. Consolidation, implementation and compliance of these Laws still need to be strengthened. Nevertheless Myanmar has yet to enact the National Framework Law and the Environmental Impact Assessment Law which are now in process.

## (8)-5. Domestic Laws for Accesses and Benefit-Sharing

Dr. Hiroji Isozaki (Professor, Meiji-gakuin University, Japan)

Article 1 of the Convention on Biological Diversity (CBD), states that "the fair and equitable sharing of the benefits arising out of the utilization of genetic resources" is one of the three main objectives of the Convention. For that purpose, a set of Articles such as 1, 8 (j), 9, 15-6, 15-7, 19 provide for the benefit sharing. An assured benefit sharing could only be possible when the access to genetic resources is properly controlled. Thus, Article 15 sets out the principles that should underpin the implementation of this objective. Those measures necessary in achieving the access and benefit-sharing objectives have been considered at various meetings of the Conference of the Parties to CBD.

The Sixth Meeting of the Conference of the Parties, in the Hague, in April 2002, adopted the Bonn Guidelines on Access to Genetic Resources and Fair and Equitable Sharing of the Benefits Arising out of Their Utilization (Decision VI/24 A). These Guidelines are expected to assist Parties, Governments and other stakeholders in developing an overall access and benefit-sharing strategy, and in identifying the steps involved in the process of obtaining access to genetic resources and benefit-sharing. Parties, non-Party Governments and other stakeholders are invited to use the Guidelines when establishing legislative, administrative or policy measures on access and benefit- sharing and/or when negotiating contractual arrangements for access and benefit-sharing. It is recognized by Parties as a useful first step, but also considered to be in need of further refinement.

The Bonn Guidelines are not a complete set of necessary actions. Outstanding issues include use of terms and definition, compliance measures in user countries including prior informed consent (PIC), needs for capacity building to implement the Bonn Guidelines, as well as other approaches, which include model contractual agreements, existing regional agreements and model laws on ABS. And for implementation of the Guidelines, the following works are required: development of appropriate national regulatory framework, scientific and technical cooperation, information exchange, identification and dissemination of case studies and best practices, regional and sub-regional collaborative arrangements, coordination between multilateral and bilateral donors and other organizations, development of model agreements and codes of conduct, training workshops, and participation of all relevant stakeholders. In addition, means for assurance of sharing of benefit or the way of distribution need further negotiation.

In access to resources, relevant rights and traditional practices should be duly respected. To that end, not only the ownership, but also such other rights as stewardship, guardianship, communal rights or traditional knowledge should be recognized. Thus, the Bonn Guidelines refer to the role of intellectual property rights (IPRs) in ABS agreements. Its Section C, paragraphs 1 and 2, invite Parties and Governments to encourage the disclosure of the country of origin of genetic resources and related traditional knowledge (TK) in applications for intellectual property rights, where the subject matter of the application concerns or makes use of genetic resources or related TK in its development. Since IPR and TK issues have been discussed and negotiated in such other international organizations as WIPO, WTO (TRIPs Agreement), FAO and UNCTAD, further work is needed in collaboration with relevant organizations.

Laws at national and local levels are in the process of preparation and private contracts are also

going to be negotiated. Following the Philippines, Costa Rica, Brazil and India have adopted laws on biodiversity and established an Access control with PIC procedures. Enforcement of laws and contracts and fair and reliable dispute settlement mechanisms are other difficult subjects to be considered.

In Japan, although there is no general laws on biodiversity nor on ABS, several specific laws relate to biodiversity and biological resources, those include the Environment Conservation Law, the Natural Parks Law, the Birds and Mammal Conservation Law and the Endangered Species Protection Law. Among them, the Natural Parks Law prescribes that within designated conservation areas, activities harmful to the landscape of the park such as building and logging shall not be carried out without permit. Camp fires, and the collection of insects, plants, fallen leaves and branches are also prohibited in Special Protection Zones. Thus, any take and access to natural resources within the Special Protection Zones is prohibited. However, an effective enforcement measures are not provided nor an export control. Neither the PIC procedures are established.

Hence, an analysis and examination is necessary which aims to provide information and a decision-making tool to assist national governments in evaluating their options in light of their international obligations and their national situations, and to assist private entities of provider and user in negotiating mutually agreed conditions of material transfer agreement and benefit-sharing methods and dispute settlement mechanisms.

