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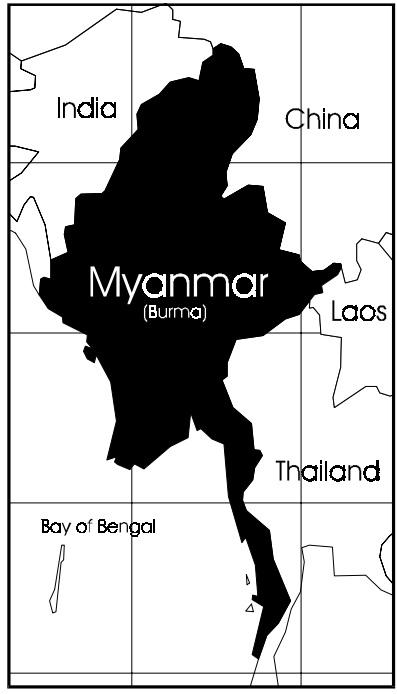

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CONVERSIONS RELEVANT TO THIS REPORT

1 kilogram (Kg) = 2.205 pounds (lb)
1 hectare (ha) = 2.471 acres (ac)
1 basket of paddy = 20.86 Kg or 46 lb
1 basket of milled rice = 34.01 Kg or 75 lb
Exchange rate (Official 1995) = Kyats 6.4 per US$1.00
Exchange rate (Unofficial 1995) = Kyats 104 per US$1.00
1 viss = 1.54 Kg or 3.6 lb
1 pyi = 2.13 Kg or 4.69 lb
1 US$1.00 = Kyats 104 at 1995 unofficial exchange rate
1 US$1.00 = Kyats 4.6 at 1995 official exchange rate

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PREFACE

In this study, the Myanmar rice economy is described in the context of the current political situation and state of national economic development. The forces that are changing rice production and exports are identified; however, the rate of development involves a complex integration of government intervention and politics, as well as availability of resources. Probable scenarios for rice production and export are projected based on recent growth trends and expected infrastructure development. The Arkansas Global Rice Model is used to integrate the Myanmar rice sector with the global rice market in developing projections.

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1.0 INTRODUCTION

Myanmar (formerly known as Burma) was the dominant rice exporting country in the world during the first half of this century, accounting for nearly three-fourths of the world rice exports. Production was severely disrupted by World War II. Thereafter, Myanmar's exports became less dependable under intervention policies of the new independent government. Thailand rapidly emerged as the dominant world rice exporter while Myanmar's position declined because of restricted output, inferior quality and uncompetitive prices.

It may be noted that the rapid growth of rice production in Thailand that occurred in the 1970s was due almost entirely to heavy state investment in flood control and irrigation development rather than to improved varieties or increased chemical inputs, especially in the Central Region, according to Richter (1976). Since Thailand has physiographic conditions similar to those of Myanmar, with rain-fed rice in the lower flood plains and low rainfall conditions in the upper Central Region, it is not surprising that the Myanmar government has been following a similar strategy to increase rice production. Irrigation development has been concentrated largely in the dry zone of central Myanmar, in Mandalay and Magwe Divisions.

Myanmar has the potential to regain its position as a major world rice exporter because of the favorable natural environment and abundant cultivatable land but has experienced repeated difficulties in maintaining growth in rice production. The major reported problems restricting the rice production potential have included conflicting government policies that distort price signals, grossly misallocated resources, political unrest and inadequate infrastructural development (Soe, 1994a). Agricultural development in Myanmar after independence included a stagnant phase from 1962 to 1973 followed by a period of transformation from stagnancy in 1973 (Hossain and Oo, 1995). Stagnation again occurred due to major political unrest and macroeconomic instability after 1985. Since 1990, both rice production and exports have again been on the upsurge as a result of the government's program to expand cultivated area and to increase multiple cropping of rice. Nevertheless, the government's policies continue to distort price signals and misallocate resources; thus, most observers of Myanmar's political and economic progress are still skeptical as to whether the current new growth phase is sustainable without dramatic change in agricultural policies and substantial investments in infrastructure.

Since most of the history of rice production in Myanmar since the 1960s has involved major government intervention, it is difficult to estimate what the potential supply response would be with increased production incentives. The nature of government intervention affecting the rice sector over the past 35 years has been highly variable and relatively complex, including 1) varying the rice procurement requirements per farmer depending on the farmer's land area, rice yield and family size; 2) varying procurement prices relative to market price; 3) overinflating the Myanmar exchange rate causing rice exports to be over priced and a serious shortage of foreign exchange to import key inputs such as fertilizer for crop production; and 4) using various forms of persuasion to increase rice production (such as providing special subsidies for rice farmers). Data shortages in Myanmar are a further obstacle to estimation of supply response.

