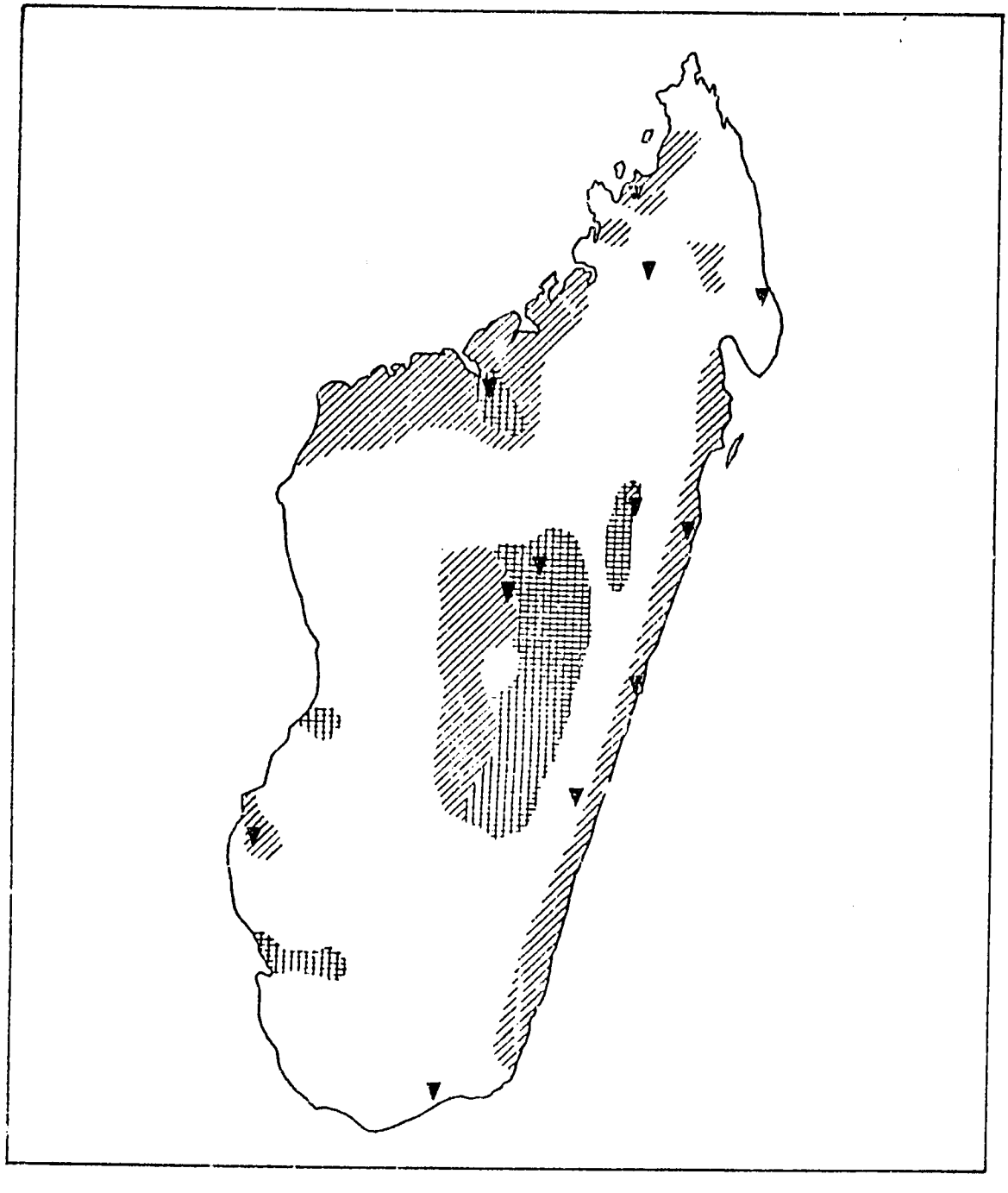
PN-AAW-596 6 2
ISN= 48836
936441.02

RICE IN THE MALAGASY REPUBLIC

Current Research and Production and Recommendations for Acceleration



THE INTERNATIONAL RICE RESEARCH INSTITUTE
1982

DEC 16 1982

RICE IN MALAGASY REPUBLIC

Current Research and Production and Recommendations for Acceleration

Report Prepared by:

M. D. Pathak, Director, Research & Training, and Team Leader
Kaung Zan, IRRI Liaison Scientist for Africa
D. V. Seshu, Coordinator, International Rice Testing Program
D. P. Garrity, Associate Agronomist

based on their visit to Malagasy on October 10-17, 1982

The International Rice Research Institute
P.O. Box 933, Manila
Philippines

FOREWORD

During the last 20 years, the International Rice Research Institute has been working with the governments of rice-growing nations in developing research strategies and technology transfer programmes for elevating and stabilizing the productivity of rice farming systems. Recently at the invitation of the Government of the Republic of Malagasy, IRRI sent a team of scientists headed by Dr. M. D. Pathak, Director for Research and Training, to visit the rice research centers and rice growing areas of Malagasy. Financial support for the visit of the team came partly from the United States Agency for International Development.

The report indicates that the untapped yield potential of rice farming areas in the Malagasy Republic is quite high. Like many developing countries which were exporters of food grains 20 years ago but which now have to balance their food budgets through imports, the Malagasy Republic also now depends on the import of rice for meeting the requirements of the growing population. Population increase and improvement in *per capita* consumption because of better purchasing power enhance the demand for food. On the other hand, loss of farm land for non-agricultural uses, population expansion leading to a reduction in the average size of farm holdings and rise in the unit cost of the factors of production involved in the process of modernization, all stress the need of achieving a continuous improvement in productivity without detriment to the long term production potential of the soil and a greater efficiency of small farm management.

The IRRI team has suggested both short term and long term programmes for achieving self-sufficiency in rice production. Immediately, there exists scope for initiating a minimum income-cum-yield guarantee project in the five major high yield potential and low risk areas. To produce another 300,000 tons of rice which is the level of current imports, the cooperation and active participation of at least 500,000 farm families will be essential. The success of any production programme will hence depend upon the extent to which farmers are enabled to help the country. IRRI hopes that this report will be of help in formulating research and development programmes for bridging the gap between potential and actual farm yields.

We are grateful to the Government of the Malagasy Republic for asking IRRI to be of continued assistance to its Ministry of Agriculture through a Memorandum of Agreement signed by the Honourable Minister Wirina Andriamanerasoa on behalf of the Malagasy Republic.

M. S. Swaminathan

M. S. Swaminathan
Director General

November 1, 1982

ACKNOWLEDGMENT

We wish to thank the Honorable Minister Adriamanerasoa Nirina for his hospitality in welcoming us to the Malagasy Republic and for making excellent arrangements for our visits in Malagasy. We are grateful to Mr. Rabe Raphael, The Secretary General of Agriculture and Dr. Ratsimbazafy Claude and Mr. Ratsimbazafy René for discussing with us the various aspects of the productivity in Madagascar. Dr. Claude and Mr. René briefed us on various programs, accompanied us throughout our trip, and acted as interpreters. We extend a special thanks to them. We also thank other scientists and extension specialists who discussed their programs with us and readily provided information we requested. Also, we thank USAID Washington for providing funds for our visit to Madagascar.

Finally, we thank Dr. M. S. Swaminathan, IRRI Director General, for asking us to undertake this mission to Malagasy. We enjoyed our visit to Madagascar. Getting to know the good natured people of Madagascar and the potential for increasing rice production in their country was an exhilirating experience.

M. D. Pathak

Kaung Zan

D. V. Seshu

D. P. Garrity

INTRODUCTION

Madagascar is the fourth largest island in the world and constitutes, along with minor adjacent islands, the Malagasy Republic. Lying 400 kilometers east of the African coast, it is basically a tropical area, although the central highlands have a typical subtemperate climate. About 70% of the population of approximately 9 million is involved in rice-growing, making this by far the nation's most important economic activity. Rice is cultivated over 1.3 million hectares, which is about one-half of the country's total permanently cultivated land. Rice yields remain low at about 1.8 tons per hectare. Per capita consumption of rice, at about 150 kg per person per year, is among the highest in the world.

The Malagasy Republic was a rice exporting country until early 1970's but has become a net importer of rice during the last decade.

	Value (millions FMG)*			
	1970	1977	1978	1979
Rice importation	667.6	4325.4	8930.4	10988.5
Rice exportation	3071.9	376.5	171.1	157.4

Importation of rice was 250,000 tons in 1981 and is expected to reach 300,000 tons in 1982. Between 1960 and 1971 rice production

---

*The current exchange rate is 375 Malagasy francs = US$1.

increased at an annual compounded growth rate of 4.1%, but this increase was only 1.2% during the period 1974-1981 (Fig. 1). Production in the last few years has been declining. This production shortfall, coupled with a serious drop in the price of coffee -- which constitutes 30% of the country's total exports -- plus a 2.5% per annum population increase have caused a severe strain on the Malagasy economy. Consequently, shortage of funds is a major constraint limiting research and production efforts. Intensive support for research and production and appropriate government policies are needed to effect accelerated increases in the productivity of rice lands.

