Management Arrangements for Diversifying Rice Irrigation Systems in Malaysia

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INTRODUCTION

THE RICE LANDS of Malaysia, totaling 0.6 M ha are broadly classified as either granary or nongranary areas. The granaries comprise 8 large and contiguous irrigation schemes, covering 210,000 ha and producing more than 65 percent of the country's total output; and it is in these granaries that further development of rice production will be concentrated.

The nongranaries are either rain-fed or have been provided with irrigation facilities to ensure that they are cropped at least one season in an year. Following the review of the rice production policy and concurrent with agriculture diversification strategies, the non-granaries have been redesignated as diverse crop production areas in contrast 10 the granaries which are monocropped with rice.

In line with this decision, a feasibility study on crop diversification and rationalization was carried out under the Technical Cooperation Program between the governments of Japan and Malaysia (ANON 1990a). The study focused on the nongranary irrigated areas of Malaysia comprising 924 schemes, totaling 130,100ha.

The purpose of this paper is to highlight results of the study and to outline current practices and issues related to rice-nonrice rotation in selected irrigation schemes originally designed arid operated for rice cultivation.

SCHEME CHARACTERISTICS

The nongranary irrigated schemes are scattered all over the country (Figure 1)and their sizes vary from less than 50 ha to over 200 ha. They are located along and adjacent to the main river systems and thus share the same water resource within the catchment. The soil textures in more than 60 percent of the schemes are either heavy clay or clay. The type of schemes are either gravity, pumping, inundation. controlled drainage or a combination of these. Morr than 73 percent are either gravity or pumping or a combination of the two.

DESIGN CRITERIA

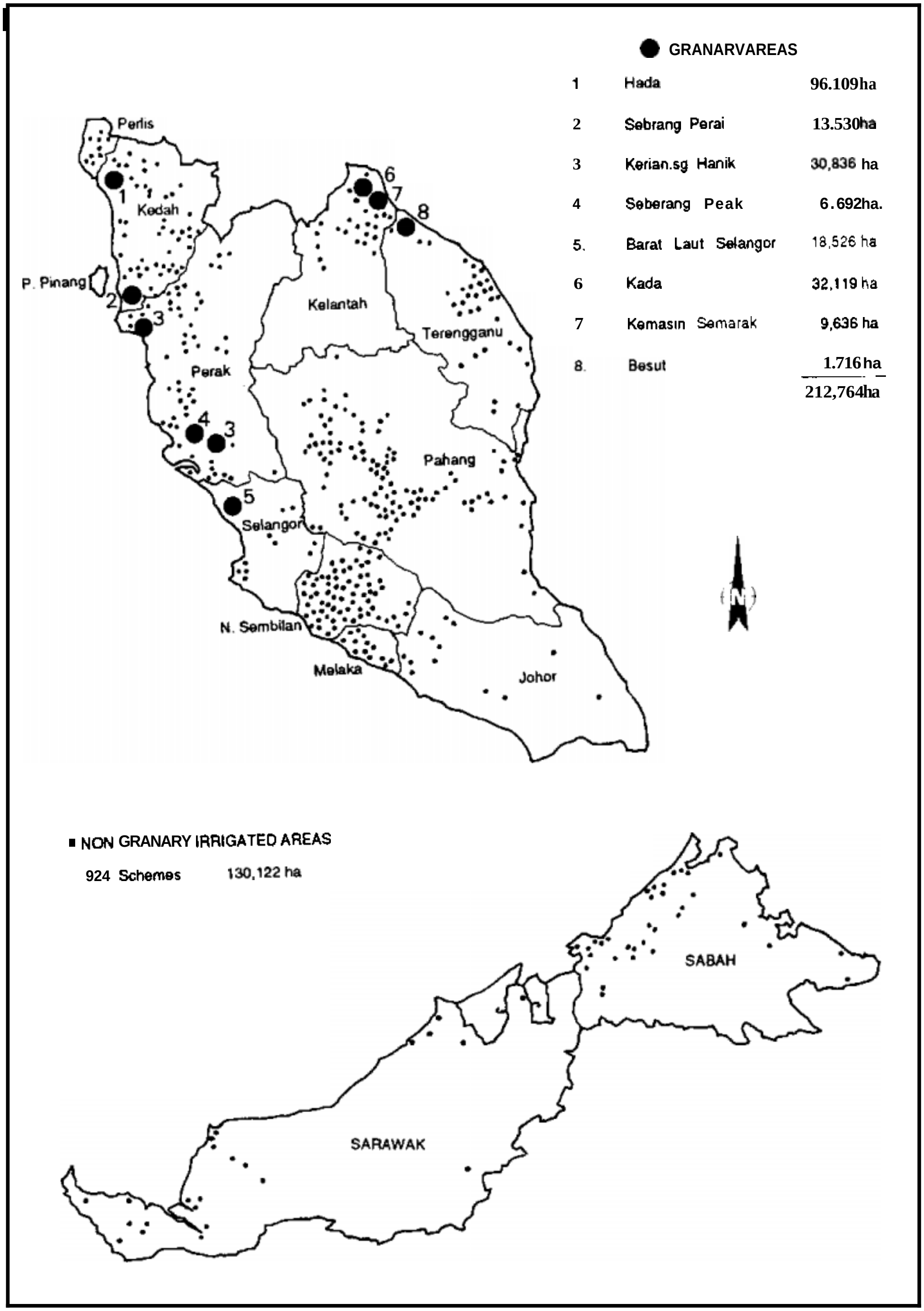
Depending on the scheme size, canal density varies from 20 to 60 m/ha. A farm offtake is provided for every 4 to 12 ha of farm lot. Canal capacity ranges from 0.9 to 2.4 l/s. For pumping schemes, operation time is usually over a period of 8-16 hours daily. Water distribution is rotational and on-fami from firld-to-field.