In considering the necessary measures for ABS, mutual benefit must be the central principle. It means that ABS measures should be of benefit to both the conservation of biodiversity and the sustainable use of its component, as well as to both provider and user, including relevant country, company and people. For that purpose, such measures should be on fair and equitable basis, with accountability and transparency. In developing such measures and system, as well as in the stage of their operation, among stake holders, user company plays the most important role.

## (8)-6. Beginning of Biotechnology Development Centre in Pathein University

Daw Aye Kyi (Professor and Head, Botany Department, Pathein University, Myanmar)

The Biotechnology Laboratory was established at the Department of Botany in May 2000 with the financial support of Ayeyarwady Division Peace and Development Council.

Since the establishment of the lab, cooperation with the National Institute of Technology and Evaluation (NITE) of Japan has increased steadily. Japanese scientists and officials from the National Institute of Technology and Evaluation (NITE) visited Pathein University to act as external examiners, hold seminars and discuss research co-operation and the signing of MOU with Pathein University.

36 researchers (including Master of Research candidates and PhD candidates) are currently doing microbiological researches in the biotechnology lab. The rise in the number of researchers, research activities and co-operative researches with NITE made it necessary for the construction of a new building for biotechnology research. The building was donated by Ayeyar-Shwe-Wah Co. Ltd and it put in service about the middle of May this year. The centregave the name as Biotechnology Development Centre (BDC).

Myanmar possesses a wealth of biological resources for those undertaking screening for new or unusual microorganisms and bioactive compounds from biological materials. Up to August 2004, 140 kinds of plant sources and 65 kinds of soil sources were studied. So many kinds of microorganisms (fungi and bacteria) were isolated from these sources. It was found that some microorganisms showed antimicrobial activities and some agricultural effects on crops and vegetables.

NITE and Pathein University signed an MOU and a Project Agreement on 26 March of this year and research activities are being boosted with the signing of the MOU.

Ministry of Education, Myanmar and National Institute of Technology and Evaluation, Japan Sign MOU

A Myanmar education delegation led by U Saw Lwin, Director General of the Department of Higher Education (Lower Myanmar) with U Cho, Rector of Pathein University and Dr Nyunt Phay, Associate Professor of the Botany Department of Pathein University as members visited Japan from 23-28 March 2004 at the invitation of the Japanese National Institute of Technology and Evaluation (NITE).

On 26 March, Director General of the Department of Higher Education (Lower Myanmar) U Saw Lwin and Director General of National Institute of Technology and Evaluation Mr. Masahiro Miyazaki signed a Memorandum Of Understanding between the Ministry of Education of Myanmar and National Institute of Technology and Evaluation of Japan on Joint Research Programme on Conservation and Sustainable Use of Biological Resources in Tokyo at the Department of Biotechnology, National Institute of Technology and Evaluation. Rector of Pathein University U Cho and Director General of National Institute of Technology and Evaluation Mr. Masahiro Miyazaki signed the Project Agreement between Pathein University of the Union of Myanmar and National Institute of Technology and Evaluation of Japan concerning joint research programme on conservation and sustainable use of biological resources. After signing MOU, Japan and Myanmar Scientists went to Bagan, Nyaung Oo, Mandalay and Pyin Oo Lwin for soil sampling in May, 2004. Second sampling on October and November, they went to Chin State and Ayeyarwady Division.

Japan scientists gave the workshop on Taxonomy and identification of fungi at two times in BDC. NITE supports the chemicals and apparatus to BDC for cooperation of researches.

## (8)-7. Overview of Myanmar-NITE Joint Research Project

Dr. Katsuhiko Ando (Director, -Department of Biotechnology, National Institute of Technology and Evaluation, Japan)

Myanmar-NITE Joint Research Project started on May 2004. In establishing the Project, both sides discussed what the Project should be regarding the CBD. On 26 March, 2004, NITE has signed a Memorandum of Understanding (MOU) with Myanmar represented by Ministry of Education, on joint research program on Conservation and Sustainable Use of Biological Resources. On the same day, NITE and Pathein University have reached an agreement of a Joint Research Project under the MOU after several discussions between both sides. Also a joint project committee was organized for promoting the programs of the Project. Any problems in accomplishment of the joint research shall be discussed at the committee meeting.