To reach self-sufficiency, rice production would need to increase to 2.6 million tons by 1990 and to 3.8 million tons by the year 2000, assuming current population growth rates. This would necessitate the doubling of present production in less than 20 years, a technically quite feasible task which can be accomplished if the will and resources of the Malagasy Republic are brought to bear on the problem.

RICE-GROWING ENVIRONMENTS OF MADAGASCAR

Madagascar is characterized by an extremely diverse array of temperature, rainfall, soil, and elevational conditions, necessitating a considerable degree of regional specificity in

most aspects of technological innovation in rice production. Countrywide production programs based upon a standard technical package would appear to be inappropriate. Given Madagascar's very limited research and extension resources at the present time, it would be most prudent to select only a small number of the most dominant and potentially productive rice environments for concentrated efforts.

The ten major rice-producing regions of the country are mapped in Fig. 2. They vary in size from over 300,000 hectares (Region I: Central Highlands) to micro-regions of about 10,000 hectares (Regions IX and X: Mangoky and Bezaha). We recommend that from these ten regions, five which have potential for high yields and are relatively risk-free should be selected for intensive rice production programs. These will be referred to as Accelerated Areas. Accelerated Area 1 (Central Highlands) and Accelerated Area 2 (Lake Alaotra) have the largest concentrated areas of rice and are judged most favorable for increasing rice production, both physically and logistically. However, certain of the smaller rice producing regions on the west coast may have relatively greater potential for double and triple cropping of rice under assured irrigation.

Somewhat more detailed information on rainfall, temperature regimes, soils, currently grown rice cultivars, crop cultural calendar, crop management practices, and relevant production

constraints follows for the three regions which contain the five proposed Accelerated Areas.

Climate

A basically tropical marine climate prevails on the island, but there are very important regional differences in temperature and rainfall. A simple description of climates divides the country into five areas (Fig. 3), three of which are important in terms of rice production. These are the Eastern Belt, the Central Highlands, and the Western Slopes.

The Eastern Belt has a wet tropical climate with no distinct dry season and 2000-3000 mm of annual rainfall. Temperature and rainfall do not constrain year-round rice production in appropriate areas, but flooding of rice lands during the period of heavy rains limits the present rice lands to one crop per year. Disease pressure is relatively higher than in the other parts of the country; rice blast is an important problem.

In the Central Highlands rice is grown at elevations of 800 to over 1700 m. Annual rainfall is generally 1000-1500 mm. The climate is a relatively pleasant high-altitude tropical climate. Cool temperatures and a long dry season limit rice production to the October to May period.

On the Western Slopes most of the rice is grown at relatively low elevation on river floodplains. Cold stress is not a problem

during the growing season (December to May), but the rainy season is limited. Annual precipitation is about 1500 mm in the Northwest and as low as 500 mm in the Mangoky and Bezaha rice-growing areas in the Southwest, where irrigation is a necessity.

Soils

Productive agricultural land is quite limited on this large island because only a small proportion of the land surface has reasonably productive soil (Fig. 4). Five percent of the total area is presently cultivated; 60% is in natural pasture. Alluvial soils exist in a long, narrow belt along the east coast, in the Lake Alaotra region, in small areas in the Central Highlands, and on the lower floodplains of several rivers on the western side of the island. Some of these soils are quite fertile and are reported to yield 3-6 t/ha without fertilizer.

The eastern two-thirds of the island has a surface layer of red, lateritic clay derived from the granite that forms the island's substructure. These soils vary greatly but are generally low to very low in cation exchange capacity, organic matter, and pH.

The western one-third of Madagascar has soils developed from varied mixtures of limestone, lateritic clay, gravels, and sediments from ancient and existing streams. These are also generally infertile, and rice in these areas is often confined to the pockets of alluvial soils.

The land available for rice production is no longer as readily available as it was during the 1960s when rice area expansion was quite rapid. Intensification of production is presently the major potential route to production increases.

The proposed Accelerated Areas

Data concerning the climatic conditions present and the crop calendar in the potential Accelerated Areas are shown in Fig. 5.

Accelerated Area 1: Central Highlands. The Central Highlands, which are composed of a series of valleys at 1200-1500 m elevation, are the heart of the country and the most densely populated area. Rice is grown on about 300,000 ha. The Betsimitatatra Plain surrounding the national capital of Antananarivo is well developed for rice cultivation, and a considerable proportion of the plain is irrigated from a river diversion irrigation system: 7000 ha out of a total of 20,000 ha. Farmers in this area are reported to have the highest levels of rice crop husbandry in the country. The average farm size is quite small (0.7 ha).

Average minimum temperatures do not reach above 17°C for 6 months of the year (Fig. 5), thereby making the possibility of a dry season crop considerably uncertain. Nowhere in the Highlands are two rice crops per year attempted. The seedbed is normally sown in September, and transplanting occurs in October

as the rains begin. The crop is harvested in April or May.

Some areas of the Plain, such as around Antananarivo, are subject to deep flooding in February. This has caused the development of a unique system to ensure harvest of the relatively long duration cultivars before February. Seedbeds are sown in April-May but are not transplanted until August-September (i.e., 80-100 day-old seedlings). The seedlings of the cultivar "Vary aloha" grow slowly during the cold period to reach transplantation size by the start of the rains.

Land preparation is done manually with hand spades or by trampling the fields with oxen. Weed control is done by hand, with some use of rotary weeders. Average yields exceed 2 t/ha.

The soils of the Central Highlands are generally poor, and years of fertilizer experiments have shown that the response of rice to NPK is quite strong (FOFIFA and FAO studies). The most outstanding responses were observed in the Fiarantsoa area in the southern Central Highlands, where 120-90-60 kg/ha of NPK increased average yields by 3.5 t/ha (six cultivars over 4 years of testing).

Phosphorus is deficient in virtually all Madagascar soils, including the Highlands. Potassium response has been noted on some Highland soils, but is not consistent. Highland farmers have traditionally used the highest fertilizer rates of all Malagasy rice farmers, and would presently be applying considerably

more if it were available.

The major rice production constraints appear to be:

- low fertilizer usage
- need for high-yielding, short-duration cultivars with cold tolerance at the seedling stage

Further crop intensification may be possible by growing short-duration cultivars of rice. CIMMYT has been involved in the development of wheat as a cold season crop. Major constraints appear to be the heavy clay soils, which make seedbed preparation difficult, and cool temperatures during the period of flowering and ripening.

Accelerated Area 2: Lake Alaotra. Lake Alaotra lies within a large intermontane basin at an intermediate elevation (about 800 m) between the Central Highlands and the East Coast. There are presently 90,000 hectares of rice grown in the basin, a portion of which is irrigated by five small reservoirs. The area has long been considered the most favorable location for intensive, mechanized rice cultivation in the country, and in the last two decades has been the scene of major development efforts.

Cool temperatures and lack of water prevent double cropping of rice during the dry season. Seedbeds are planted in October-November, transplanted in December-January, and the crop is harvested in April-May. An estimated 90% of the rice area is

cropped to a local selection, Makalioka 34, a javanica-type cultivar with a 180-day growth duration. Land preparation is done by tractor or oxen-drawn plow. Fields are quite large and suitable for mechanization.

Gley soils of three types dominate the basin. A large proportion of these have high organic matter contents and pose soil management and plant nutrition problems. Considerable areas have high native nitrogen levels, and yields of over 5 t/ha are frequently obtained without added nitrogen fertilizer. Phosphorus response is pronounced over nearly all of the basin. Potassium response is significant on only a limited portion of the basin.

The average farm size is relatively high (4 ha), and this accounts for major problems with weed control and other aspects of optimum management. Because of the existing labor constraint a considerable portion of many farmers' rice lands cannot be transplanted and is broadcast seeded. This direct seeded rice is generally not well managed and yields only about one-half as much as the transplanted rice.

The major production constraints include:

- labor bottlenecks in land preparation, transplanting and weed control
- poor weed control in direct seeded fields
- little or no fertilizer use by most farmers

- soil nutrient imbalances in the high organic matter soils
- lack of short-duration improved cultivars

The possibility of double cropping rice on the limited portions of the basin with dry season irrigation needs to be investigated. Cold tolerant cultivars are required. Wheat-rice rotation seems more feasible here than in the Central Highlands because of the more moderate temperatures.

Accelerated Areas 3, 4, and 5: Northwest and West Coast. The rice areas along several of the island's westward flowing rivers appear to have good potential for contributing to increased production. The country's only area of double cropped rice land, about 7000 hectares, is at Bezaha in the Southwest. Rainfall is generally confined to a 3-5 month period, but most of these areas have irrigation facilities.