The drainage system is designed to remove excess water and flood within 48 hours for total submergence and 72 hours for partial submergence. A 3-day rainfall duration for 1 in 5 yrars return interval is used for the design giving Uows of about 9 l/s. Drain density ranges from 1 to 20 m/ha and one drainage offtake serves between 4 to 12 ha.

CURRENT STATUS

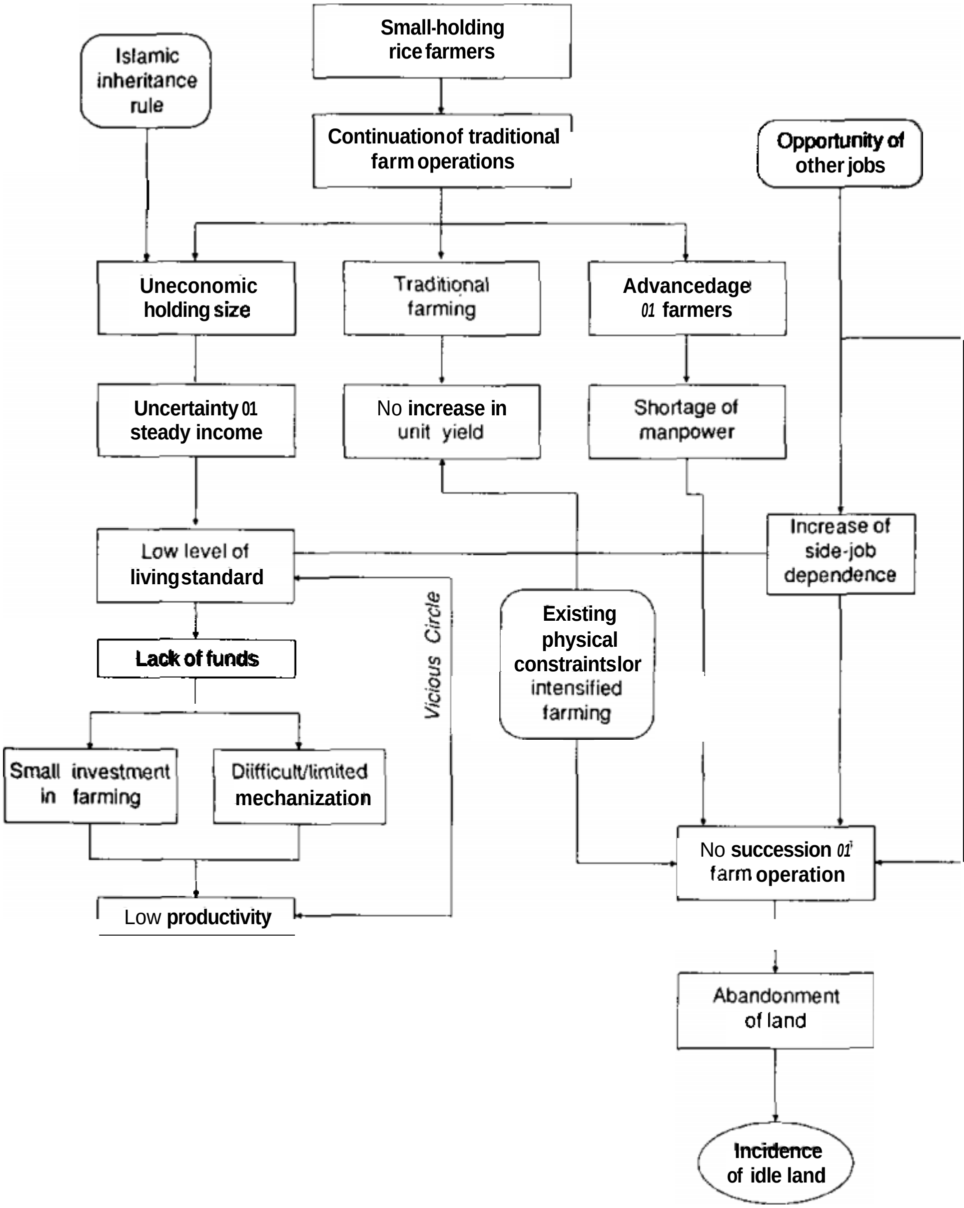
One of the major probleins of rice areas is underutilization. Out of the 924 irrigatioaschemes, 305 (91,000 ha) are completely idle and in another 250 schemes (34,000 ha) more than 50 percent of their irrigahle areas are not utilized during the main season. Factors leading to such situations arc many and interrelated. Uneconomic farm holdings, labor shortage, aging rice farmers, diflirulties in mechanization, inadequate water resources due to development, low productivity and low remuneration from rice are some examples of these factors. The incidence mechanism of idlr land is illustrated in Figure 2. In some areas, in order to overcome these problems, farmers, either on their own initiative or assisted by the government, have started lo practice diverse crop production instead of the traditional rice

Figure 1. General location and distribution of irrigated rice areas in Malaysia.



Source: Jawatankuasa Perlak Sanaan Penyiasatan Pengeluaran Padi (1989): Penylasatan Penegeluaran Padi-Kaputusan Bagi Musim Utama (1987/1988).

Figure 2. Incidence mechanism of idle land.



Source: Feasibility Study on Rationalization and Crop Diversification in Nongranary Areas in Malaysia, 1990.