Both sides were interested in especially microbial resources in Myanmar. On May 2004, NITE researchers collected some samples in Myanmar together with Myanmar researchers and isolated microbes from the samples. From 8 to 18 May, 2004, 127 samples including soils, litters and intact leaves were collected at Bagan, Pin Oo Lwin and Pathein areas in Myanmar. From 70 soil samples, 818 cultures of fungi were isolated by soil dilution method. Those fungi were identified into 69 genera based on morphological characteristics. The dominant genera from the soil samples with high frequencies more than 10% were *Trichoderma, Aspergillus, Penicillium, Paecilomyces, Fusarium, Ochroconis, Cladosporium, Talaromyces, Acremonium, Chaetomium, Emericella, Myrothecium, Eupenicillium, Gongronella* and *Verticillium*. Also 53 genera including the genus *Curvularia, Chloridium, Gliomastix, Humicola, Absidia, Aureobasidium, Cunninghamella, Dactylaria, Graphium, Phialophora, Scopulariopsis, Sesquicillium, Acrophialophora, Alternaria, Geniculosporium, Metarrhizium, Microascus, Mucor, Nodulisporium, Pestalotiopsis, Scolecobasidium, Scytalidium, Stachybotrys, Arthrinium, Beauveria, Botryosporium, Chrysosporium, Cylindrocarpon, Doratomyces, Drechsrela, Geosmithia, Gonytrichum, Mariannaea, Menmoniella, Monodictys, Mortierella, Pochonia, Pseudobotrytis, Rhizopus, Torula, Torulomyces, Trichobotrys, Virgaria* and *Wardomycopsis* were isolated from the soil samples with frequencies less than 10%. From 10 litter samples, 130 fungal cultures were isolated by washing method and 44 genera were recognized. The dominant genera from the litter samples were *Alternaria, Dactylaria, Cladosporium, Curvularia, Fusarium, Idriella* and *Pestalotiopsis*, and the genus *Acremonium, Myrothecium, Nigrospora, Ochroconis, Penicillium, Trichoderma, Absidia, Arthrinium, Aspergillus, Colletotrichum, Drechslera, Epicoccum, Mucor, Phoma, Rhinocladiella, Rhizopus, Stachybotrys, Aureobasidium, Beltraniella, Bipolaris, Clonostachys, Cunninghamella, Cylindrocladium, Emericella, Geminoarcus, Gonytrichum, Isthmolongispora, Monacrosporium, Nodulisporium, Sublispora, Thozetella, Torula, Umbelopsis, Verticillium* and etc. were also observed with low frequency. From 47 intact leaves, 78 and 109 cultures of fungi were isolated by washing method and surface sterilization method, respectively, and 30 genera were recognized. The dominant genera from the intact leaf samples were *Colletotrichum, Cladosporium* and *Curvularia* with high frequencies more than 10%, and the genera of *Alternaria, Khuskia, Nigrospora, Pestalotiopsis, Arthrinium, Aspergillus, Fusarium, Trichoderma, Chaetomium, Dactylaria, Phoma, Rhinocladiella, Acremonium, Aureobasidium, Beltrania, Codinaea,*

*Cylindrocarpon, Dactylella, Menmoniella, Mucor, Stachybotrys, Tetraploa, Trichobotrys* and etc. were also observed with low frequency. From 18 of 70 soil samples, 38 fungal cultures were isolated by soil direct inoculation method and 14 genera including genera of *Arthrobotrys* and *Pythium* were identified. From 19 of 70 soil samples, 67 fungal cultures were isolated by baiting method using galleria and mealworm, and 19 genera including genera of *Circinella, Gliocladium, Isaria, Lecanicillium* and *Staphylotrichum* were recognized.

Ninety-eight genera were identified in 1240 fungal cultures isolated from all 127 samples collected in Myanmar from 8 to 18 May, 2004 by soil dilution method, washing method and surface sterilization method. Unknown fungi were also including in the isolates. Therefore, we shall continue identification work of them and make a list of fungi in Myanmar near future. Also, to expand sampling sites in Myanmar is important for the inventory work of fungi and other microbes to make a more correct inventory list. We believe the inventory list and the isolated cultures will be useful for developing biotechnology studies in Myanmar.

## (8)-8. Medicinal Plants

Dr. Daw Aye Kyi (Professor and Head, Botany Department, University of Yangon, Myanmar)

Myanmar due to its unique geographical position is endowed with rich diversity of flora and fauna, ranging from high mountain Himalaya flora in the north to the lowland wet tropical forest with Malayan flora in the south with dry, mixed deciduous, bamboos, evergreens and pine forests, including plains and valleys in between. A series of expedition and studies by botanists and foresters have recorded that there are around 7,000 species in 1987. Recently a revised checklist published in 2003 contains 273 families, 2,371 genera and over 11,800 species.

