General Discussion

Chairman: Nozaki, M. (Japan): During the symposium 5 country reports and 19 technical reports were presented. From these presentations, it appeared that the major problems for rice double cropping culture can be categorized as follows: 1. Disease and pest problems; 2. Water problems including excess, deficiency or instability in water supply; 3. Labor shortage as in the case of Malaysia where industrialization is being promoted; and 4. Injuries due to low temperature, salinity, acid sulfate soils, etc.

The discussion will be centered on the two main following topics which are most important for the improvement of rice cultivation in future, namely the development of irrigation technology for rice double cropping and crop management technology.

I would like to ask Mr. Jegatheesan to comment on the first topic.

Chairman: Jegatheesan, S. (Malaysia): I shall focus on the importance of new irrigation development to promote rice double cropping in the tropics. It is generally agreed that the source of new rice production in future will stem from existing areas which are single- or double-cropped. As mentioned in the keynote address by Dato Syed as well as by Dr. Singh and Dr. Khush the most important requirement for the expansion of rice double cropping in the tropics is new irrigation development. Indeed the other technological components, such as short term varieties, fertilizers and pest and disease control are available but their diffusion may not always be satisfactory depending on the countries. The type of new irrigation development envisaged could include the improvement and upgrading of the infrastructure in existing double cropping schemes to increase water efficiency and stabilize production or the construction of new irrigation facilities in single-cropped lands wherever the water situation permits. Although presently there is a surplus of rice, the demand for this commodity will increase in tropical Asia due to the population increase and income growth. As a result it is necessary that the investment continue in future. The potential for the expansion of irrigation in tropical Asia amounts to 88 million hectares of which two-thirds could be double-cropped. The cost of new investment is very high, amounting to approximately US$52 billion (1978). The major problem is how to expand irrigation for double cropping at the rate required as for most of the governments in this region both financial and technical resources are scarce.

In this regard I would like to ask Dr. Perez what is the policy of the major lending institutions such as the Asian Development Bank and the World Bank for the continuation of the funding of such projects.

Perez, A.T. (ADB)*: The Asian Development Bank which was established in 1966 has a membership of 47 nations of which 29 are developing countries located in the Asia and Pacific Region. The ADB, as a regional development Bank, is committed to promoting the socio-economic development of its developing member countries (DMCs) particularly in the agricultural sector including the irrigation sub-sector based on three considerations: 1. The Asian economies will remain dominated by agriculture, with farmers accounting for the majority of the population until approximately the year 2000; 2. Irrigation will continue to be a prerequisite of Asian agriculture for rice and other crops to feed the population and earn foreign exchange; and 3. Asia's share in the world economy is expected to continue to grow. In my opinion, future ADB financing in agriculture and irrigation will continue to be equal to the present proportion, i.e. about 35% and 16%,

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* Asian Development Bank

respectively of the Bank's lending commitment which during 1985 amounted to a total financing of about US$1.9 billion. Furthermore, project preparation for new irrigation schemes will continue to be facilitated by ADB through its technical assistance (TA) activities. TA grants approved by the Bank during 1985 increased to US$34 million from 22 million in 1984.

As was highlighted in a recent review of bank operations in the irrigation sector, three factors will have far-reaching implications for the future direction of the Bank operations, namely: 1. The start of Bank lending to India; 2. The membership of the People's Republic of China in March 1986; and 3. The fast-emerging capabilities of several DMCs to provide capital goods and export advisory services.

It is my opinion that in Indonesia the Bank's operational strategy will continue to support the country's attempts at a more labor-intensive development and shift to a more diversified and export-oriented economy to reduce the current dependence on oil. Agriculture will continue to receive priority. While past activities in the irrigation sub-sector were centered on the development of large surface irrigation projects, more attention will be given to the development of groundwater resources and command area development through full utilization of the existing irrigation system by improving tertiary canals, extension of command area and proper operation and maintenance of irrigation systems. In line with government preference, new surface irrigation projects will largely be undertaken in the outer islands outside Java.

Finally the strengthening of irrigation institutions at the provincial and farmers' water user group levels will also receive greater attention in the near future. In Thailand, the Bank's operations will take into account the continuing dominant role of agriculture in the economy and will focus on assisting government efforts toward crop diversification and export-oriented, agro-based activities. Emphasis will be placed on the rehabilitation and improvement of existing irrigation systems and development of medium-sized surface irrigation projects (2,000 hectares) in the rice-deficit southern Region and on multi-sectoral development of the Songkhla Lake area, including irrigation. In Malaysia, future activities will focus on poverty alleviation which is one of the long term objectives included in the new economic policy of the government by continuing to place emphasis on the agricultural sector, provision of social infrastructure facilities and regional development. Future activities will involve three main agricultural development projects, namely flood mitigation, irrigation and drainage in the Semarak Rural Development Project Phase II, construction, rehabilitation of irrigation and drainage infrastructure and development of coastal and lowland areas in Sarawak.