monocropping. However, the extent is still small and up to 1987 only 6 percent of the total irrigated areas have been diversified. Nonetheless, indications are that farmers have adopted appropriate technology and this trend is increasing. With the current government emphasis and support, it is anticipated that diversification of other rice areas will be accelerated.

CROP DIVERSIFICATION

Crop diversification of the irrigation schemes in Malaysia takes a broad definition covering changes in seasonal and annual cropping pattern, multiple cropping. conversion to permanent tree crops, mixed farming inclusive of livestock rearing and aquaculture but not totally eliminating rice production where it can be shown that this is still the best choice.

In this context, the study has established 8 categories of diversified land-use of the existing irrigation schemes as shown in Table 1.

Table 1. Categories of diversified land use in nongranary irrigation schemes

Category	Description
1	Converted to high value crops (e.g. vegetables, tobacco)
2	Converted to tree crops (e.g. oil palm, fruits)
3	Rice-Upland crop rotation
4	Grazing/Livestock rearing
5	Aquaculture
6	Positively maintained for rice
7	Present situation maintained for social reasons until predetermined period for review
8	Converted to housing

As can be seen, Category 3, where rice-upland crop rotation is proposed, fits the IMCD Research Network's general definition of diversified cropping in rice-based systems.

The categorization procedure is based on 7 key factors: water resources availability, farmers' intentions towards rice cultivation and diversification, land suitability, soil suitability, crop profitability, crop marketability and investment performance.