The major production constraints appear to be:

- lack of high yielding, short-duration cultivars
- poor maintenance of irrigation systems
- salinity/alkalinity problems in most of the Marovoay area
- lack of fertilizer and production inputs
- poor transport and marketing infrastructure, which reduces production incentives

CULTIVAR IMPROVEMENT

Cultivar research

Most of the conventional cultivars grown in the Malagasy Republic are selections made by farmers from the local indica and javanica cultivars introduced to the country's diverse ecosystems by immigrants several centuries ago. Cultivar research was initiated in 1927 at the Marovoay Agricultural Station and later at the Lake Alaotra Station. It involved primarily making selections from local ecotypes and evaluating introductions from different countries. Hybridization was initiated on a modest scale in 1960, most of the crossing being done at the experimental station at Tametave. These resulted in the identification of cultivars with improved yield potentials such as Makalioka 34, Vary Lava Marovoay 47, Ali-combo, Tsipala A, Rojofotsy 1285, Hmbalalava 1283, and Vary Vato 462 for wetland rainfed and irrigated conditions; Boina 1329 and RS 25T for dryland conditions in the northwest; and three higher yielding strains of Latsika for the central high altitude regions.

Among the various introductions to the country, Chianan 8 from Taiwan, China was outstanding showing good performance at several locations under 1600 m altitude (average yield of 5 t/ha over 11 years). Other introductions which performed well in specific localities include IR8, IR20, TN1, and Taichung line 137. None of the introductions were found suitable for altitudes

higher than 1600 m.

During 1960-1976 approximately 700 crosses involving 300 parents were made. Indica/ponlai crosses were reported to be more useful. Twenty-two crosses were made specifically for pluvial rice using the best local ecotypes/selections and introduced cultivars as parents. Some of the more promising lines obtained through hybridization include Madirat 27 (Balaole/IR8), Madirat 123 (Makalioka 34/Chianan 8), and Madirat 36 (line 90/ Chianan 8). Madirat 27 (also referred to as line 2523) showed good response to fertilizers and has resistance to blast and lodging. However, the hybridization program was reported to have been discontinued after 1976. Mutation breeding was attempted involving 26 cultivars, but with limited success.

The results of multilocation trials indicated that the yields were better at higher altitudes than in the coastal plains. Average yields of local cultivars were higher in experimental plots than in farmers fields, indicating that the average farm yields could be increased with improved cultural practices. Based on the results of testing during the past several years, many cultivars/breeding lines were identified as promising for different regions (Table 1). Some of the widely grown cultivars include Chianan 8, Makalioka 34, Ali-combo, Kagoshima Hakamuri, Boina 1329, and Rojofotsy 1285.

Of the recent introductions through the International Rice Testing Program (IRTP), IR36, IR38, and IR45 have produced high yields and are of much shorter duration at the Lake Alaotra Station. However, these and the other cultivars/breeding lines have as yet not been tested at other stations because of the delay in their clearance through the plant quarantine requirements.

Suggestions for cultivar improvement

Low temperature is a major constraint in the Lake Alaotra basin region of Tametave Province and in the Central Highlands of Antananarivo and Fiananrantsoa Provinces. Cultivars presently grown in these areas do not have high yield potentials as well as cold tolerance, and cultivars with these attributes plus short growth duration could drastically improve yield per crop and the number of crops per year in these regions.

In some parts of the Central Highlands the rice crop has to be harvested by end of January before the heavy rains in February. While the normal sowing time in these regions should be September-October, because of the lack of appropriate short duration cultivars which could be sown in September-October and harvested in January, the nursery beds are raised in the month of May (beginning of the winter season) and seedlings more than 3 months old are transplanted in August-September. The seedlings of the conventional cultivars which do not have cold tolerance

grow slowly during the winter. Thus, a single rice crop is spread over 8-9 months.

For more productive land use it should be possible to grow a winter crop such as wheat from May to September and a short-duration, cold-tolerant (vegetative stage), and blast resistant rice crop from October to January. Alternatively, in the regions with excess water (500 to 2000 mm) from February to April, it should be possible to grow cultivars adaptable to medium deepwater and stagnant water situations that could be sown in November and harvested in May. With the residual moisture a wheat crop could be grown from May to October where the soils were suitable for such rotation.

In the Central Highland plateau, improved medium duration cultivars with resistance to blast can be grown in irrigated areas during the wet season, November to April, but short duration cultivars with some degree of drought tolerance are needed for areas without irrigation facilities.

In the East Coast region, weeds and blast are the major problems. It rains almost throughout the year. Medium to long duration cultivars of semidwarf to intermediate stature with resistance to lodging and blast and having grain dormancy are needed for these areas.

Soil salinity and alkalinity are the major problems in most of the West Coast region. Except for one or two local cultivars,

presently recommended cultivars do not have alkalinity/salinity tolerance. There is an excellent possibility of identifying early to medium duration, salt-tolerant, high yielding cultivars from the international nurseries.

In the Marovoay region in the northwest, considerable area is under deep flooding during the rainy season (December to April). Rice is grown only during the drier season, i.e., May to November, and is irrigated with the water stored from the rainy season. Winter months, however, have mild temperatures, and thus high yielding semidwarfs could prove very productive.

In the southwest (Mangoky region) two crops of rice can be grown where irrigation facilities are available, the first crop during the rainy season, i.e., November to May and the second crop from May to October. There is no problem of low temperature. IR8 has been yielding 6-8 t/ha for the last several years, and its highest yield was more than 11.0 t/ha. There is great potential for accelerated production in this region through use of appropriate improved cultivars of 130-135 days duration.

In the extreme north of Diego-Suarez Province, the potential exists for three crops of rice per year. This would require the use of high-yielding, early maturing cultivars coupled with appropriate fertilizer management. Zinc deficiency and iron chlorosis have been reported in certain areas of this region.

Judging from the rice growing environments and the cultivar

needs, it is obvious that a great potential exists for augmenting rice production through the use of high yielding cultivars with resistance/tolerance to common biological, physical, and chemical stresses. Use of nonphotoperiod sensitive, short duration cultivars would also help increase the cropping intensity in certain areas. However, little research has been conducted on this aspect in Madagascar.

To identify appropriate cultivars for immediate use, selected IRTP nurseries should be evaluated under various agro-climatic conditions as soon as possible. These should include irrigated yield nurseries of early and medium duration (IRYN-E and IRYN-M) for several regions; cold tolerant nurseries (IRCTN), irrigated yield nurseries of very early and early maturity (IRYN-VE and IRYN-E), and blast nurseries (LRBN) in the Central Highlands, Lake Alaotra, and the East Coast regions; medium and long duration cultivars (IRYN-L) in the East Coast; medium-deep and deepwater nurseries (IRDWON) in parts of the Central and East Coast regions; salinity nursery (IRSATON) in several areas of the West Coast; very early maturing irrigated nursery (IRYN-VE) in the northern province of Diego-Suarez for three crops of rice; and the rainfed wetland (IRLRON) and dryland rice (IURON) at appropriate locations throughout the country. In the initial stages, only selected entries from each of these nurseries could

be sent for expeditious clearance through plant quarantine and for careful evaluation under selected conditions.

In the long range, with improved research facilities and availability of trained manpower, it should be possible to undertake locally an intensified hybridization program to develop cultivars for the different ecosystems in the country. Meanwhile, seeds of the best adapted local and improved cultivars currently popular in the different regions of Madagascar can be sent to IRRI for making crosses with cultivars of superior agronomic attributes and resistance/tolerance to stresses common under Madagascar conditions. A well-organized, multilocation testing network within the country would speed up the identification of superior germplasm. The test sites chosen should be representative of the targeted ecologies.

ORGANIZATION

The Ministry of Agriculture and Rural Development was reorganized in October 1982. Most research is done by the National Center of Applied Research in Rural Development, known as FOFIFA, the abbreviation of its Malagasy name. The organizational structure is shown in Fig. 6 and 7.

A formal agreement coordinates departmental research activities and many scientists working with rice conduct research on other crops. An organization to handle all rice research and production would be helpful.

All seed entering Malagasy must go through plant quarantine. The plant quarantine department is careful to ensure that incoming seeds are healthy, but often it takes more than one year to clear seeds. Closer coordination between the plant quarantine department and research departments would speed appropriate seed clearance.

PRODUCTION CONSTRAINTS

Water. Improved, expanded irrigation facilities would increase rice production substantially. About one-third of the rice land has fairly dependable irrigation. The majority of rice is bunded rainfed wetland.

The Lake Alaotra basin has the largest irrigation area (30,000 hectares). The Antananarivo Plain has about 7000 hectares of irrigated land. A few areas of the western river floodplains have irrigation facilities.