Medicinal plants are also included among these species and their traditional uses has flourished over many centuries since the time of Myanmar kings. A variety of traditional drugs has proven to be very effective and reliable. Recently the government has encouraged research and development of the practice of traditional medicine that can cure six diseases including malaria, diabetes, high blood pressure, pulmonary diseases, dysentery and diarrhea which are common in Myanmar. Internationally, herbal medicine is already providing its important role in providing health care services for the global community.

With a vision on the pressing need for scientific identification of the medicinal plants, the isolation of their crude drugs and their active principles have been conducted as a research program in Department of Botany, University of Yangon.

### Introduction

In 21st century, herbs which have always been the principal form of medicine in developing countries are once again becoming popular throughout the development world, as people strive to stay healthy in the face of chronic stress and pollution and to treat illnesses with medicines that work in concert with the body's own defences. The variety and sheer number of plants with therapeutic properties is quite astonishing. It is estimated that around 70,000 species from lichens to towering trees have been used at one time or another for medicinal purposes.

From the earliest times, herbs have been prized for their pain-relieving and healing abilities, and today we still rely on the curative properties of plants in about 75% of our medicines. Over the centuries, societies around the world have developed their own tradition to make sense of medicinal plants and their uses. Some of these traditions and medicinal practices may seem strange and magical, others appear rational and sensible, but all of them are attempts to overcome illness and suffering, and to enhance quality of life.

### Medicinal Plants and their Uses

Many of the thousands of plants species growing throughout the world have medicinal uses, containing active constituents that have a direct action on the body. They are both used in herbal and conventional medicine and offer benefits that pharmaceutical drugs often lack, helping to combat illness and support the body's efforts to regain good health.

The medicinal effects of certain plants are well known. *Senna*, for example, has been taken as a laxative for thousands of years, and *Aloe vera* was known to Cleopatra as a soothing skin remedy. It is only recently, however, that the active constituents responsible for the medicinal actions of plants have been isolated and observed.

## Traditional Medicine

Myanmar traditional medicine essentially herbal medicine began to be used alongside Western conventional medicine. The authorities aimed to provide the best of both worlds. One Institute of teaching Myanmar traditional medicine is established in Mandalay and is attached to 50 bedded teaching hospital where it was taught on a scientific basis. The aim of this Institute is to update and modernized the traditional medicine, to carry out research work, to produce skill researchers and to give effective treatment to local people. In addition great efforts were made to improve the quality of plant medicines contrary to the trend in conventional Western medicine that makes the patient even more dependent upon the doctor and high-tech machinery, Myanmar Traditional medicine like other forms of complementary medicine, stresses the patient's personal responsibility for his or her own cure, encouraging a holistic approach to treatment.

The government has a plan to open a University of traditional medicine in Mandalay which will confer Bachelor of Myanmar Traditional Medicine as a five year course including one year internship. As medical services there are two 50 bedded traditional hospitals and ten 16 bedded hospitals in Myanmar. In addition more than 200 townships traditional medicine department with its own out patient clinics are established in the country. There are two traditional medicine manufacturing factories, one is situated in upper Myanmar and the other in lower Myanmar.

The main task of research and development department in traditional medicine is to carry out analysis for traditional drugs for their registration purposes, quality control analysis for department owned drug production factories, disseminating uses of traditional medicine information through mass media and conserving old palm-leaves manuscripts regarding traditional medicine which are translated to Myanmar version.

## Research and Development of Medicinal plants in Yangon University

Research activities on medicinal plant were started since 1973 in Yangon University, when scholarship holders from abroad came home with advanced knowledge and technology. At that time only research program was undertaken for Master of Science Degree. As Botany Department was not well equipped with necessary glasswares and machines we have to collaborate with the other research institutions such as Central Research Organization (CRO), Burma Medical Research Institute (BMRI), Burma Pharmaceutical Industry (BPI), etc. During the year 1973 to 2000 more than (144) candidates have established their research work on medicinal plants.

Starting from the year 2000, Master of Research Degree and Doctoral Degree program were started in University of Yangon. Few candidates have already achieved their degree with medicinal plants and have promising results, which will be useful as a drug for the treatment of dysentery in Myanmar public. Many ongoing research on medicinal plants have been undertaken to investigate their active constituents

and pharmacological activity which will be beneficial for our mankind.

