General Discussion

Chairman : Seyama, N. (Japan) : The four following topics will be taken up in the general discussion : 1. A brief summary of the reports presented during the symposium will be outlined and some specific aspects will be discussed ; 2. Means of organizing cooperative networks to promote the development of technology for vegetable production will be considered; 3. Various aspects relating to the collection, preservation, characterization and utilization of genetic resources of vegetable crops will be discussed. This topic is indeed very important for breeding work because the lack of good cultivars is one of the major constraints on vegetable improvement, as mentioned in many reports ; and 4. Problems relating to the application and transfer of biotechnology or advanced techniques in the field of physiology, pathology, post-harvest technology, etc. will be discussed as some of these techniques may allow to alleviate some of the constraints on vegetable production, as emphasized in several presentations.

I will now briefly summarize some of the main problems brought forth in the presentations during the last three days, in focusing on the technical constraints on vegetable production in the tropics and sub-tropics. These can be grouped into four categories as fol lows : 1. Lack of good cultivars well-adapted to the tropics and sub-tropics. In this category we may include disease resistance, tolerance to various physical or chemical stresses, response to temperature and photoperiod as related to the development of crops, for example vernalization, flower formation, as well as constraints on seed production ; 2. Insufficient development of cultivation methods and production systems ; 3. Insufficient development of pest and disease control ; 4. Inadequate handling and inadequate transportation system of vegetable products.

Chairman : Imai, H. (Japan) : I would like to ask Dr. Midmore what is the main strategy adopted by CIP for the production of sweet potato, namely as staple crop, processed food product (snacks) or for industrial use. Are sweetlessness and control of the sweet potato weevil to secure quality the main priorities?

Midmore, D. J. (CIP) : Sweetlessness is not the main target in CIP's sweet potato breeding program. The main priorities are breeding of sweet potato varieties that can grow under dry and saline conditions and tolerate a tropical rainy season, including waterlogging. Emphasis should be placed on genetic diversity and agronomic practices that allow vegetables to grow during the rainy season. At CIP studies are carried out on screening for tolerance to waterlogging as well as on cultural practices such as the use of raised beds, etc. As for the sweet potato weevil, since the species occurring in South America are different from those occurring in Asia, a close cooperation has been initiated between CIP and AVRDC for the evaluation of germplasm. Screening of sweet potato for antibiosis toward the weevil in closed containers (South American species) has yielded positive results. The optimum strategy to overcome the sweet potato weevil is a combination of selection for genotypes that develop their roots deep in the soil and agronomic practices such as heavy earthing-up, The weevil is indeed very important in terms of reduction of quality of sweet potato roots.

Kobayashi, M. (Japan) : I consider that quality is very important for the consumption and increase of the area cultivated to sweet potato. To improve the quality of sweet potato as a vegetable, the control of the weevil is essential. Incidentally, in Japan, to increase the consumption of sweet potato sweetless varieties have been developed for processing as snacks. Also I would like to mention that more emphasis should be placed on quality improvement of vegetables as well as stable production under the tropical and sub-tropical conditions.

Chairman : Imai, H. (Japan) : Could I ask Dr. H. Kobayashi from AVRDC to comment

on those topics.

Kobayashi, H. (AVRDC) : Dr. Takagi is in charge of the research on sweet potato breeding at AVRDC. In Taiwan, the summer is very hot with abundant precipitation. Also typhoons hit the island resulting in flooding under which conditions sweet potatoes are growing. At AVRDC the breeding objectives include high protein content in relation to the carbohydrate content. Attempts are also made to use the edible parts of sweet potato as a source of food for human beings in the tropics.

Chairman : Imai, H. (Japan) : Can I ask Dr. Hanada to outline some of the constraints on the production of vegetables in the sub-tropics.

Hanada, T. (Japan) : In Okinawa the production of vegetables is easy in winter while in summer it is difficult due to the high temperature and strong solar radiation, occurrence of typhoons and high incidence of pests and diseases. As a result 80 to 90% of the vegetables consumed in summer are shipped from mainland Japan, resulting in a severe economic loss. To alleviate these constraints, research is centered on the development of cultivars that tolerate heat and pests and diseases. Also cultivars are introduced from temperate and tropical regions for adaptation to the sub-tropical conditions. Research on suitable methods of protection of vegetables against typhoons, insect attacks, strong solar radiation, stabilization of soil moisture, decrease of soil temperature by the use of cover materials (cheesecloth, plastics, etc.) is being promoted.