Using data obtained from the inventory survey and the socioeconomic survey, each scheme was evaluated on a step-wise procedure and its category identified. The procedure was repeated for various possibilities pertaining to the key factors such as profitability of crops and the best category; the one with the highest investment performance is termed the super category. The distribution of super category by number of schemes and area is shown in Table 2. None of the schemes under livestock and aquaculture categories was classified as super, primarily because of poor profitability and marketability.

A study on selected schemes to evaluate the feasibility of Categories 1,2 and 3 was also carried out as these require some form of physical structural and non-structural adjustments to the existing system. In all cases, the feasibility was found to be positive. It is interesting to note that for Category 1 where conversion to high-value crop is proposed, the study recommended that this be introduced gradually by initially implementing Category 3. This is to allow time for the traditional rice farmers and system operators to adapt themselves as well as adopt appropriate technology for the change in cultivation system. Thus the potential of crop diversification based on Category 3 has increased to 193 schemes totaling almost 20,000 hectares.

Table 2. Distribution of super category by number of schemes for each category of land use and total area.

Category of diversified land use *	Number of schemes[1]	Total area (ha)[2]
1	144	10,167
2	333	39,899
3	47	9,665
4	-	0
5	-	0
6	74	40,973
7	172	23,363
8	154	8,303

*See Table 1.

Sources: [1]Government of Malaysia (1990).
[2]Estimated from irrigation database (Department of Irrigation and Drainage, Malaysia).

In general, Category 3 schemes are those with inadequate water resources for rice during the dry season but enough for upland crops. The farmers here are willing to diversify production, the land arid soils are suitable for nonrice crops and profitability, marketability as well as investment performance are shown to be positive.

CASE STUDY AREAS

Focusing on Category 3, salient features of its successful implementation and current practices with potential for adoption in future projects are summarized. These were based mainly on case studies of three schemes, namely, the Bachaug Irrigation Scheme in Malacca State in the South-West, and Bendang Kekabu and Bendang Pauh both in the State of Kelantan in the North East of Peninsular Malaysia.

Bachang Irrigation Scheme

This is a pumping scheme with a single earth main canal constructed in 1950. Water source is the Malacca River. Besides the pumping station, a control drop, a check structure and several offtakes form the complete system. The system commands 140ha of rice land. It is operated and maintained by the Department of Irrigation and Drainage (DID). Water supply is generally reliable with the occasional low flows during the dry season. Between 1985 and 1989, only 72 ha remained under rice. Of the balance, 45 ha were devoted to asparagus, tobacco, melon and vegetables. Those planting these upland crops still include rice in their rotation although not in an alternating sequence. The development of crop diversification was initiated by the fanners themselves. Most are third generation farmers and have formed a loose form of cooperative association.

Bendang Kekabu and Bendang Pauh Irrigation Schemes

Although the schemes are in different locations within the State of Kelantan, there are many common features. Both are groundwater pumping schemes. Bendang Kekabu was con-pleted in 1989 and Bendang Pauh in 1986. The water yield is said to be good but supply is limited by the pump capacities running at the maximum of 70 l/s. The conveyance canal uses precast U-shaped concrete sections each ranging from 3.7 m to 4.5 m in length. The cross-sectional dimensions range from 0.3 m width by 0.3m depth to 0.92m width by 0.92 m depth. The minimum bed level is set so that the whole storage in the canal can be discharged by gravity into the fanns. To cater for head losses and command, the canal sections towards the pumping source have to be elevated above the ground level. Concrete boxes are provided atjunctions and changes in flow directions. Both systems were designed and constructed by the DID based on supplementary rice irrigation requirements during the main season.

The rice-tobacco rotation is practiced in Bendang Kekabu scheme (ANON 1990b). The system construction was financed by the National Tobacco Board (NTB) which also organized fanners for tobacco cultivation and marketing channels. The operation and maintenance costs are borne by the farmers themselves through deductions during sale of produce.

In the Bendang Pauh Scheme, rice-tobacco-vegetable rotation ispracticed. Rice is planted over 50 ha and the tobacco and vegetables, over 8 ha. Group farming is organized by the local Area Fanners' Association. Extent of tobacco growing is controlled by the NTB by a quota system while vegetable growing is governed by prenegotiated contracts.