Irrigation sources are reservoirs (138 country-wide) and river diversion systems. The government builds and maintains the primary and secondary canals. Farmer groups are responsible for tertiary field ditches. Maintenance of the major irrigation infrastructures has been inadequate during the past decade. Farmers have also let farm ditches silt up in many systems. Therefore, renovation of existing irrigation systems should receive high priority.

Drainage is a major problem in many areas. Flooding prevents rice double-cropping on the east coast, shortens the available growing period in parts of the Antananarivo Plain, and limits rice production to the dry period in many parts of the northwestern river valleys.

Soil. Madagascar rice soils are generally of low inherent fertility. Available phosphorus content is particularly low.

Response to phosphate fertilizers, applied with nitrogen, is frequently high.

Acidity is a problem on Lateritics in the highlands and other areas. In parts of the Northwest alkalinity and salinity are major constraints. Extensive areas of high organic matter soils of Laka Alaotra and the central highlands have nutrient imbalances. Straw application increases yields on these soils.

LACK OF APPROPRIATE VARIETIES

The unavailability of well adopted high yielding varieties with resistance to appropriate physical and biological constraints limits the increase of rice production. Most of the presently grown varieties are long duration and are not resistant to common pests, diseases, and tolerant of low temperature. Many varieties are prone to shattering, causing severe post harvest losses to occur.

It is likely that appropriate varieties for various ecosystems can be identified by growing relevant International Rice Testing Program nurseries. New varieties, expected to be of short growth duration, will help increase cropping intensity.

Availability of fertilizer and other inputs. Although commercial fertilizer is effective in Madagascar, usage rates are exceptionally low. The FAO estimated that only 9,300 hectares of riceland, of a total rice area of about 1,300,000 hectares, received fertilizer applications in 1979. The government bought 17,000 tons of

fertilizer in 1982, of which 80% was used on rice. This averages about 10 kg fertilizer applied per hectare country-wide, which is less than 2-4 kg of N, P, and K per hectare. At current prices, farmers' demand for fertilizer is estimated to be an additional 10,000 tons per year. Data available are inadequate for a precise analysis, but clearly indicate need to emphasize fertilizer use as a key component of increased rice production.

Major constraints to increasing fertilizer are a deficiency of foreign exchange, and lack of transportation (rail and road capacity) to ship the fertilizer from the port city (Tametave) to the highlands where most of rice is grown. Virtually no insecticides, herbicides and fungicides are available to farmers.

PESTS, DISEASES AND WEEDS

Pests and diseases are important problems of rice in Malagasy. Stem borer is the most serious problem. We were told that diseases are not very severe although a few fields were destroyed by the rice blast. There is potential danger of disease problems which may get accentuated by increased fertilizer use:

INSECTS:

Major pests:

White borer, *Maliarpha separaratela;* Pink borer, *Sesamia colomistis; Trichispa sericea;* and *Hispa gestroi*

Minor pests:

Leucaria loreyi, Borbo borbonica, Diplosis fallax, Nazara viridula, Asparia longispina, Acrosternum acutum, Spodoptera mauritia, Nymphula depunctalis, Nymphula fluctuosalis, Nephotettix apicalis and *Locais vienna*

The white borer is found in irrigated rice and the pink borer is prevalent in upland rice. *Hispa* spp. and *Trichispa* spp. are common to all types of rice culture.

Detailed biological studies of most common insects have been conducted. Several years ago, research to determine varietal resistance to stem borers was undertaken but local selections were even moderately resistant. The project was discontinued. Several experiments have also been conducted to determine appropriate insecticides and the correct rate and time for their applications.

These experiments were at FOFIFA station plots. No tests

were conducted in farmers fields. Farmers rarely use insecticides.

More research has been done to develop biological control methods using parasites, predators, and bacterial pathogens of the white borer. *Bacillus thuriengiensis* is effective against this insect but additional research is needed to determine its effectivity in farmers fields. Two species of bacteria that show high entomogensis against *Maliarpha* have been isolated. Their identity has not yet been established.

DISEASES

Major rice diseases in Madagascar are blast, brownspot, and ufra (caused by nematode *Ditylenchus angustus*).

Blast is the most common disease, although plant pathologists believe that its races in Malagasy are less virulent than races elsewhere. Nevertheless, a few fields have been destroyed by blast disease. It is a potentially serious problem. It is more prevalent under upland conditions, particularly following droughts.

Screening of rice varieties for resistance to blast has been conducted since 1968 but no varieties have been found resistant. Most recommended varieties possess a medium level of horizontal resistance. Varieties 1490, 1300, and 2366 were rated to be highly tolerant; 1418 was rated moderately resistant and 1632 is susceptible. FOFIFA plant breeders have tested selected varieties at various locations in the country during the past 2-3 years but plant pathologists are not acquainted with the test

methodology or results. There is also some question regarding the consistency of results. For example, the variety MK-34 was moderately resistant in the tests but became very susceptible following the application of 200 kg/ha of nitrogen fertilizer.

High organic matter soil (peat soil), high irrigation water aluminum content, phosphorus deficient soils, and green manure caused high disease incidence. High silica content in soil reduces disease persistence. Epidemiology is closely associated with climate. Yield losses caused by leaf and neck blast were severe in peat soils of Lake Alaotra region. Application of a mixture of scories (ash from factories) and ash of the various refuses in the rice fields minimized blast incidence.

Fusarium monoliforme has been observed in irrigated rice fields but has not been systematically investigated. Damping off in the seed bed caused by *Pythium* and *Costicium* has also been recorded. Treating seeds with mercury fungicides prevents blast infection.

Panicle discoloration was caused by fungi such as *Anvularia*, *Nigrospora*, *Cladosporium* and *Fusarium*.

Sheath rot *Rhyzoporium*, and rice virus diseases have not been recorded although bacterial leaf streak, *Xanthomonas campestris* pv. *oryzicola*, and bacterial leaf blight, *Xanthomonas campestris* pv. *oryzae* have been reported.

Ufra disease occurs sporadically. In the 1960s it was a serious problem but has been a minor problem in recent years. Treating seeds with hot water and with the extracts of certain plants (actual names could not be determined) is practiced by farmers.

Brown spot disease is more prevalent in the east coast and south west regions. Low phosphorus and high aluminum soils favor the disease.

Recent studies have shown that disinfecting seeds with vanomena and five other fungicides prevented infection by various pathogens.

WEEDS

Weeds are a serious problem, particularly in direct seeded rice. Farmers are well aware of the weed problem and most fields we visited were relatively weed free. Hand weeding is the prevalent method of weed control and virtually no herbicide is used by farmers. In experiments at research stations several herbicides have provided efficient weed control.

Plant Quarantine

Clearing seed through plant quarantine usually takes 6 months, usually much longer, and is a major constraint. A sample of seed from each package must be grown in the greenhouse. The remaining seed is released if the plants in the greenhouse are disease free, otherwise, they are destroyed. Seeds are also carefully screened in the laboratory for the presence of any insect or pathogen. Greenhouse facilities being used for all crops can accommodate only 3,000 varieties at any one time.

Two groups of promising breeding lines and varieties (IRTP nurseries) have been introduced into Malagasy. The first was cleared through quarantine after one and one-half years. The second group, brought in about six months ago, is waiting to be tested. We were told that 200 tons of IE36 seed imported to Malagasy was later sent to another African country as it could not be cleared by quarantine for cultivation in Malagasy.

Marketing, Prices and Transport Facilities

Since the Societe de l'Interet National des Produits Agricole (SINPA) was created in 1973, rice marketing has been a government monopoly. SINPA shares this responsibility with several other government agencies.

Nonincentive prices and delayed payment reduce farmers' enthusiasm for raising productivity. The official price for paddy

was 38 FMG/kg in 1979, and is now 60 FMG/kg. The open market price is more than double this price. Assured and remunerative marketing holds the key to stimulating and sustaining farmers' interest in enhancing production.

Another important disincentive is the scarcity of reasonably price consumer goods. With little to buy and low income from rice production, farmers are only maintaining or sometimes reducing per hectare productivity.

Transporting rice from surplus areas to deficit areas is increasingly difficult because the road network is deteriorating. Storage facilities are inadequate and the government estimates that about 20% of total production may be lost during processing and marketing.

Farmers are not producing surpluses and urban areas are increasingly depending solely on imported rice because of existing disincentives. Milled rice is rationed in Antananarivo. The official price is FMG 140/kg. However, rice is being sold unofficially for FMG 255/kg.

The poor performance of the rice sector during the past several years has resulted from inadequate management of rice marketing and from inappropriate price policies.

Action to improve rice marketing efficiency and to set paddy prices that reward the farmer for his toil in sun and rain is urgently needed.

RECOMMENDATIONS

The information reviewed in preceding sections shows there is potential to substantially increase rice yields and cropping intensity in the Malagasy Republic. Although the national rice yield average is 1.8 ton/ha, 6-8 tons/ha yields have been obtained in experiments at research stations and in production trials in farmers fields. It is also possible to increase cropping intensity by using short growth duration rice varieties tolerant to common biological and physical constraints.