Chairman : Imai, H. (Japan) : We will now consider the next topic, namely the organization of cooperative networks for promoting the development of technology for vegetable production.

Chairman : Johansen, C. (ICRISAT) : I would like to ask the participants, in particular those from the tropical countries to indicate what type of cooperation would be most suitable to address the constraints on vegetable production. Should a formal international network on vegetable research and production be organized or would it be desirable to establish an institute dealing specifically with vegetable problems within the CGIAR system or should the existing institutes take on a vegetable mandate? May I ask Dr. Singh to describe the FAO effort in the establishment of a vegetable network in Asia and outline the current status and the future orientation of the activities of the network.

Singh, R. B. (FAO RAPA) : In 1986 and 1988 an expert meeting composed of members of 18 countries represented in RAPA who are heads of vegetable programs in their respective countries was held at the FAO Regional Office in Bangkok. As a result a non-formal regional network independent of government control and consisting of vegetable research institutes in the various countries of the region was eventually established as most of the problems faced and the solutions appeared to be common to the respective countries. The activities are as follows : 1. Information collection, collation and dissemination of genetic resources of vegetables ; 2. Germplasm exchange ; 3. Organization of sub-regional and regional or country-level training programs under the financial support of FAO ; 4. Support of national infrastructure for vegetable research and development (case by case basis). To this effect, a regional project with UNDP funding was formulated during the 1988 meeting in which 14 countries are scheduled to participate. In this regard, the cooperation from Japanese organizations and IARCs in the activities of the network would be greatly appreciated in order to increase the national capability of vegetable production and distribution in the region.

Chairman : Johansen, C. (ICRISAT) : Could I ask a representative from tropical countries who has problems is vegetable production to comment on the type of international cooperation that would be most appropriate.

Ram Phal (India) : I am pleased to learn that FAO has taken the initiative of organizing

a non-formal network on vegetable research and development. In addition, I would like to suggest that the mandate of AVRDC and the location of this center be modified for the following reasons : 1. When one considers that there are 60 varieties of vegetables including 40 that are grown on a large scale, AVRDC covers 3 crops of which only tomato is a major vegetable. Indeed Chinese cabbage is a commercial vegetable grown only in a few countries while sweet potato is not a typical vegetable crop ; 2. The location is not suitable for various objectives of vegetable improvement including heat and drought tolerance as well as resistance to pests and diseases. Moreover the agro-environmental conditions (dependence on dams) do not allow for research findings adaptable to a wider range of environments.

Nkansah, G. O. (Ghana) : The problems faced in some tropical countries are as follows : 1. lack of funds in the farming communities ; 2. Inadequate storage and distribution facilities lead to crop losses ; 3. Lack of irrigation facilities in rainfed dry savanna regions results in low yields ; 4. Inadequate cultural practices are due to the fact that there is a lack of extension activities. As a result, research results and technological innovations are not transferred to the farmers. Suggestions/solutions : 1. Implementation of joint programs/projects between some private institutions or AVRDC, FAO, UNDP and universities or research institutes in the tropics ; 2. Improvement of storage, distribution, irrigation and extension facilities by the provision of funds from developed countries.

Henry, G. (CIAT) : Various national programs, AVRDC, private institutions and the FAO informal regional network deal with activities relating to research and development in the field of vegetables. However there is a need for the establishment of a "formal" international center for research on vegetables. Since 1984 the Technical Advisory Committee of the CGIAR has put forward several proposals for the establishment of such a center within the CGIAR system. A final decision should be reached in the near future.

Chairman : Saxena, M. C. (ICARDA) : The time has now come to discuss in more detail various aspects relating to the collection, preservation, characterization and utilization of genetic resources of vegetables.

Many presentations highlighted the fact that improved varieties with a very high yield potential must be introduced in the production system to maintain the economic viability of production. Many of the varieties due to their high yield and quality parameters are replacing the land races and conventional varieties which may not be as highly productive but may harbour genes as a source of resistance to diseases and pests and unforeseeable disasters. There is a need to make efforts to collect, preserve, characterize and utilize these genetic resources of the 60 vegetable crops mentioned. It is important that this heritage available to mankind should not be lost as progress is made in terms of increased productivity. I would like to suggest that we discuss how we can ensure that these valuable resources from specific areas are actually collected, preserved, characterized and shared with those who want to use them.

Could I ask Dr. Singh to comment on these aspects as the FAO and IBPGR are involved in this effort.