Other Schemes

Other schemes considered in formulating generalities and salient features of crop diversification are the Tanjung Minyak Scheme in Malacca, the Kampung Kijang Badang in Kelantan and the Pinang Tunggal in Penang.

SALIENT FEATURES OF RICE-UPLAND CROP ROTATION IN IRRIGATION SCHEMES

Towards formulating system planning and implementation criteria for crop diversification projects in other areas, the following features of current practicrs are summarized.

Farmer Organization Models and Institutional Support

Farming objectives are commercially oriented. Farmers either have an informal yet cohesive organization, or are organized in groups led by government agencies such as the NTB, Area Farmer's Association and the Department of Agriculture (DOA). Existing agricultural support services provided by the Ministry of Agriculture and its agencies are still necessary. Technology development and transfer are through lead and resourceful farmers as well as through the Malaysian Agriculture Research and Development Institute (MARDI) and extension services of the DOA. The Federal Agriculture Marketing Authority (FAMA) assists whenever necessary in securing marketing outlets.

Crop Choice

Profitability and marketability are important factors for crop selection (Rabman et al. 1990). Rice is maintained in the rotation because of upland crop sensitivity to waterlogged conditions and rain drop damage during the rainy season. Another reason is that the cultural practice requiring flooded field conditions helps to control weed, remove diseases and pathogens in the soil.

Location and Extent

Diversified cropping areas are located adjacent to water sources such as canals and drains and where farms are contiguous. Soil texture ranges from sandy loam to clay loam with clay content not exceeding 40 percent and the farm elevation ranges from 0.3 m lo 1 m above surrounding rice fields to reduce risk of waterlogging or flooding conditions. Water supply reliability controls the extent of diversification within an irrigation scheme. Predetermined production targets to ensure profitability and a reasonable market is another limiting factor.

On-Farm Adjustments

The upland crops are planted on raised beds in order to improve drainage conditions in the root zone. To complement canal and drain storage, farm ponds have been constructed in some areas where short-term but frequent droughts occur. Where possible, shallow groundwater wells have also been developed.

Water distribution to farm plots is through farm ditches connected to farm offtakes. Being nonpermanent and crudely constructed, water loss from these ditches due to leakage, seepage and overtopping can be high. Reconstruction after the rice season and subsequent maintenance are a potential source of conflicts between farmers since the ditches need to pass through lands belonging to different owners. There is a need therefore for formal construction of these on-farm distribution systems, especially where crop type and water requirement schedules differ between farms.

In some cases, farmers have resorted to constructing their own pipe system or the use of collapsible hoses. However, portable pumps are necessary to account for the hydraulic head losses.

On-Farm Irrigation Practices

Furrow and basin irrigation methods are quite common. For furrows, water is diverted from the head ditch by blocking the flow with earth. Three furrows are irrigated simultaneously. Supply is cutoff when the water level at the end of the Surrow is 100 mm below the top of the bed.

For the basin irrigation method, water is allowed to pond within the plot boundary to a level 100 mm below the top of the ridges. The water is then left to stagnate for about 2 hours before being released. Alternatively, it is left overnight to allow complete infiltration into the soil.

For light irrigation just after planting, a portable single nozzle sprayer attached to the end of a flexible hose is also used. With pumps becoming a standard equipment for the individual farmer, sprinkler and drip irrigation are becoming popular. Although their capital cost is higher, it provides flexibility for water management, thus stabilizing production.

Irrigation intervals vary between 4 and 6 days. The decision to irrigate is based on visual and physical inspection of the soil moisture conditions and leaf turgidity. Morning wilt in tobacco leaves is indicative of water stress situation. For some vegetable farmers, irrigation is provided daily except if it rains overnight.

Main System Adjustments

Water storage appears to he an important criterion. This allows instant water availability and lead time before the arrival from the main supply source. Some sections of the earth canals were deepened to increase storage capacity. For precast concrete canals, the construction is such that all water is available by gravity flow.

For farms situated close to canals and far away from the main drains, the canal full supply levels were purposely lowered out of command in order lo facilitate drainage, although this necessitates the use of pumps for irrigation.