Climate and soils in several areas are favorable for rice production and there are seven rice research stations located in major rice producing areas. However, although some excellent rice production research has been conducted, their adoption and integration into farmer production, and even at experiment stations is not documented. There is shortage of qualified staff and severe funding constraints have curtailed most research activities. These limitations, compounded with fertilizer, pesticides and other production input, scarcities and low rice prices to farmers have caused virtual stagnation in rice production during the past several years.

A three-step process is recommended to accelerate production of rice and associated crops during the next 5 years and to build a base to further increase production. This will consist of:

1. Accelerate production programs in selected favorable, relatively risk-free areas (Fig. 2) using available rice varieties and production technology. Because some production technology still needs to be verified it would be best to start with pilot projects and then expand when appropriate production technology becomes available. Various inputs should be made available and the rice marketing and price policy should be revised to provide more incentive to the rice farmers.

2. Immediate steps should be taken to train scientific personnel and improve research facilities. Experiments to develop appropriate technology to accelerate rice production beyond the 5-year period should be taken. Experiments must include rice breeding programs using locally adapted varieties. High yielding, short-duration varieties resistant to common biological and physical constraints should be introduced and research on various aspects of rice-based cropping system, and other rice production technologies should be conducted.

3. The existing irrigation system should be repaired and additional irrigation systems should be built. Roads and transportation systems must be improved and expanded to provide better transport facilities for rice and production inputs.

A more detailed description of this plan is outlined below:

TO IMPROVE PRODUCTION WITHIN THE NEXT 5 YEARS

1. Accelerated production programs using conventional varieties could be undertaken in the 5 favorable and low-risk areas shown in Fig. 2. Fertilizer availability and adoption of improved cultural practices (proper sowing and transplanting dates, land preparation, weed and water management) are essential to this program's success. A pilot project should be started in each of the selected ecosystems as soon as possible.

2. Selection of appropriate high yielding varieties. Rice varieties with 4-5 month duration that have cold tolerance, are high yielding, have insect and disease resistance, are drought tolerant, have low grain shattering and are of good grain quality should be selected. Varieties for the western coast should be tolerant to salinity.

International nurseries evaluation will probably identify varieties/breeding lines suitable to these areas. Testing a limited number of short growth duration breeding lines and IRRI named varieties has shown several of them to be better than the currently grown varieties. Evaluation of international rice nurseries should be given high priority. The selected lines should be used in applied research trials in farmers fields. If they show promising results, accelerated production programs should be started as soon as possible.

3. Planting short duration varieties will increase rice or rice-based cropping system intensity. Rice-rice, rice-wheat, and rice-legumes are good possibilities of several areas but will need to be verified, because little cropping systems research has been done in Madagascar.

4. Five scientists should be trained in each International Rice Testing Program (RPTP) and Genetic Evaluation and Utilization (GEU) course at IRRI. These scientists will provide leadership to pilot production programs.

5. The Plant Quarantine Department should be strengthened to make expeditious clearance of seed materials possible.

6. The manual rice transplanter should be evaluated in Malagasy. If it is satisfactory, arrangements for manufacture in Madagascar should be made. The use of communal rice nurseries appears appropriate in Malagasy. This will help adopt appropriate methods for growing nurseries that will be suited to transplanter use.

7. Rice prices paid to the farmers should be increased and marketing facilities should be improved to provide greater incentive for increasing production.

LONGER-TERM PROGRAMS

1. More scientists need to work with rice and research facilities must be expanded.

2. Scientists should be trained in relevant training programs. M.S. and Ph.D. degree training should also be emphasized.

3. An integrated and multidisciplinary rice research, extension, and production program should be organized. It should include research on rice-based cropping systems, and applied research in farmers fields. It would be advantageous to start a separate rice research institute to coordinate these activities.

4. Well-adapted traditional varieties and exotic promising lines/varieties should be tested in breeding programs to develop high yielding varieties that are resistant to common biological and physical constraints to rice production and are adapted to various agroclimatic conditions in Malagasy.

5. Existing irrigation facilities should be repaired. New irrigation systems should be developed.

6. Fertilizers, certified seed, pesticides, and other production inputs should be made available to farmers. Farmers should have access to credit to purchase these inputs.

7. With the availability of additional information, scientific personnel and research facilities the accelerated production program should be also expanded to the remaining rice production 5 zones in the Republic of Malagasy.

We believe the implementation of these policies will not only make the country self-sufficient in rice but will likely make it a rice exporting nation again.

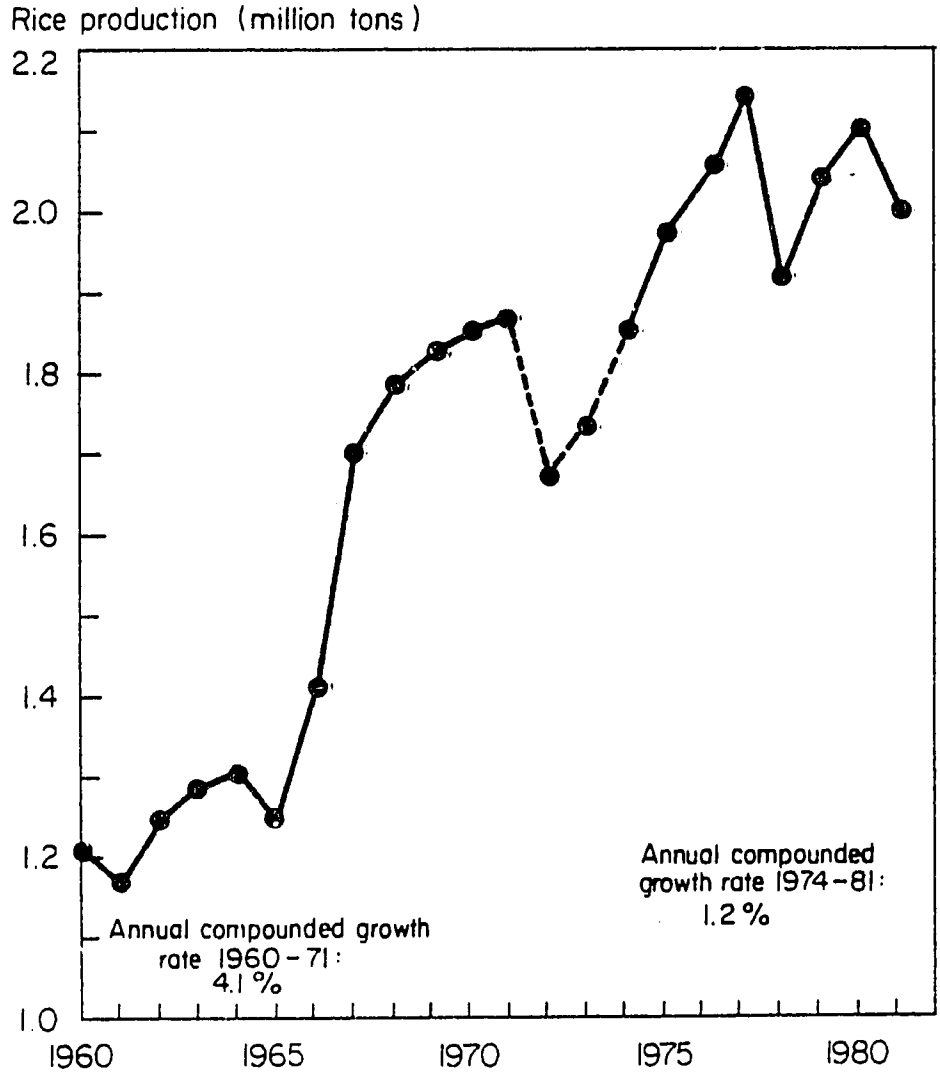


Fig. 1. Trend in paddy production in Madagascar, 1960-1980.
Data sources: MORRA, World Bank.