Despite the complexity of modeling Myanmar's rice sector, an econometric study claiming some success was reported by Hossain and Oo (1995). An appraisal of this major supply response study is included in this report. The elasticity coefficients available from this 1995 study are helpful in making projections of the potential rice output and of the export capability of Myanmar under alternative growth scenarios. However, the timetable for attaining these projections will depend on other factors besides available production coefficients, such as the progress of current infrastructural development programs and the potential for further area expansion and for multiple cropping. It is also important to evaluate the impact of expanding Myanmar's rice exports on the world rice market and the potential of Myanmar to compete on quality and price with other major rice exporters such as Thailand and Vietnam. Since

Myanmar has the potential physical capability to match Thailand as the dominant world rice exporter, there is a clear need to examine and understand the conditions under which Myanmar's rice sector has been operating.

This report is organized as follows. Section 2 presents a general description of Myanmar's agricultural development and of its rice sector. Section 3 reviews major changes in Myanmar's rice policy. Government interventions in rice production are examined from the British Colonial period to the present independent government. Sections 4 and 5 describe the different rice production systems in Myanmar and the marketing system, milling sector and trends in rice consumption, including the government interventions in marketing. Section 6 assesses the capability of expanding rice production and identifies constraints. Section 7 discusses results using the Arkansas Global Rice Model (AGRM) to project Myanmar's potential rice exports, drawing on supply elasticity coefficients derived from other studies, on government planning for infrastructural development, on rice production improvements reported in rice research studies and on price implications derived from evaluating increased rice exports from Myanmar. Sections 8 and 9 present production and export projections and a summary and conclusion.

2.0 STATUS OF AGRICULTURAL DEVELOPMENT IN MYANMAR

2.1 Natural Resources of Myanmar

Myanmar is situated on the mainland of Southeast Asia, lying between 10^0 and 29^0 N latitude and between 92^0 and 101^0 longitude. It is the largest country in the southeast Asian continent with a total land area of 676,577 sq. km. or 261,228 sq. miles, nearly five times the size of Arkansas and about 7.4 percent the size of the United States (Fig. 1). Myanmar shares a land boundary of 5,858 km with five neighboring countries—Bangladesh and India on the northwest, China on the northeast and Laos and Thailand on the southeast. The total coastline extends 2,276 km along the Bay of Bengal on the west and the Gulf of Martaban on the south. The capital and major export port are located at Yangon (formerly called Rangoon).

Topographically, the country is very rugged and mountainous in the north and in the west. The eastern part is less mountainous and forms the Shan plateau, which extends south to the Tenasserim coastal range. The topography varies from flat land at sea level in the delta and in river valleys to snowcapped peaks of over 5,881 meters (18,000 ft.) in the north. Annual average rainfall ranges from about 800 mm (30 inches) to nearly 5,000 mm (200 inches) (see Table 2.1). Most of the rainfall is during the monsoon season, mid-May to mid-October, with a pronounced dry period during the winter months. Recorded temperatures in various parts of Myanmar range from a low of 0.3^0C (32.5^0F)