Singh, R. B. (FAO RAPA) : There is a real danger of losing the indigenous variability along with the inevitable popularization of modern and hybrid varieties, (some of which produced in Japan) which are highly productive and cultivated over wide areas throughout the Region. While we have the advantage of growing more food and increasing both the productivity and quality of crops, at the same time, we should preserve the genetic resources and reduce the genetic vulnerability to diseases and pests associated with the uniformity of the modern varieties that are cultivated. In taking account of this situation, FAO and IBPGR set up several

regional networks in collaboration with South-and Southeast Asian countries, with Japan taking the lead in the collections in this region. These three sub-groups, namely the South Asian, Southeast Asian and Far-Eastern committees on genetic resources met in Tsukuba 5 or 7 years ago. They identified priorities for the collection and conservation of genetic resources of crops including vegetables. Through these efforts sizeable collections were made in these countries, for example in the Philippines, 6,000 accessions of vegetables have been collected. However presently priorities should involve : 1. Characterization of these collections ; 2. Elimination of duplications, as in the case of the winged bean collections, and filling the gaps in the collections ; 3. Place emphasis on the collection and characterization as well as exchange of information on wild species to secure a source of genes for resistance to diseases and pests ; 4. Consideration on quarantine problems in particular in the case of root and tuber crops. FAO is coordinating approximately 15 projects in the South Asian and Southeast Asian countries, each with a component on genetic resources. The IBPGR has its own programs. The CGIAR institutes also deal with this problem for their mandate crops. Japan is engaged in bilateral programs with several countries to assist them in building gene banks. It would be desirable to coordinate all these activities to develop national capabilities for vegetable germplasm research and development.

Kobayashi, H. (AVRDC) : At AVRDC, the collection of accessions and lines of pepper was started a few years ago on a small scale. Presently plans are being made for the collection, conservation, evaluation and characterization, distribution and establishment of regional or international networks in relation to data banks, in taking account of quarantine problems, for the genetic resources of other vegetables. However funding is the major constraint on the promotion of such activities.

Chairman : Saxena, M. C. (ICARDA) : It appears that major efforts have been made to identify the existing gaps in the collections and to avoid duplications. The most important problem is to identify the responsibility for the characterization of the resources for specific traits, i. e. resistance to biotic (pests and diseases mainly) and abiotic stresses to eventually distribute the materials. Screening techniques that are more reliable, more rapid to enable the handling of a large amount of materials need to be developed. Once the screening is completed, methods should be available to identify specific traits and genes. In this regard, bio-technological procedures could be applied. It may be appropriate to discuss who should take the responsibility for the characterization of germplasm. There are already various organizations in charge of such activities, including AVRDC, NIVOT, the National Bureau of Plant Genetic Resources in India. Are there any suggestions for the development of a common linkage in characterization and sharing of responsibility.

Ram Phal (India) : The National Bureau of Plant Genetic Resources in India is the largest organization in the country for the collection, evaluation and conservation of germplasm of various crops including vegetables. Also in India, the Indian Institute of Horticultural Research (IIHR) in Bangalore and the Indian Agricultural Research Institute in New Delhi have good facilities for the evaluation, maintenance and characterization of germplasm of vegetables. In addition, such facilities are also being developed at the recently initiated Project Directorate of Vegetable Research located in Varanasi. The facilities could be made available for the evaluation and characterization of germplasm of different vegetable crops for their agronomical characteristics and reactions to various biotic and abiotic factors.

Chairman : Saxena, M. C. (ICARDA) : In the case of genetic resources, areas of application of biotechnological innovations in the characterization of economically important genes need to be given increased consideration, for instance the application of Restriction Fragment Length Polymorphism (RFLP) technique in gene mapping and in following up the economically important genes in the breeding

program to enhance the efficacy of conventional breeding methods. In this regard it would be important to identify centers that can assume a leadership in these areas. Collaborative work between the centers of excellence and national programs could be promoted in the case of the development of probes, for example.

Hossain, M. M. (Bangladesh) : Many problems for the improvement of vegetable production in the tropics and sub-tropics are common such as varietal improvement, seed production, pest and disease control and post-harvest technology, as mentioned in the reports. In this context I believe that the use of biotechnological procedures may enable to solve some of these problems, i. e. varietal improvement and development of cultivars resistant to pests and diseases. Biotechnology could help develop such varieties within a shorter time than conventional methods. Interspecific and intergeneric hybridization could be utilized to broaden the gene pool and to achieve a wide range of genetic variability. We may start with the most commonly used technique such as embryo, ovary and ovule culture for breeding, anther culture for pure line selection and breeding, and meristem culture for obtaining virus-free materials. However, to achieve this objective, it is important that FAO, the IARCs and organizations in Japan extend their assistance for the training of scientists from developing countries where facilities are lacking.