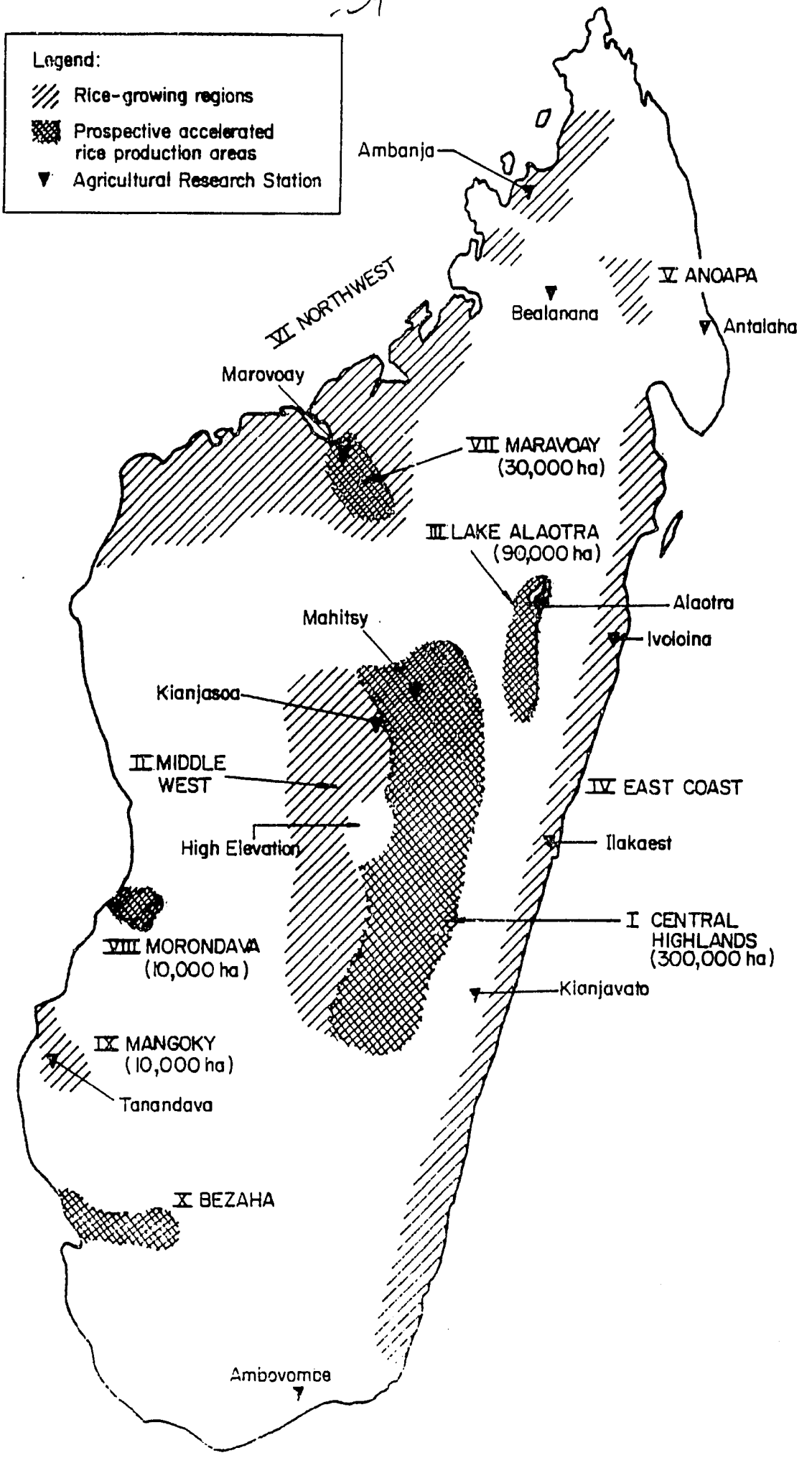
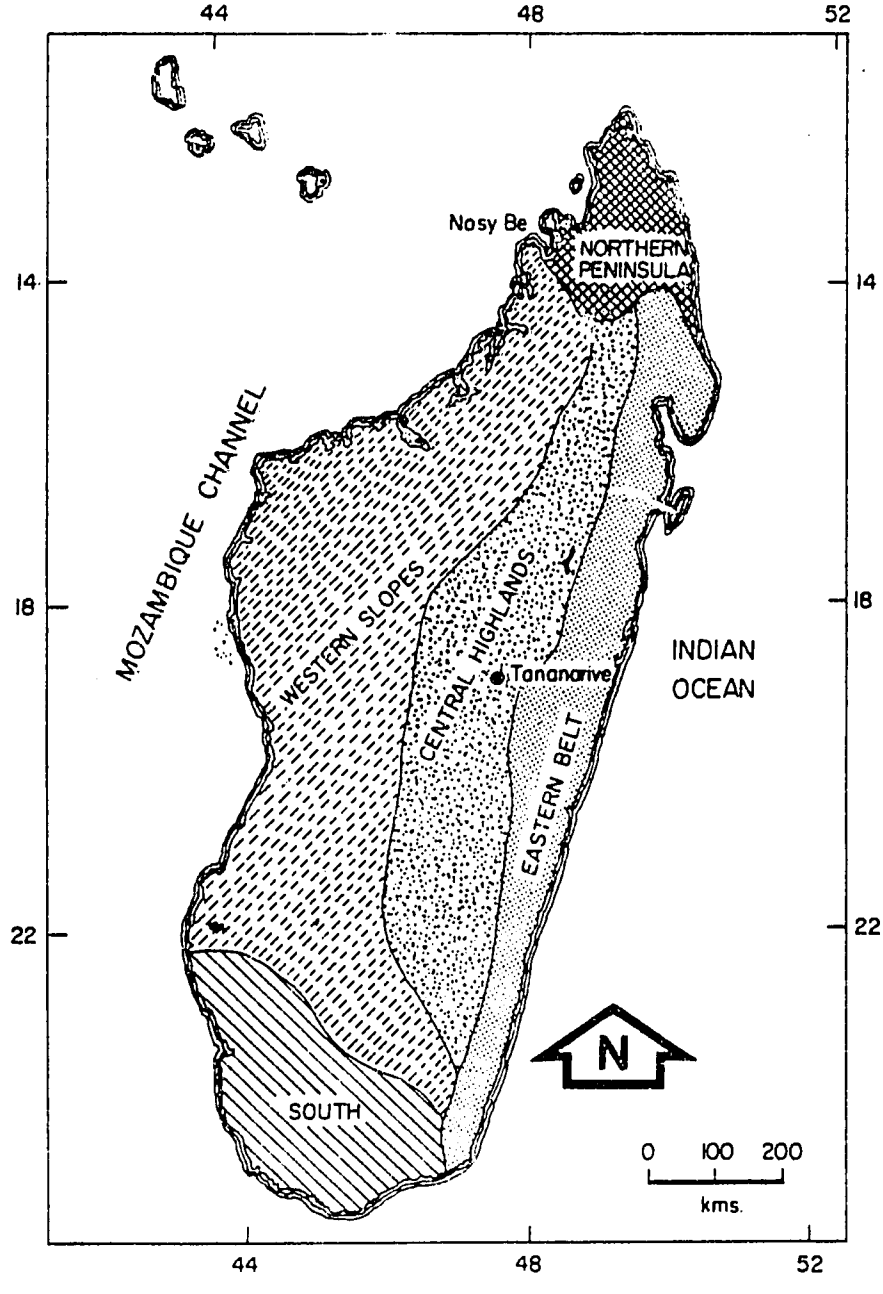


Fig. 2. The ten major rice-producing regions of Madagascar.



Eastern belt: no dry season; rain forest; commercial and subsistence agriculture.

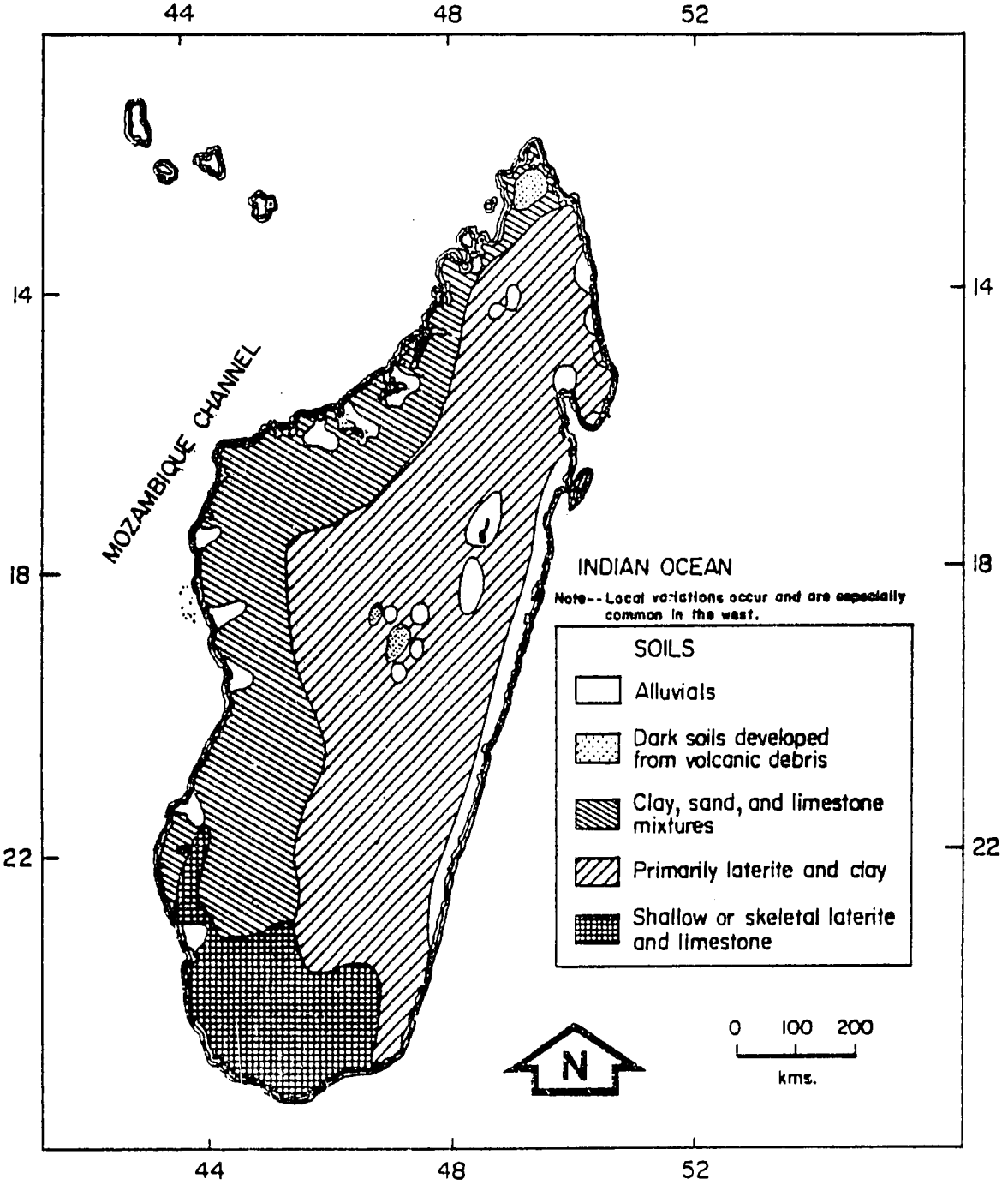
Northern peninsula: similar to eastern belt, with seasonal differences in rainfall.