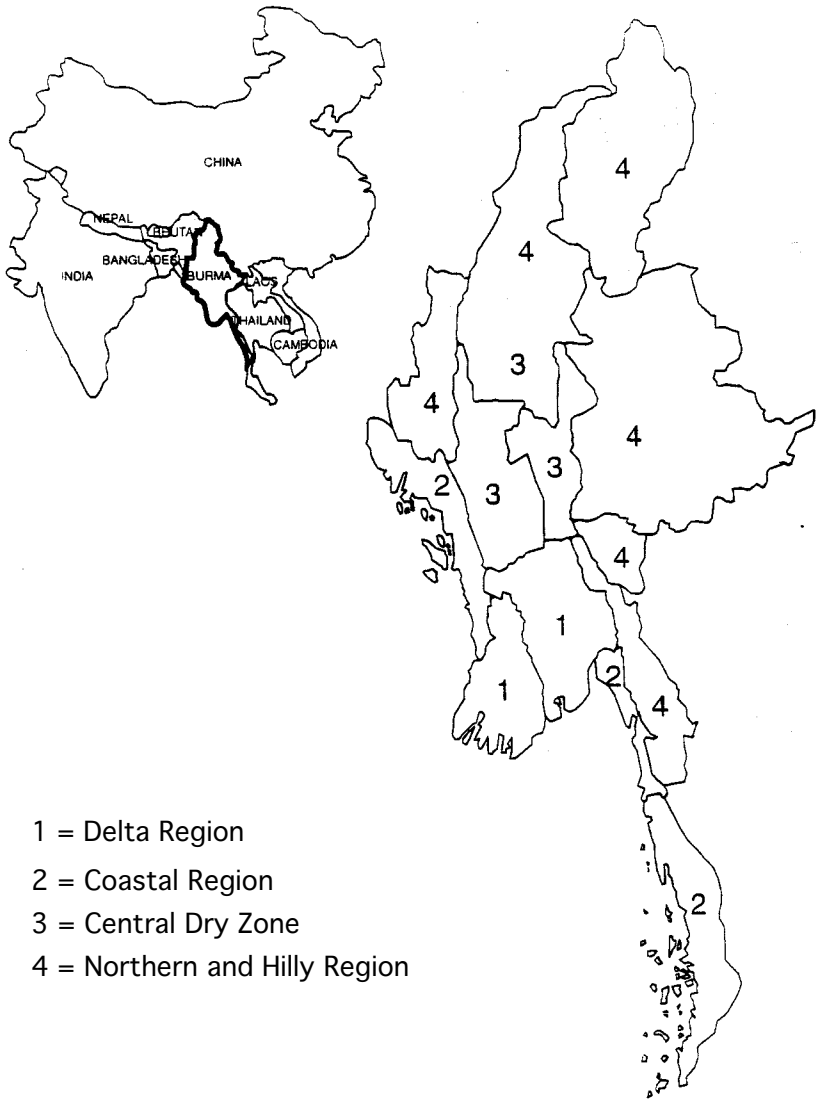
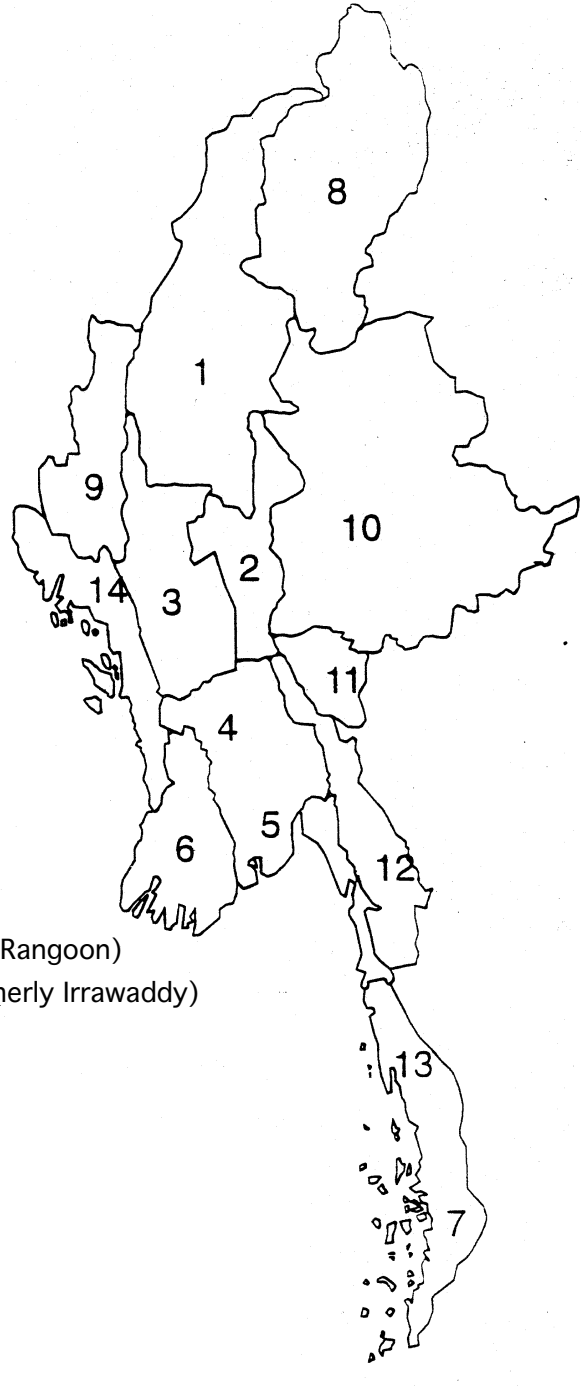


Figure 1. Map of Myanmar showing major geographical regions.

to a high of 46^{0}C (114.8^{0}F). The central part of Myanmar, including Mandalay and Magway divisions (Fig. 2), is a dry zone, the northern and hill zones are relatively wet, and the coastal and lower delta zones have high rainfall. The Ayeyarwady (formerly called Irrawaddy), stretching 2,170 km, and its major tributary, the Chindwin, covering 960 km, constitute the major river system. The river system is navigable through the center of the country, from Yangon north to near Bhamaw at the China border. The Ayeyarwady forms a large delta



Divisions

1 = Sagaing
2 = Mandalay
3 = Magwe
4 = Pegu
5 = Yangon (formerly Rangoon)
6 = Ayeyarwady (formerly Irrawaddy)
7 = Tenasserim

States

8 = Kachin
9 = Chin
10 = Shan
11 = Kayah
12 = Karen
13 = Mon
14 = Arakan

Figure 2. Administrative regions of Myanmar.

of 240 km by 210 km where it enters the sea. This delta is the major rice production area.