## Conclusion

In general, the herbs provide the starting material for the isolation or synthesis of conventional drugs. Reserpine which is used to lower blood pressure was isolated from *Rauwolfia serpentina* and contraceptive pill was synthesized from constituents found in wild yam *Dioscorea villosa* or *Costus speciosus.* The high cost of Western medical treatment is a factor that has encouraged people and governments to re-examine traditional healing. Although there were spectacular successes with modern chemical medicines, there were also horrific disasters, most notably the thalidomide tragedy in 1962.

This event marked a turning point in the public opinion of chemical medicines. People began to realize a serious cost with using modern pharmaceutical drugs and there is a great change in public perception of the value of using herbal medicine. Alongside physicians trained in conventional Western medicine there are medically trained traditional practitioners, medicine practitioners, local healers and homeopaths. Even significant increase in life expectancy in developed countries is starting to go into reverse, perhaps a results of environmental pollutants and toxic accumulation within the body.

Myanmar due to its richness in plant diversity should further investigate the medicinal plants from remote areas before they become extinct. Advanced technology is also essential for the conservation of rare and valuable species. Technical advice and funding support are also needed for the advance development of medicinal plants research.

## (8)-9. Medicinal Plant Project in Myanmar

(1) Substitution of Medicinal Plant for Opium Plant in Myanmar

(2) Utilization of wild plant growing in native forest in Myanmar for the medicines

Motoyoshi Satake, Ph. D. (Ochanomizu University, Japan)

### (1) Substitution of Medicinal Plant for Opium Plant in Myanmar

Our NPO Myanmar Substitutionary Medicinal Project is active working in Myanmar Northern Highland, Kachin State.

Our purpose is the Cultivation of Medicinal Plant in the mountain part of illegal Opium cultivated aerial in Myanmar;

(1) Economical effect for the mountain purples to cultivate the medicinal plants and the fruit trees

(2) Stopping of burning out of natural forest for opium cultivation

(3) Conservation of wild medicinal plant

Teaching knowledge and more use of medicinal plant for public health

Active Report;

Record of Discussion between Ministry of forestry Myanmar and Ministry of Health, Labor and Welfare Japan on March 2001

Making the model garden in Kachin state on March 2001, Our Project Side is Kachin State of Northern East of Myanmar, Seilon village (alt.1,700 20ha) and Gaitei village (alt.1,200 10ha).

Cultivation of 100 kinds of medicinal plant on May 2001,2002

Sending the professional expert, Mr. Yutaka Agatsuma each 6 mouths, (2002-2004)

Publish the Medicinal Plant in Myanmar on February 2002

Symposium of MSMP Project in Tokyo (2002, 2003, 2004) and invited the several specialist in Myanmar Forestry.

Japanese Experts visiting on Myanmar and training technique how to cultivate the medicinal plant.( total 40 scientist and expert of members between 2001-2004)

What kind of Medicinal Plants is cultivated in Myanmar medicinal garden;

Japanese and Chinese medicinal plants and some them is useful in Myanmar

Valuable wild medicinal in Myanmar

Medicinal trees for conservation of forest

### (2) Utilization of wild plant growing in native forest in Myanmar for the medicines

(In Vitro Screening of Leishmanicidal Activity in Myanmar Timber)

What is leishmania

According to a report of the Japanese Ministry of Health, Labour and Welfare, Quarantine Station, several infectious diseases, such as malaria, cholera, Japanese encephalitis, bubonic plague, filaria and leishmania, are distributed throughout Myanmar (http://www.forth.go.jp). Malaria eradication is a priority.

Leishmaniasis is endemic in tropical regions. Leishmaniasis currently affects 12 million people in 88 countries. The disease is transmitted by small biting sandflies (Phlebotomus spp.). The first line drugs for treatment of leishmaniasis are pentavalent antimonials such as N-methylglucamine antimonate (Glucantime) and sodium stilbogluconate (Pentostam); however, these drugs are toxic and generally expensive. Cutaneous leishmaniasis is also found in Myanmar. Although some quinone derivatives are known as antiprotozoal agents, only a few with antiprotozoal activity have been extracted from heartwood (a rich source of quinone compounds). For these reasons, we focused our screening for antileishmanial activity on the heartwood constituents.

Timber samples in Myanmar

Timber samples in Myanmar were donated by the Ministry of Forestry in Myanmar. In general, woody plants biosynthesize defensive compounds within heartwood to protect the tissue against attack by pathogens, such as fungi and bacteria, and from oxidants.