In conclusion, the ADB will continue to serve its 29 DMCs in the Asia-Pacific Region to achieve socio-economic progress by the development of the agriculture sector and the irrigation sub-sector. To realize such objectives, financing of capital investments and technical assistance will be provided not only for project preparation but also to assist in the resolution of non-project-related matters such as institutional building and support for regional workshops and studies.

Tan Jin Tun (Malaysia): How can ADB extend its assistance in O&M of completed irrigation projects in developing member countries?

Perez, A.T. (ADB): There are several ways the ADB can assist: 1. Provision of technical assistance aimed at solving problems related to proper O&M towards efficient and full utilization of existing irrigation schemes, as in the case of the Nong Wai Irrigation Project in Thailand; and 2. Provision of financing towards command area development, training of project staff and organization of farmers' water user groups and development of O&M manual for the irrigation systems as well as technical cooperation between bank specialists (irrigation engineers, agronomists, etc.) and staff of concerned government irrigation agencies.

Chairman: Jegatheesan, S. (Malaysia): I would like to discuss some aspects relating to the farmers' attitude and participation in the maintenance, care, operation of irrigation facilities, which is extremely important and varies with the respective countries. In Malaysia, the farmers expect that the government will take care of these problems. This is a major cause of concern to us as the capital cost for the construction of schemes as well as the cost for maintenance and care is very high and is a heavy burden on the economy of the country. I would like to know what is the experience of Indonesia with regard to farmers' participation in the operation and maintenance of irrigation systems in rice double cropping areas.

Soetjipto Partohardjono (Indonesia): To promote more efficient use of water, we in Indonesia, developed the so-called "Improved Management at Tertiary Block" through the promotion of Water Use Association by Farmers. Through informal farmer leaders (key farmers) field extension workers can transfer the improved practices of water management to the farmers over wide areas. Guidance and persuasion are being exercised to convince the farmers that the recommended practices are beneficial to them.

Singh, R.B. (FAO, RAPA*): As regards farmers' participation in irrigation management I would like to refer to the system implemented in the Republic of Korea. In Korea, after an irrigation project is built by the government, it is transferred fully to farmers' organizations who run the entire project from the maintenance to the on-farm development of the irrigation system. As a result, the efficiency of irrigation in Korea is among the highest in the region. This experience was recently presented during the intergovernmental conference held at the FAO Regional Office to increase the efficiency of irrigation in paddy fields. In addition I would like to emphasize the fact that there is a general dearth of transfer of technology on irrigation management. This gap should be filled urgently in order to optimize water use. With regard to the expansion of irrigation for double cropping, needless to say, adequate and timely water supply is vital to increased and sustained production of rice or other crops. Several governments in the Asia-Pacific Region have made huge investments in irrigation projects but studies have shown that in most of the cases the impact of irrigation has not been commensurate with the level of investment. Among several factors, responsible for the gap between realized and expected results, the most important reason has been inadequate on-farm development of irrigation infrastructure and thus inefficient use of irrigation water. Therefore, this aspect should receive due attention. It is in this context that India which had made large investments during the past Five-Year Plans in irrigation system development is now giving more attention to on-farm development to optimize the use of the existing resources, besides building additional infrastructure.

Finally I would like to emphasize that it would be useful if the experience accumulated by the MADA officials could be critically documented and published so as to enable other countries to learn from the success and failure of the Muda project.

Dato Syed Ahmad Almahdali (Malaysia): Thank you for your appreciation of the Muda Project. I would like to take this opportunity to mention that any country or organization is welcome to observe the Muda experience.

Chairman: Nozaki, M. (Japan): Mr. Dat Van Tran will now lead the discussion on the technology for rice double cropping.

Chairman: Dat Van Tran (FAO):** It appeared from the presentations made in the previous days that wetland areas should be developed for rice production in the world as they can support high densities of population, as seen in Asia, and since they have a vast potential. However the implementation of development programs is associated with a large number

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** Food and Agriculture Organization of the United Nations.

of constraints both technological and socio-economic. During the symposium there were many suggestions on how to improve the technology for rice double cropping and some of the aspects related to this subject could be further discussed.