Four transitional seasons have been defined as follows (Ministry of Foreign Affairs, 1992):

1. Pre-southwest monsoon from March to mid-May (dry, hot season);
2. Southwest or summer monsoon from mid-May to mid-October (wet season);
3. Post southwest monsoon from mid-October to November (dry season); and
4. Northeast winter monsoon from December to February (dry, cool season).

The southern coastal strips and delta regions receive heavy rains, whereas the central plain is a dry zone receiving low and erratic rainfall.

Myanmar has a relatively benign climate compared to Bangladesh and other neighboring rice-producing countries. Droughts or floods are rare, and the incidence of cyclones, earthquakes and other natural hazards is also low. The country has so far had limited industrial development. Agriculture is the most important economic sector, accounting for 65 percent of the labor force and 38 percent of the GDP in 1993-94 (Ministry of Agriculture, 1995b). The rate of deforestation has been relatively moderate compared with that of most other Asian countries (Table 2.2) with a remaining forest area covering a third of the country, an area nearly the size of Japan. The population pressure is low compared to most developing countries in Asia and the Pacific with an estimated total population of 43.13 million in 1993-94. The recent population growth rate has averaged 1.88 percent annually with a population density of 64 per sq km in 1993 (Minister of Foreign Affairs, 1992). About 76 percent of the population live in rural areas.

Rice is the single most important crop, grown on 5.5 million ha (13.6 million acres), about 60 percent of the country's total cultivated area in 1993/94. The land area suitable for rice in Myanmar has been estimated at 6 million ha (International Rice Research Institute, 1993). The estimated potential total cultivable area is 17 to 18 million ha, but so far only about 8.5 million ha is under cultivation. Major infrastructural improvements are needed to increase production of the agricultural sector, including irrigation, flood protection and drainage. Currently, about 1.5 million ha, or 17 percent of the crop land, is under irrigation, of which about 0.3 million ha is double cropped. About 1.2 million ha is protected from flood damage. Flooding in low areas is a problem in rain-fed lowland rice production, which comprises about 52 percent of total ricelands, and excess water also restricts deep-water rice, about 24 percent of land planted to rice.

Overall, Myanmar has a large reserve of nearly 10 million ha of idle cultivable land, including 1.6 million ha of fallow land and 8.2 million ha of cultivable wasteland (Table 2.2). Much of the potential cultivable wasteland is located in relatively less-populated and remote areas to the north and east in river basin areas of Kachin State and Sagaing Division that are not readily accessible and have low infrastructural development (Fig. 2). Many of the existing roads in these remote areas are not passable in the rainy season, and navigation is currently limited to the Ayeyarwady and Chindwin rivers. The Thanlwin (Salween) River is only partially navigable. The fallow land currently has some beneficial use as it generally is used as part of a long-term crop rotation system to help control weeds and to restore fertility to the land, e.g., in Shan State.

Potentially cultivable land may be further increased with the use of new technology. For example, rice-fish farming was only recently introduced in deep water areas as a new farming system. The 1993-94 total sown area in all crops was 11.39 million ha, including 2.65 million ha of double cropping (Ministry of Agriculture, 1995b). The total cropping intensity on all cultivated land was 130 percent in 1993-94 but potentially could be increased with further drainage and irrigation development. Less than 10 percent of the surface water flow to the coast is currently utilized.

The three main soil groups in the country that are important for agriculture are alluvial soils, black soils and red lathyritic soils. Alluvial soils occupy about 50 percent of the total sown area and are located in river basin and delta regions. Black soils occupy about 30 percent of the area and are generally found in the central dry zone (Calhoun, 1989). Red lathyritic soils occupy about 20 percent of the area and are found in lower Myanmar, associated with undulating topography. Problem soils currently encountered on cultivated land include 0.6 million ha of saline soils (about 3.3 percent of the total potential cultivable land stock of 18.3 million ha), 0.05 million ha of alkaline soils and 0.3 million ha of local problem soils, such as acid sulphate soils, degraded soils, peaty soils and swampy soils (Ministry of Agriculture, 1994b).