Pharmacological properties of heartwood constituents

Several pharmacological properties of heartwood constituents (for example, antibacterial, antifungal, and antioxidant activities) that play a role in the defense of heartwood tissue have been reported.

Many quinone analogues have been isolated from the heartwood of woody plants and they are thought to function as free radical scavengers of oxidants.

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Result of leishmanicidal activities

Seventy-five Myanmar timber extracts belonging to 27 families were examined for their leishmanicidal activities.

Some timber extracts had significant leishmanicidal activity, especially extracts of Millettia pendula, which exhibited the most potent activity (MLC 3.1 μg/ml, MIC 1.6 μg/ml).

Other timber extracts showing potent activity include those from *Cedrela serrata, Cedrela toona, Cordia fragrantissima, Calophyllum kunstleri, Dalbergia cultrate, Grevillea robusta, Haplophragma adenophyllum, Michelia champaca* and *Tectona grandis*. From a literature search for reports on chemical constituents of these plants, most constituents were found to be quinone derivatives or some other compounds possessing unsaturated carbonyl groups.

Some timber extracts had significant leishmanicidal activity, especially extracts of *Millettia pendula*

Benth. (Syn. *M. leucantha* Kurz) (Leguminosae) (Entry No. 61; local name, THINWIN), which exhibited the most potent activity (MLC 3.1 μg/ml, MIC 1.6 μg/ml). Other timber extracts showing potent activity include those from *Cedrela serrata* Royle. (Meliaceae) (Entry No. 51; Local name, TAUNG-TAMA), *Cedrela toona* Roxb. (Syn. Toona ciliata M. Roem.) (Meliaceae) (Entry No. 63; Local name, THITKADO), *Cordia fragrantissima* Kurz. (Boraginaceae) (Entry No. 44; Local name, SANDAWA), *Calophyllum kunstleri* King. (Guttiferae) (Entry No. 57; Local name, THARAPI), *Dalbergia cultrate* Grah. (Leguminosae) (Entry No.70; Local name, YINDAIK), *Grevillea robusta* A-Cun. (Proteaceae) (Entry No. 18; Local name KHA DAW-HMI), *Haplophragma adenophyllum* (Wall.) Dep (Bignoniaceae) (Entry No. 37; Local name PETTHAN), *Michelia champaca* Linn. (Magnoliaceae) (Entry No. 43; Local name SAGAWA) and *Tectona grandis* Linn.f. (Verbenaceae) (Entry No. 22; Local name, KYUN).

*Millettia pendula* Benth. (local name, THINWIN): Isolations of several prenylated isoflavanones from root bark of the genus *Millettia* have been reported. From the heartwood of *M. pendula,* two isoflavane-quinone derivatives have been reported to date. Their chemical structures include a quinone moiety, and many leishmanicidal constituents from natural sources possess quinone moieties in their molecules. For this reason, it was presumed that this moiety was responsible for the leishmanicidal activity of this timber extract. It showed the potent activity (IC50 0.066(g/ml).

Finally, WHO (Traditional Medicine section) will be published the two guidelines for medicinal plant to include the biodiversity problem. The guideline of conservation of the medicinal plants and Guideline of Good Agricultural and Wild Collection Practice were discussed by WWF, IUCN, FAO, UPOF and NGO. I hope to use the guidelines for utilization of medicinal plants.

## (8)-10. Plant Sciences

U Zennith Oo (Professor and Head, Botany Department, Maubin University, Myanmar)

### Introduction

Myanmar is situated in the South East Asia with a total land area of 676,577 Sq Km with a long international border of 5,858 km sharing with Bangladesh, India, China, Laos and Thailand. Myanmar also has a coast line of 2,832 km and three major river systems, Ayeyarwady, Sittaung and Thanlwin running from North to South. These unique geostrastegic positions pose both an asset to and a liability for Myanmar. The topography and climatic conditions favored Myanmar to have diversity of florae and fauna. It endowed with a rich diversity of forest ecosystems which stretches from tropical evergreen forest habitat with Malayan flora in the South to snowcapped Khakaborazi Mountain with Himalayan flora in the North.

The rich biodiversity being natural heritage of the country deserve to be save guard for the benefit of both present and future generation.

A UNEP report on Global Biodiversity notes that the world's biodiversity is made up of million of microbial, plants and animals, species that inhabit the planet.

It is important to conserve these biodiversity within each species as insurance against future environmental changes or new human uses of these resources.