Chairman : Saxena, M. C. (ICARDA) : To summarize the various aspects of genetic resources which have been discussed, there is a need for pursuing the collections, identifying the gaps, avoiding duplications and taking up the responsibility of characterization. It might be suitable to convene a symposium specifically devoted to the genetic resources of vegetables in the tropical and sub-tropical countries to develop a system for effective conservation and evaluation of germplasm.

Chairman : Imai, H. (Japan) : We could now proceed to the last topic of the general discussion, namely the use of new and advanced techniques for the improvement of vegetable production.

Hirai, (Japan) : I shall present a brief outline of the present status of research and application of biotechnological procedures for vegetable improvement.

Biotechnological methods can be divided into two groups : 1. Cellular level which involves the propagation of plants and cultivars by cloning in the case of valuable ornamental plants such as orchids. However, such techniques are not being used in the case of the propagation of vegetable seedlings in Japan. These techniques can be used for the propagation of parental lines of F_1 hybrid cultivars which cannot be easily maintained by conventional sexual propagation. Thus propagation by *in vitro* culture is likely to become very effective in future. A second technique consists of interspecific hybridization. Embryo culture is very important but there are limitations as it is not always possible to cross remote species. Cell fusion techniques could be effective but are complex. Such techniques have been applied at NIVOT and somatic hybrids of *Brassica* crops or tomatoes and wilder species have been developed. However some of them are sterile and cannot be used for further breeding. The production of such interspecific hybrids enables to broaden the genetic variability of breeding materials. 2. At the molecular level, transformation systems for vegetable crops involving DNA incorporation to plants are being studied at NIVOT. Through the use of *Agrobacterium* as transformation systems for dicots, we have succeeded in the transformation of vegetables such as tomatoes, eggplant, lettuce but not *Brassica*. In the case of monocotyledonous vegetables, it is very difficult to use *Agrobacterium* systems for transformation and other techniques are being considered. For the techniques at the molecular level, it is very important to isolate genes valuable for agriculture. However, the isolation or molecular cloning of such genes is very limited and difficult as presently there are no reliable methods that are available. I believe that it is important to study characters valuable for agriculture at the biochemical level to identify key enzymes

for certain characters and carry out molecular cloning of important characters. I must add that conventional breeding is very important as biotechnological methods at the cellular and molecular level alone do not allow the development of new varieties. Conventional breeding methods are the background for the development of new varieties.

Chairman : Imai, H. (Japan) : I learned that some of the national institutes in Japan have initiated training programs in biotechnology for young scientists from the developing countries.

Singh, R. B. (FAO RAPA) : Biotechnology is an excellent tool for genetic restructuring of vegetable crops to meet varying needs. These tools should, however, be used as an adjunct to conventional breeding approaches for accelerating the pace and precision of development of new varieties. A cautious optimism should be developed about the impact of biotechnology on improved vegetable production. Based on capabilities or needs, the various levels of biotechnology should be advocated at various levels of country development. At the cellular level, biotechnological methods such as micro-propagation, distant hybridization, cell fusion, etc. may be given priority. In the case of rice, the Rockefeller Foundation has supported a rice network on biotechnology which has enabled to develop RFLP systems of probes and catalogues. In this regard, Japan could take the lead in developing such systems for a few major vegetables to facilitate conventional breeding work and make it more efficient, precise and rapid.

Kobayashi, M. (Japan) : Presently, we cannot expect too much of biotechnology because it is only a technique and not an integrated system like conventional breeding. We should consider which technique may be useful practically for combination with conventional methods. In this regard, diagnosis techniques developed recently may be practical as well as RFLP technique to enhance the efficiency of crop improvement.

Chairman : Seyama, N. (Japan) : To conclude the general discussion, I would like to mention that a wide range of problems was covered during this symposium. There are many constraints on vegetable production in the tropics and sub-tropics. I believe that it is very important to promote the development and application of new technology. By combining conventional technology with newly developing one we can expect to overcome the present difficulties as well as to stabilize and improve vegetable production in the tropics and sub-tropics. Therefore, international cooperation encompassing a wide range of scientific fields and mutual exchange of information are required along with the formation of cooperative networks.