2.2 Social and Economic Conditions in Myanmar

Economic growth in Myanmar has lagged behind that of most other Southeast Asian countries, particularly during the period of increased government intervention from 1962 to 1988. Except for a surge in activity from 1973 to 1985, this period was relatively stagnant. During the 1962 to 1988 time period, high priority was placed on the use of central planning. Since 1988, the centrally planned economy in Myanmar has been transformed into a more liberalized, market-oriented economic system with the introduction of some economic reforms. During the 27 years prior to 1988/89, rice production grew at only 2.3 percent per annum (p.a.) while domestic rice consumption increased 3.6 percent p.a. (Soe, 1994b). The overall economy also fared poorly, and total im-

ports exceeded total exports throughout the 1980s, resulting in constant annual deficits of about 4 percent of GDP. The debt service payments almost doubled to reach 70 percent of current receipts in 1986/87, and the country's international reserves went down from Special Drawing Rights (SDR) $73 million in 1982/83 to SDR $36 million in 1986/87. Continuing foreign exchange shortages in Myanmar have created serious bottlenecks in the national economy, including restrictions on some imported agricultural inputs such as fertilizers.

Improvements in economic performance that have occurred since the 1988 reforms have increased reported agricultural production and exports, but continued high inflation, limited growth and a trade imbalance still exist. There were Kyats 4,069.7 million domestic exports compared with Kyats 5,241.5 million imports in 1993/94 (Ministry of National Planning and Economic Development, 1994b). The availability of chemical fertilizers has improved since the economic crisis in 1988 but is below the planned annual utilization targets to date due to restricted foreign exchange.

The Government of Myanmar has held ownership of all agricultural land since 1965 but provides long-term leases to tenants and their descendants to enable them to benefit from making capital improvements. Annual rental charges (taxes) for cultivated land are extremely low at only Kyats 12 to 25 per ha. The agricultural sector labor force was 10.97 million in 1993/94 compared with a total labor force of 16.82 million. About 62 percent of the farms are under 5 ha in size, as shown in Table 2.3. There are an estimated 4,442,000 farms in the country, accounting for 9.9 million ha of land. The largest farms are mostly used for perennial crops, such as rubber or oil palm.

For administrative purposes, the country is divided into seven states and seven divisions (Fig. 2). The four levels of administration include 1) the central level at Yangon, the capital of the country; 2) the state or divisional level in the capital cities of the states and divisions; 3) the township level in the capital cities of the townships; and 4) the village level. These levels have been traditionally administered by council members, who are elected every four years.

2.3 General Overview of Rice Sector Development

2.3.1 Historical Development of Rice Production Development. Myanmar experienced three distinct periods of rice production growth from the latter 1880s to 1985 (Win and Win, 1990). The first major period of growth between 1885 and 1910 involved rapid expansion of rice area in Lower Myanmar under British colonization. The second growth period occurred between 1955 and 1965 when riceland abandoned during World War II was returned to production. The third period occurred from 1975 to 1985 as a result of applying new technology in rice production. Since 1988, the area of rice production has increased because of an expansion of irrigation in the dry season; however, there has been no perceptible improvement in yield since 1985.

The British began annexation of Myanmar in 1826, starting with Arakan and Tenasserim, and finally most of the country including the Ayeyarwady Delta in 1885. Strong support was given to developing rice production in Myanmar as the American Civil War had shut off Britain's usual imported rice supply from the United States, and the Suez Canal had been opened by 1869 to facilitate export trade from Oriental countries to Europe. Measures taken by the British to encourage rice production included legislation to protect foreign investors, a protected land tenure system to give farmers a permanent and inheritable title to their land, improvement in river and rail transport, tax exemption on newly cleared land and an immigration scheme to bring in Indian migrant labor and also to facilitate resettlement of upper Myanmar farmers to the lower delta rice growing areas.

The national rice area increased from only 27,000 ha in 1830 (Win, 1991) to 4.9 million ha by 1932. Annual rice production increased from about 44,000 mt in 1830 to over 8 million mt by 1932. The newly developed Ayeyarwady Delta in lower Myanmar accounted for 59 percent of total rice production in the early 1930s. Production in other rainfall zones included 4 percent in the Northern Wet Zone, 13 percent in the Upper Dry Zone, 6 percent in the Mid Zone and 18 percent in the Coastal Wet Zone (Appendix Table 1). The Ayeyarwady Delta had the highest average annual paddy yield, about 1.85 mt per ha, in the 1931/32 to 1933/34 period. Total annual exports of milled rice and paddy in terms of milled rice increased from 1.1 million mt in 1890 to 2.9 million mt by 1930 (Fig. 3). Myanmar quickly became the major world rice exporter, contributing 47 percent of world exports in 1938/39.