As the knowledge of microbiology and biotechnology become advance "bioprospecting" for potentially lucrative organisms could be well carried out for Bio-industry.

### Plant Science In Myanmar

The list of plants specifically recorded for Myanmar was first completed in 1912 by J.H face and published as the list of Trees, Shrubs, Herbs, and principle climbers which includes 2483 species.

The current research list contains 275 families, 2371 genus and over 11800 species recorded in Flora of Myanmar.

However, there is no record cataloguing the microorganisms and thus plant microbiologists are needed to fulfill the long term wide spread tasks in the country.

Plants which are beneficial to human kinds as food, shelter and clothing, the role of plant science is much important and indispensable for this country blessed with rich natural resources.

Moreover Myanmar is an agro-base country which depends on rice and vegetable as their staple food.

Because of the gradual increase in population in our country, the requirement of production and distribution of food have to be markedly increased.

Strains of high yield cereal and crop plants are genetically researched to obtain new strains of quality seeds and high yielding variety seeds. of local and foreign paddy, maize, beans and pulses sunflower and cotton. Adaptability and pest disease resistant research works are carried out to suit the ecological condition of specific regions and to improve quality and yield of agriculture products.

Good yield and high quality of edible plants can also be obtained through the feeding of fertilizer preferably the bio-fertilizer which are more effective and cause less side effects.

One kind of bio-fertilizer is now being produced at Daga factory located near Pathein Township, Ayeyarwady Division.

Various kinds of other foods and medicine are prepared through biotechnology. Variety of Micro-organisms with their specific raw material mostly plant parts can produce industrial products organic acid, alcohol, flavouring agents, vitamins, medicines including antibiotics, pharmaceutical products, and fertilizers.

## Plant Science In Botany Department

Research work concerning with various discipline of plant science in different levels. M.Sc, M.Res, Ph.D and others are carried out at the Botany Department. If has been recorded as follow;

| | |
|---|---|
| Pharmacognosy | 1-134 |
| Morphology and Anatomy | 144-252 |
| Taxonomy | 253-359 |
| Fungi | 360-373 |
| Genetics | 370-383 |
| Tissue Culture | 384-455 |
| Industrial Microbiology | 456-555 |
| Algae | 556-560 |
| Plant physiology | 561-570 |
| Agriculture | 571-572 |
| Ecology | 573-617 |
| Geobotany | 618-622 |

Due to the limitation of laboratory equipments and other facilities some research works had to be done cooperatively with other departments such as central Research Organization (CRO), Agriculture Research institute (ARI) Forest Research Department (FRD), medical Research Department (DMR) and Development Centre of Pharmaceutical Department (DCPD).

Most of the pharmacognostic studies and research works had been conjointly under taken at DMRI, CRO and DCPD and Myanmar Pharmaceutical factory (MPF).

Endophytic research works are now carrying out at Botany department, Pathein University, Botany department of Yangon, Mawlamyine, and Sittwe Universities are collectively doing research on Mangrove area which is one of the socio-economic aspects in Myanmar.

## Conclusion

Since Myanmar aim is to build a modern Developed nature thorough Education and Technology, the challenge of 21$^{st}$ century have to be faced by using the advance knowledge and technicality of advance methods of biodiversity conservation, biotechnology, computer sciences as well as information Technology.

Although on going research works are undertaking in various discipline of plant science, with so many natural resources left to study in the country more advance research work should be extensively carried out.

Up to date and informative literatures, advance facilities and equipment and proper laboratory are

the most essential for further research work.

Hopefully these problems encountered during these days would be solved in the near future by the establishment of Biotechnological centre at Pathein University.

## (8)-11. Highlights on the Collaborative Project on Crop Genetic Diversity between MOAI and a Japanese Forum for Plant Genetic Resources

Dr. Kazuo Watanabe (Professor, Tsukuba University, Japan)

### I. Backgrounds:

The research initiative has been started in 2002 as inter-academic organization collaboration at Japan, and formerly agreed with MAS (Myanmar Agriculture Service) - DAP (Department of Agriculture Planning) of MOAI (Ministry of Agriculture and Irrigation) in June, 2003 on the crop genetic diversity research collaboration between MAS-DAP & University of Tsukuba. Upon suggestion from MOAI, Japanese scientists made integration of information on the research interest and activities in Myanmar with respect to plant genetic resources, agriculture and biotechnology. Scientists over twenty research organizations in Japan are aware of activities each other and exchange the interest with Myanmar agricultural & biodiversity sciences.