From the technological viewpoint the main problems are as follows: 1. The performance of the varieties depends on the ecological conditions; 2. Land preparation involves no tillage, low tillage, minimum tillage or maximum tillage depending on the first or second crop; 3. Among the cultural practices the planting date is very important for the interval between the two crops depending on the agro-ecosystems (conditions prevailing in the tropical, high elevation and subtropical areas at low or high temperatures); 4. Plant protection is most important as well as; 5. Water management to improve the efficiency of water use for increasing rice production; 6. Weeds must be controlled; 7. The appropriate use of fertilizers and inputs must be defined; 8. To increase the productivity of double cropping, post-harvest problems must be considered. The socio-economic problems are equally important, including the shortage of labor and the need for reducing the production costs in taking account of the fact that the rice prices are declining (presently US$200 per ton of milled rice). Also the selection of appropriate cropping systems to increase the profitability for the farmers must be considered.

I would like to ask Dr. Khush to present a brief introduction on varietal improvement for rice double cropping.

Khush, G.S. (IRRI)*: I described some of the achievements made in the development of varieties for rice double cropping by international centers and national programs. I shall discuss now some of the future challenges, namely what needs to be done to further improve the varieties for rice double cropping. One of the challenges that we all face is how to break the yield plateau of the improved rice varieties. The yield potential increased 2 to 3 times by the introduction of the dwarfing genes which enabled to increase the harvest index from 0.3 to 0.5 while the increase of nitrogen use was made possible due to the short stature of the plant. However after the initial improvement in the yield future yield increases in the last twenty year period have been negligible. Yield is a function of total biomass and harvest index. It appears that the total biomass production of the rice high-yielding varieties as well as of other cereals has not changed appreciably. Although the harvest index has increased further improvement would be very difficult to achieve. Therefore it will become necessary to increase the biomass production which could be performed by the introduction of genes from wild species, as observed in the case of sorghum, pearl millet and oats. The second challenge is to maintain yield stability as the resistance of varieties to insects or diseases does not last long. Varieties which were once resistant become susceptible as in the case of the resistance to the brown planthopper due to the development of biotypes. The strategy adopted is to identify new resistance genes that will be incorporated, resulting in the sequential release of varieties with new resistance genes. The development of durable resistance would be desirable but is very difficult to achieve particularly when attempts are made to incorporate resistance to a large number of diseases and insects. In this regard some of the genes present in wild germplasm could be useful due to their high level of resistance to diseases and insects and such resistance should be incorporated into cultivated varieties. However since crosses with these wild varieties are not easily performed, biotechnological techniques including, DNA recombinant, embryo rescue, genetic engineering will have to be applied. It will also be important to introduce genes for tolerance to adverse environments including tolerance to low or high temperature, tolerance to moisture stress in case of drought or to submergence in case of flood. Other challenges include the reduction of the growth

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duration while maintaining the same yield potential. It would be highly desirable to reduce the growth duration to 90 days to be able to grow two crops of rice in one rainy season under rainfed conditions. Finally along with the increase in self-sufficiency in rice, grain quality will become increasingly important as is the case for Indonesia and China. National preferences for grain quality will have to be considered as well as the aroma to increase the palatability.

Chairman: Dat Van Tran (FAO): I would like to ask Dr. Soetjipto Partohardjono to comment on various aspects relating to crop management for rice double cropping.

Soetjipto Partohardjono (Indonesia): To increase and stabilize production of rice double cropping the following strategy could be adopted: 1. Suitable varieties with the following characteristics should be used: varieties with a high yield potential, with multiple resistance to various stresses including low temperature or drought, with proper maturity to avoid harvesting during heavy rainfall which would result in the decrease of grain quality; 2. Nursery manipulation: to avoid low temperatures, a plastic film could be used in the subtropical zone as recommended in China. Duration of the nursery period could be prolonged but the reduction of yield in the field should also be avoided. Optimum planting time should be determined; 3. Land preparation is important and the degree of tillage depends on the physical properties of soil which should be improved. Lack of tillage often results in hardening of soil which hampers seedling establishment; 4. Early planting through direct seeding at the beginning of the rainy season under unpuddled and dry conditions would enable to save water for land soaking; 5. To stabilize rice production in double cropping schemes, rice-based cropping systems could be adopted since year-round rice cropping is undesirable as the soil properties tend to deteriorate due to submergence. Early-maturing legumes such as soybean or mungbean or green manure crops could be incorporated in the rotation. Above all I believe that research should be further promoted to meet specific regional requirements.

Chairman: Dat Van Tran (FAO): I would like to summarize the comments made by both Dr. Khush and Dr. Soetjipto Partohardjono.