The major classes of rice produced in Myanmar during the British Colonial period included Emata, Letywezin, Ngasein, Meedon and Byat (Appendix Table 2). The Emata and Letywezin groups have relatively long, thin grains whereas

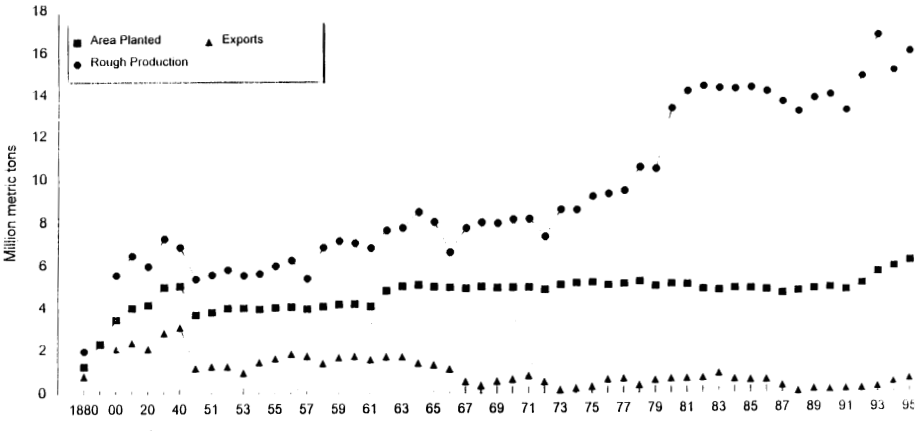


Figure 3. Historical change in paddy production and rice exports.

the Ngasein, Meedon and Byat groups may be classed as "bold," short-medium grain types. Other differences in classification are that the Emata, Letywezin and Ngasein are hard and translucent, and the Meedon and Byat groups are softer and more opaque. Ngasein was the most common type produced and exported during the Colonial period—it was known everywhere as "Burma Rice." Current production and exports are mostly of the Emata type.

Myanmar's rice exports to Europe during the 1930s competed with medium-grade exports from Indo-China and Thailand and with high-grade exports from Thailand, America, Spain and Italy. Myanmar was the major supplier to India and Sri Lanka because of the transport advantage over other rice surplus countries such as Indo-China and Thailand.

2.3.2 Current Development of Rice Production. The estimated total 1993/94 planted paddy area for the different rainfall zones of Myanmar (shown in Appendix Table 3) has increased only about 16 percent since the early 1930's. The 1993/94 area was 5.7 million ha compared with 4.9 million ha from 1931/32 to 1933/34. Virtually all of the 1930s rice crops were rain-fed crops in the wet monsoon season whereas nearly 0.9 million ha of the reported 5.7 million ha total sown ha in 1993/94 were irrigated second crops in the dry season after the monsoon crop. The only land area used for rainy-season rice that had increased substantially since the 1930s is in the Northern Wet Zone. The rain-fed area had declined in all other rainfall zones except for a slight increase in the Ayeyarwady Delta.

Yield in 1993/94 was about half larger than in the early 1930s (Appendix Tables 1 and 3). About half (53 percent) of the rice produced in 1993/94 was high-yield varieties (HYVs). Average national rice yield is still very low compared to other Asian countries because of low input use.

3.0 RICE POLICY IN MYANMAR

3.1 British Colonial Policy, 1885-1948

The major policies used to help develop the rice sector under British Colonial rule included the following:

- Setting specific grades and standards for rice to facilitate trade, e.g., standard varieties defined in Appendix Table 2;
- Assisting in the transmigration of settlers from Upper Myanmar to Lower Myanmar and in the immigration of Indians to settle in Lower Myanmar to develop the Ayeyarwady Delta for rice;
- Improving river and rail transport to facilitate north-south movement between Upper Myanmar and the delta;
- Providing tax exemption for 12 years on newly cleared land;

- Providing government loans for development in the rice industry (not used much by farmers);
- Providing legal protection for private money lenders and other investors to support development of the rice sector;
- Constructing embankments at government expense in tidal swamp areas to prevent flooding and encroachment of saline water;
- Providing improved rice seed to farmers, particularly to improve milling outturn (reduced variation in grain size);
- Encouraging the rice milling industry and trade, both internal and external, by helping many commercial firms and private enterprises;
- Providing a secure ownership title to property owners; and
- Providing a "laissez faire" competitive environment with minimal government intervention in production or trade except for maintaining basic law and order.

The free enterprise rice policies of the British Colonial government encouraged rapid growth in Myanmar's rice cultivation with production tripling from 2 million mt in 1885 to 6 million mt in 1910.

Rice production, rice exports and rice prices were remarkably stable for a relatively long time under the free enterprise system established in the British Colonial period. Annual paddy production ranged from a low of 5.4 to a high of 7.6 million mt in the period from 1900 to 1936, and annual exports ranged from 1.8 to 3.4 million mt over the same period. Production varied with the behavior of the monsoon rain. The domestic rice price in Yangon ranged from a low of 95 rupees per 100 baskets in 1900 to a high of 195 rupees in 1922, 1924 and 1925 and then fell to a low of 75 rupees in 1931 in the midst of a major world recession (Appendix Table 4). Rice yield remained relatively low over the colonial period, and production was mainly determined by changes in area rather than changes in yield. No commercial fertilizer or modern rice varieties were used during the British Colonial period in Myanmar. Rice production was seriously interrupted by World War II, and half of the rice area was abandoned.