Central Highlands transition zone; moderate highlands climate; short dry season; mixed vegetation and varied agriculture.

Western slope: dry season, longer toward the south; savanna vegetation; pastoralism and some form areas.

South: semidesert; scrub; pastoralism.

Fig. 3. Geographical regions of the Malagasy Republic.



Source: Adapted from André Guilcher and René Battistini, Madagascar: *Géographie Régionale*, Paris, 1967.

Fig. 4. Predominant soil types of the Malagasy Republic.

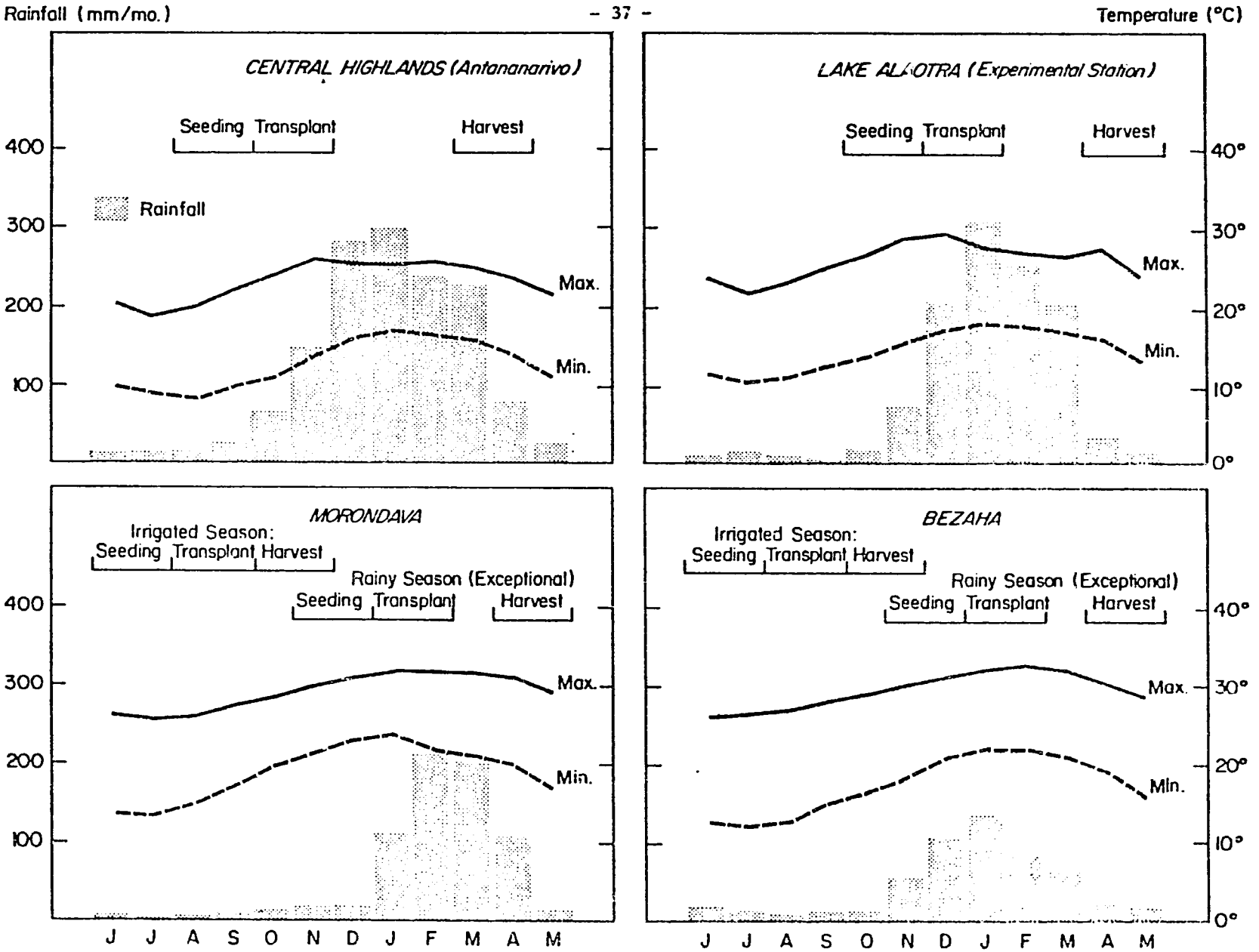


Fig. 5. The rainfall and temperature regimes and rice crop calendar for four prospective areas of accelerated rice production in Madagascar.

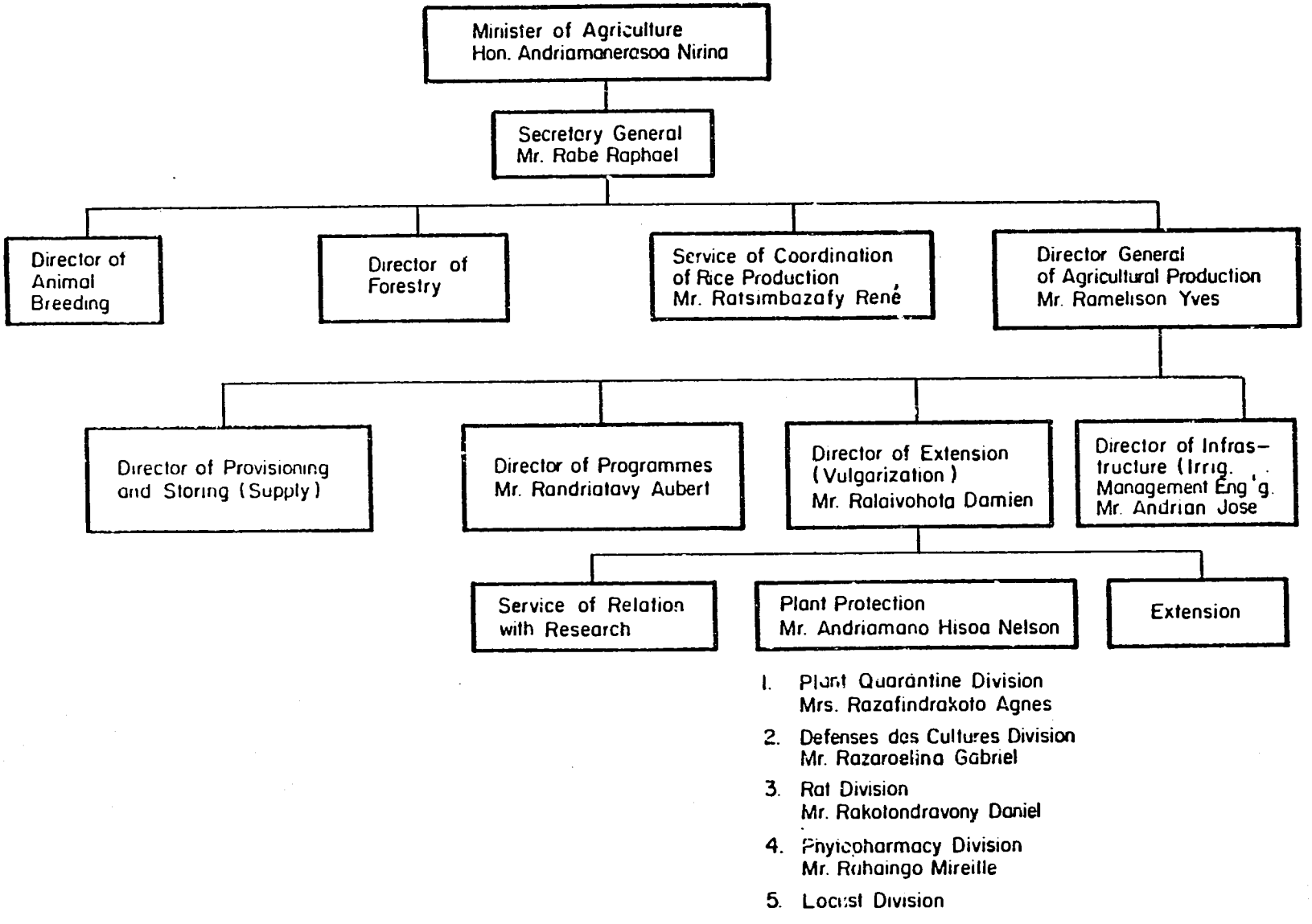


Fig. 6. Organizational structure of the Ministry of Agricultural Production and Agrarian Reform, Madagascar.