Dr. Khush mentioned that the future challenges in the field of breeding of new rice varieties are as follows: 1. How to break the present yield ceiling of 6 to 8 tons per hectare; 2. How to improve the biomass to increase the yield as further improvement of the harvest index would be difficult to achieve; 3. Development of rice varieties that are resistant to pests and diseases as well as adverse environments such as flood, drought, etc.; 4. Reduction of the period of growth of rice from the seedling stage to maturity below 100 days without sacrificing the yield potential; and 5. Importance of the improvement of the grain quality. As for the management of the rice crop, Dr. Soetjipto Partohardjono emphasized the following aspects: 1. Appropriate nursery management; 2. Land preparation; 3. Planting methods including seeding or transplanting; 4. Planting date in relation to the interval between the crops. Need to adjust the crop duration to avoid injury caused by low temperature or grain damage when harvesting takes place during the rainy season; and 5. Importance of cropping systems whereby a legume crop could be introduced in the rice rotation to improve the soil conditions, particularly the physical properties of soil.

Singh, R.B. (FAO, RAPA): Technology generation is important but more important is to generate appropriate technology and to see that it gets transferred to and translated at farmers' fields whom it is meant for. Of the 20 rice-producing countries in the Asia-Pacific Region where 92% of rice is produced, 14 countries have yields lower than 3-4 tons per hectare, below the regional average level. This points to the gap in technology transfer and not in the availability of technology. For example in Indonesia rice production increased through the use of fertilizers which were subsidized by the government. On the other hand, in Thailand which is the leading rice exporter in the world, yields are among

the lowest in the region as a very low amount of fertilizers is being applied (20 to 25 kg NPK). Therefore, additional attention should be paid to the transfer of technology. However, no technology will work in a vacuum. It must be economically profitable and agro-ecologically compatible. The key word is relevance. We may not forget that about 75% of our land is rainfed and that the majority of the farmers are resource-poor. Therefore appropriate technology must address to these factors also and the governments must adopt policies and provide the infrastructure which could be conducive to increased and sustained production. For example the impact of high yield technology in Malaysia as developed under the Muda Project is apparently not felt as yet at the national level. It would be worthwhile to monitor the adoption of the new technology in the near future, especially under the new agricultural policy of the government which envisages 60 or 65% of rice self-sufficiency.

Chairman: Dat Van Tran (FAO): I agree with Dr. Singh that technology is only useful if it is transferred to the farmers. For example the use of fertilizers and irrigation resulted in 15 and 29% increase of rice production, respectively. In Thailand the policy is to increase production by allocating large areas to the production of rice at a low cost in using a minimum amount of inputs to keep the price of rice competitive in the world market.

Chairman: Jegatheesan, S. (Malaysia): It is true that the policy of the Malaysian government is to reach a 65% level of self-sufficiency in rice to meet the domestic requirements. However the government will promote the use of high technology for the production of rice within restricted areas with intensive irrigation. In the marginal areas the farmers will be encouraged to switch to other crops.

Chairman: Dat Van Tran (FAO): I would like to add that the improvement of crop management is the most important factor to close the gap between the present yields and potential yield. For example in Africa and Latin America the yields remain very low at 2 tons per hectare in general. In Latin America although the same methods of cultivation are applied, the yields remain much lower than in California where the average yield of rice is 8.2 tons per hectare.

Nakamura, R. (Japan): The problems of double cropping are closely related to those of crop diversification as double cropping is made possible by growing rice in the dry season along with other crops. ADB and FAO have been strongly advocating crop diversification and Dr. Singh proposed a "cropping systems approach" to solve this problem. The long history of Japan in promoting crop diversification tells us that the solution to this problem is not as easy as it may seem. In the case of crop diversification one farmer may want his land to be dry while a neighboring farmer may require that his fields be flooded. Irrigation planners will be confronted with such problems and for the successful implementation of crop diversification, they may need the advice of agronomists as to which crops should be selected or that of economists to determine which crops would be more profitable to the farmers. Therefore in future the cooperation among researchers in various fields will become essential.

Chairman: Dat Van Tran (FAO): There is obviously a need for promoting farmer cooperation for coordinating the implementation of programs in the case of crop diversification.

Soetjipto Partohardjono (Indonesia): For crop diversification, profitability of the operations to the farmers must be taken into account along with a multidisciplinary approach.

Chairman: Dat Van Tran (FAO): I would like to add that FAO places emphasis on the production of wetland rice rather than on that of upland rice. Also attention is given to increase the productivity of rice while reducing the production cost in line with the decline of the rice prices.

Chairman: Nozaki, M. (Japan): To conclude the general discussion I would like to say that wide areas and numerous problems were covered during this symposium. There are many constraints on the implementation of rice double cropping, namely technical and socio-

economic ones. I believe that the successful implementation of this type of culture requires the integration of hardware components with software aspects including the establishment of a proper cropping pattern along with the effective use of water, labor and appropriate crop management through the use of short duration rice varieties with multiple resistance.