The major criticism of government rice policy during the British Colonial period was that it eventually led to political instability and pressure for land reform, particularly when the private money lenders ended up owning a major part of the rice land in lower Myanmar. The landlords also charged exorbitant rents (e.g., small tenant farmers were often forced to pay about 84 percent of their output as paid-out costs, largely for rent and interest to their landlord, leaving them only 16 percent to cover the "cost of living"). The British Colonial system in Myanmar provided no remedies or laws to prevent these economic and social inequalities. These social and economic problems led to increased government intervention and socialist policies after independence.

3.2 Post-Independence Policy, 1948-1962

Food grain policy objectives followed by the new independent country of Myanmar from 1948 to 1962 have been described by Soe (1994b) as follows:

1) Maintaining food self sufficiency and food security;
2) Improving consumer welfare by subsidized sale of basic food grains, particularly rice;
3) Expanding food grain production for promotion of export and raising government foreign exchange (FE) via implicit export laws for food grains;
4) Keeping domestic food grain prices low to maintain a low cost of living to contribute to socioeconomic stability;
5) Giving farmers a guaranteed minimum price to maintain stability of farm production and income; and
6) Stockpiling rice to stabilize the market and domestic price.

The post-independence government promoted food self sufficiency and food security (welfare and stability) as major changes in rice policy compared to the British Colonial period but maintained the principle of "export promotion" under a mixed economic system that retained a leading role for the free market. The new government intervention and control measures introduced at the beginning of the post-independence period were confined largely to procurement and export of food grains; however, there was also some intervention in domestic retail marketing to distribute subsidized rice to the poor. Other wholesaling and retailing of food grains continued to be conducted by private traders in a free trade environment. The government maintained a relatively stable rice market from 1948 to 1962 with inflation kept reasonably well under control (Appendix Table 4). The sown paddy area was gradually increased to replace the area abandoned during World War II, but Myanmar did not reach the former peak production level of over 7 million mt achieved by 1930 until the 1960s (Fig. 3). There was little improvement in varieties or production methods to increase the average rice yield compared with that of the British Colonial period.

3.3 Socialist Republic Government Policy, 1962-1988

The food grain policies followed by the socialist government in power from 1962 to 1988 added two more new objectives to the earlier list of six:

1) To encourage food grain production by subsidized sales of inputs, free provision of agricultural extension services and cheap agricultural credits; and
2) To introduce scientific methods and improved cultivation practices in agriculture to raise per-acre yields and total output.

Although the stated government policy objectives were little changed from the previous post-independence 1948-1962 administration, the means used and

the level of intervention of the new socialist government in food grain production and trade were changed dramatically. Government intervention and controls were introduced to cover almost all activities of food grain production, procurement, distribution, milling, storage, transportation and domestic wholesale and retail trade, etc. (Soe, 1994b). Private land ownership was changed to state ownership, and the previous landholding right of farmers was replaced by "the land tilling right." With the change in property rights, food grain growers became obligated to sell a fixed quota of their food grains, the "Compulsory Delivery Quota," to the government at a fixed price. The policy emphasis of the socialist government was put on consumer welfare with extensive use of food subsidies, and private marketing was prohibited. The government subsidized the sale of rice to consumers and distributed rice through the state economic enterprise (SEE) system.

The agricultural sector was relatively stagnant from 1962 to 1973 as there were no significant improvements in technology or institutions; the production level was determined mainly by weather.

A new socialist government formed in 1971 established high growth targets for the agricultural sector and actively began promoting the use of technology and strengthened institutions to achieve the planned growth targets. Paddy production increased 80 percent from 1973 to 1983 and surpassed an average yield of over 2 mt per ha by 1978-79. The paddy area in high yield varieties (HYVs) increased from 4.3 percent in 1972-73 to over half of all paddy in 1986-87. Average fertilizer use per ha increased from about 5 kg in 1970 to 49 kg in 1983. The rice technology package introduced through the government extension service in a major campaign in 1973 included use of HYVs, proper tillage, optimum plant population, optimum seedling age at transplanting, greater use of farm yard manure and chemical fertilizers, modern practices of weed control, insect and disease control and other improved practices for reducing crop losses. Experiment stations were established to conduct location-specific research in all administrative regions by the early 1970s. Rice procurement prices were more than doubled from 1972 to 1974 (Table 3.1). Urea prices were reduced by half and held constant until 1987. Other inputs were also subsidized. This development program ran into difficulties in the 1980s as fertilizer demand far exceeded supply and producers were forced to reduce the fertilizer application rate.