### II. Interest and purposes

The general interests are:

1. Research and development on the conservation and uses of the agricultural genetic diversity
2. Sharing knowledge on the international interest on biotechnology and biodiversity
3. Basic knowledge sharing on biosafety, CBD, FAO IT and other international legal instruments and practical implementation
4. Enhance collaborative research with Myanmar organizations, particularly with Plant Biotechnology Laboratory, Orchid lab, VFRDC, CARTC, and CARI (Seedbank) - Ye Zin, with relevant consultation by the Academy, Department of Agriculture Planning, Myanmar Agriculture Service and Department of Agriculture Research under Ministry of Agriculture and Irrigation.

The research topics are:

a. Ex situ collection evaluation: information integration
b. Ex situ conservation promotion (tissue culture, diagnostics, population genetics)
c. On-farm diversity study
d. On-farm conservation case studies
e. Origin of diversity
f. Participatory understanding on the international interest such on LMO biosafety & IPR on biodiversity
g. Capacity building & technology transfer, emphasizing basic biotechnology knowledge
h. Access and benefit sharing case study (ies)

The specific research interests are:

i) House-commodity and under-utilized species are the main subjects within the context as well as rice as the major staple crop. Local root and tuber crops such as taro, sweetpotato, arrowheads, gingers as priority species, banana, mango and other tropical fruits that can be lead to cash-making and rural

development such as orchids are also the targets with relevant discussion with Myanmar partners.

ii) Supplying relevant information on the biotechnology, LMO biosafety and biodiversity to wide range of stakeholders in Myanmar for sustainable use of genetic resources. Preliminary evaluation of genetic diversity of selected crop species

### III. Present activities are:

1) Preliminary case study in in-situ conservation
2) Consultation on in vitro conservation
3) Germplasm health and small scale epidemic search
4) Preparation for fingerprinting important varieties
5) Capacity building in-house by seminar / workshop in Myanmar on basic biotechnology applicable for genetic resources studies
6) Invited training programs in Japan on biotechnology

### IV. Finding in research

1) Preliminary evaluation of ex situ field collection of banana, mango, ginger, turmeric, tomato: Diversity present and unique
2) Tomato and ginger at farmers' fields: There may be serious genetic colonization of foreign cultivars and incorrect orientation of their uses, which lead to rapid loss of on-farm diversity and adapted landraces.
3) Genebank (CARI and VFRDC): diversity maintained but genetics knowledge and capacity are needed for elaborating conservation and uses. Genebanks are important for supporting the crop diversity.
4) Plant health issues may considered seriously as in vitro materials often contain virus according to provisional survey by ELISA and NASH on potyviruses.

### V. Achievements in technology transfer and capacity building

1) Plant Biotechnology Laboratory is functional on PCR based molecular marker technology with three sessions of workshops and consultation on lab set up, research management and human resources development.
2) Several sessions biosafety issues to different level of officers at MOAI.
3) Gift donation of chemical reagents, consumable lab materials and equipments to VFRDC, Plant Biotech Lab and CARTC.
4) Gift donations of books. journals and electronic media to MAS, VFRDC, CARTC, Biotech Lab, CARI and YAU
5) Particularly YAU has received two shipments of bulk amount of scientific journals
6) A total of eight individuals from MAS, CARI and YAU were trained for two to eight months in Japan (U of Tsukuba and Chiba U) for basic biotechnology and biosafety

### VI. Future plans

1. In Myanmar

1) Specific on farm studies
2) Characterization of economically important traits
3) Cases in germplam enhancement
4) Further field trips on diversity study and collection
5) Assistance in institutional capacity development on genetic resources and breeding including biotechnology

2. Research assistance for Myanmar conducted in Japan
1) Taylor-made finger prints for specific landraces / cultivars, particularly on rice and fruits
2) Large scale diversity study by molecular markers

## VII. Consideration issues

1) Constant training needs in invested individuals, science & technology move fast and rejuvenation of knowledge is essential at a yearly-basis for successful jobs and institutional achievement.
2) Resources support provided for and by Myanmar.
3) Needs in a cohort of well-trained and highly-qualified scientists at Ph.D. level.: No Ph.D. who comprehends and guides the new holistic scenarios on the contemporary issues: more opportunity making for higher and practical education.
4) Increase opportunities in in-house training and research at lab worker level in Myanmar.
5) Joint exploitation of the extramural funding to achieve the above to the international sponsors.

## VIII. Acknowledgments:

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