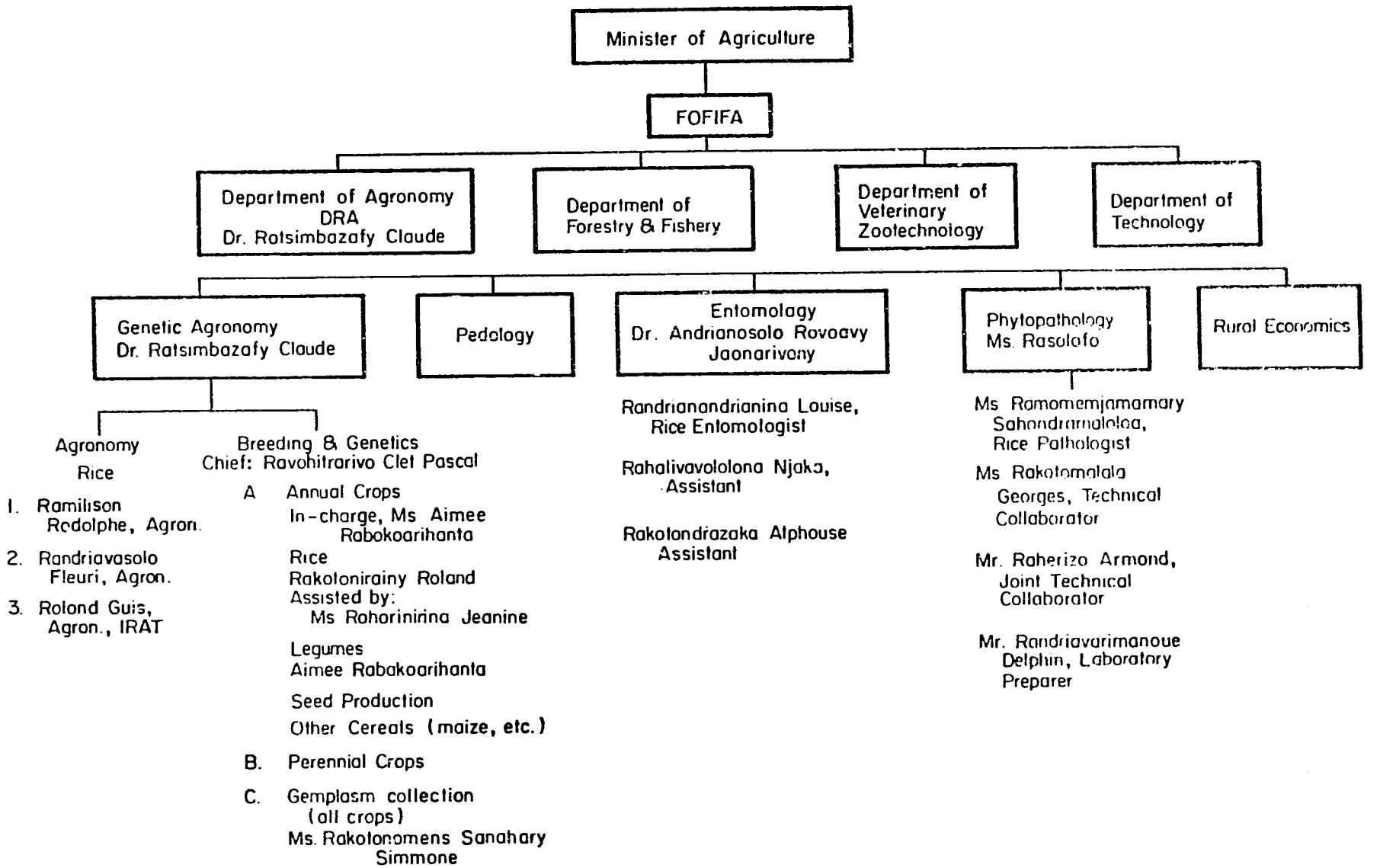


Fig. 7. Organization structure of the National Center of Applied Research in Rural Development (FOFIFA), Madagascar.

Table 1. Current and prospective cultivars for different regions of Madagascar

Province	Cultivar	Origin	Duration	General Adaptability	Lodging[a/]	Grain shattering[a/]	Grain quality	Blast	Culture
Diego-Suarez	Bengala Morima	local	120	good	S	S			irrigated
	IR8	IRRI	135	good	R	R	intermediate		irrigated & rainfed lowland
	Cica 4	Colombia	120		R	R	good		irrigated & rainfed lowland
	IR20	IRRI	130	moderate	MR	R	good		irrigated & rainfed lowland
	Boina 1329	local	140	moderate	R	R	good		irrigated & rainfed lowlan.
	Chianan 8 selection	Taiwan, China	130		R	R		R	irrigated
Fianarantsoa	Very Lava	local	170	good	S	S			irrigated
	Ambalalava	local	170	good	S	S		R	
	Chianan 8 selection	Taiwan, China	170		R	R		R	irrigated
	Vary Vato	local	170	moderate	S	S	good		irrigated
	Ali Combo	local	175			R	very good		irrigated
Antananarivo Alt. 1300 m	Rojofotsy	local	180	very good	MR	MR		MR	irrigated
	Chianan 8 selection	Taiwan, China	170		R	R		R	irrigated
Alt. 1300-1700 m	Rojofotsy	local	180	very good	MR	MR		MR	irrigated

contd...

Province	Cultivar	Origin	Duration	General adaptability	Lodging	Grain shattering	Grain quality	Blast	Culture
Antananarivo									
Alt. > 1700 m	Latsika D	local		very good (tolerant to low temperature)			intermediate		
Mid-West	Kagoshima Hakamuri I	Japan	155	good	R	R		MR	pluvial
	Daniela	Brazil	early	good	R	R		R	pluvial
Tulear	Chianan 8 selection	Taiwan, China	150		R	R		R	irrigated
	Tsipalamena	selection R.A.M.		very good					
	Tsipalafotsy	selection R.A.M.		very good					
	34/38	local hybrid	160		MR		very good		
	IR8	IRRI		very good	R	R			irrigated
Mahajanga	Cica 4	Colombia	120		R	R	good		irrigated & rainfed lowland
	Alicombo	local	160	moderate		R	very good		irrigated
	Boina 1329	local	140	moderate	R	R	good		irrigated & rainfed lowland
	IR8	IRRI	135		R	R	intermediate		irrigated & rainfed lowland

contd....

Province	Cultivar	Origin	Duration	General adapatability	Lodging	Grain shattering	Grain quality	Blast	Culture
	Rakaraka	local	145	good	S	S			irrigated
	Makalioka 34	local	180	good	S	S	good	S	irrigated
	Chianan 8 selection	Taiwan, China	140		R	R		R	irrigated
Tamatave (East Coast)	Chianan 8 selection	Taiwan, China	140		R	R		R	irrigated
	Madirat 36	local hybrid	150	moderate					irrigated & pluvial
	RS 25T	local	130	very good	MR	MR		MR	pluvial
	Kagoshima Hakamuri I	Japan	150	good	R	R		MR	pluvial
Alaotra	Daniela	Brazil	120	very good	R	R	intermediate	MR	pluvial
	Makalioka 34	local	180	very good	S	S	good	S	irrigated
	Vato	local	150	very good	MR	MR		MR	irrigated
	Madirat 27	local hybrid	150		R	R		R	irrigated
	Chianan 8 selection	Taiwan, China	140		R	R		R	irrigated
	IAC25/64	Brazil	125		MR	MR		MS	pluvial

a/ S= susceptivle, MR= moderately resistant, R= resistant.

-oOo-