Operation and Maintenance

As for rice, rotational supply system is still practiced without adverse effects to the upland crop and negative reactions from farmers. Main pump operation is also maintained for periods of between 8 to 16 hours daily. However, it is reported that system operators need to operate control gates more often to regulate flows during peak demand periods.

Where farmers operate their own pumps or pay for the system maintenance. water management is improved since pumping is an added cost of production. In a way, system operators view this as an indirect cost of water to the farmers.

During drought. water supply is strictly controlled. The decision as to the. time and duration of supply is made by the DID and farmers are duly forewarned. In the Bachang Scheme, the farmers then organize themselves by allocating a fixed period for pumping hy each fanner. During the allocated time, usually 1 day, all pumps are loaned to that particular farmer.

General

On the whole, the present diversified schemes do not require major physical structural aiid nonstructural adjustments. There are 3 main reasons. First, the size and the total number of schemes involved are relatively small. Second, the area diversified within a scheme itself is small arid judiciously located in relation to soil type, water availability. accessibility and topography. Third, the farmers are small in number, well-organized and continually supported hy the government.

FUTURE DIRECTION AND RESEARCH NEEDS

Malaysia is fully committed to crop diversification in the nongranary areas. In the recent National Seminar on Crop Diversification (ANON 1990c), several conclusions that are reflective of Suture directions were made:

1. The broad policy framework now in existence for crop diversification needs to be translated into a more definitive implementation plan. The modus operandi has to be developed for specific situations.
2. Emphasis must be given to supportive activities such as planning, training, operation, farm credit, production and marketing. Marketing is particularly critical with respect to outlets and price stability.
3. The institutional framework to ensure or sustain farmers' participation needs to be carefully developed. The present inclination is towards central management systems or mini-estates. This seems to be a better approach as opposed to individual farming which is harder to organize and manage because of divergent views of individuals.
4. For long-term sustainability, continuing research and development in all areas are necessary.

The immediate plan is to implement a pilot project in Kulim Irrigation Scheme to convert 55 percent of the total irrigable area of 3,223 hectares for the cultivation of upland crops. The elements of research, monitoring and evaluation to be emphasized here include system design and management criteria, socioeconomic aspects of farmers' organizations and production technology. Meanwhile, MARDI continues to do research on component technologies related to upland crop production on rice lands. Examples of such research are water table management, suitable irrigation practices, techniques of on-farm waterdelivery, mechanization and agronomic practices. In research, development and implementation, there is already a close link between MARDI and DID.

CONCLUSION

The scale of current crop diversification on rice land in Malaysia is small. The impact on irrigation management is minimum. As such, for the moment, there is no monitoring and evaluation in the operation of the irrigation systems for diversified cropping. No major physical, structural and managerial adjustments have been imposed on the system but nevertheless crop diversification has been successfully practiced. Minor adjustments that were enforced and have potential application elsewhere include:

1. Reducing flow to below FSL so that a canal can function as a drain as well.
2. Deepening a canal to increase storage for pumping.
3. Acquiring portable pumps to provide flexibility in water management by farmers.
4. Having stable, reliable and predictable water supply to be augmented whenever necessary by farm ponds and tubewells at farm level.
5. Improving on-farm conveyance systems by using concrete-lined canals or pipe system and complementing with regulatory structures.

Irrigation system management will not be complex enough as to be restrictive to effective crop diversification if:

1. The scheme is small.
2. Crop diversificatioii is on a small scale within a scheme.
3. Locational features preempt water management problems.

Malaysia is now gearing up for crop diversification on rice land. As this proceeds, complexities in irrigation management and production are expected to be encountered. The following strategies are to be adopted:

1. Identification of suitable schemes within the nongranary areas based upon water resource, physical condition, marketability, and agronomic and socioeconomic criteria.
2. Implementing pilot projects for representative schemes.
3. Coordinated multiagency implementation programs with strong participation of farmer's associations in an integrated approach.
4. Research on, and development of system design and management, socioeconomic aspects of farmers' organizations and production technology on rice land.
5. Collection of basic data and information to establish a comprehensive database on the nongranaries and rain-fed rice fields as the first step towards a master plan on crop diversification.

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