Despite the high cost of the agricultural development program and consumer subsidies of the socialist government, only moderate inflation problems were experienced until 1986. Average annual inflation then accelerated to 28 percent from 1986 to 1987, mainly due to huge increases in fiscal deficits financed by foreign loans and borrowing from the banking sector. The excessive spending resulted from the government fixing prices without proper assessment of the supply-demand situation and artificially maintaining the ex-

change rate at a very high level. As exports became uncompetitive due to the continued high exchange rate, the severe decline in export earnings reduced the capacity of the economy to import essential capital goods and agricultural raw materials, such as fertilizer. The limited earnings from food grain export were drained away by the increased import costs of raw materials and by increased domestic costs of food subsidies. The official procurement of food grains also declined, restricting both the domestic food supply and the food grain exports; consequently, the demand-supply balance of food grains was upset, and the economy deteriorated quickly. The outcome was a chronic food shortage, development of "Black Markets," and the collapse of Myanmar to less-developed-country status in 1987.

3.4 State Law and Order Restoration Council, 1988 to Present

The State Law and Order Restoration Council (SLORC), a military government organization, assumed power in September 1988. The SLORC largely discontinued the socialist philosophy of the previous government and adopted the concept of a market-oriented economy. Official food grain policy objectives of the SLORC were 1) to produce surplus paddy for domestic food security and for promotion of exports, 2) to be self sufficient in vegetable oils and 3) to expand production of pulses and beans for export.

In line with the SLORC's goal of developing a market-oriented economy and reducing socialism, the subsidized sale and rationing of food grains became limited to only government employees; however, a program to increase the supply of "nutritional food" for the poor was initiated (Soe, 1994b). The major policy change of the SLORC was to replace the former socialist government's "welfare first, import substitution, and inward-looking programs" with "growth-first, export-promotion, and outward-looking programs."

Methods of increasing the food supply were defined by the SLORC as follows: 1) transforming wasteland into cropland; 2) expanding the capacity and sources of irrigation; 3) increasing the cropping intensity; 4) increasing the use of high-yielding seed varieties, modern inputs and improved and locally suitable practices and technologies and 5) encouraging the entrepreneurial skills and the innovative ability of farmers.

Until the SLORC administration, the food grain policies since 1989 have become more concerned with enhancing production rather than with enhancing consumption. The SLORC has also decontrolled agricultural commodity prices and increased the price of gasoline, electricity, telephone service and water. However, the state has still remained strongly interventionist despite some significant liberal reforms by preventing speculation in the market and by extending special privileges to joint-venture companies that are quasi-government organizations. These continued interventions have contributed to the

persistence of segmented markets and price distortions, including continued high inflation (Soe, 1994b).

Visits to Myanmar in 1994 and 1995 for this study confirm that the SLORC has been making visible progress in completing some infrastructural improvements, including irrigation development, road construction and drainage, although there is a severe shortage of available capital to finance infrastructural improvements in the country. A total of 32 new irrigation dams were constructed from 1990 to 1994, and the crop irrigated area increased from 12.1 to 16.6 percent of the net cultivated area (Ministry of Agriculture, 1994a). Foreign exchange to import raw materials has been the primary constraint in infrastructural development, and few foreign donors have been present in Myanmar to assist on government projects.

Continued border conflicts and lack of confidence by private investors have further limited economic development in Myanmar. Discussions with government representatives also indicate possible management and administrative problems within the government in developing the economy due to the highly centralized SLORC management system and to inexperience of some SLORC officials. The responsibilities for developing different sectors of the economy are reported to have been assigned to a few key individual officials of the SLORC with apparently limited coordination among them. For example, there is a strong policy emphasis on increasing production of oilseed crops such as groundnuts and sesame to reduce dependence on imported cooking oil, but there is reportedly excessive waste in processing the oil from available oilseed crops in Myanmar. The available domestic groundnuts and sesame seeds continue to be extracted with antiquated and inefficient animal-operated mechanical extraction methods although more modern solvent extraction equipment is being used for the rice bran processed from procured rice. The value of surplus (unextracted) oil contained in exported sesame and groundnut cake with present extraction methods is estimated to be the equivalent of nearly half of the current annual import cost of vegetable oil to Myanmar. Improving the oil processing methods would save the government considerable foreign exchange and also reduce the competition in resource use between rice and oilseed crops since increasing oilseed production is given equal policy priority to increasing rice production. Other examples of inefficient utilization of raw materials and of antiquated production methods were observed throughout the country, indicating the need for technical assistance. However, the lack of foreign exchange as well as previous isolationist policies have been a serious constraint to improved technology.

4.0 DESCRIPTION OF RICE PRODUCTION SYSTEMS IN MYANMAR

4.1 Methods of Rice Cultivation

Traditional rice cultivation methods in Myanmar are divided into two categories: dry upland and wet cultivation. The dry upland cultivation methods generally practiced on wooded hillsides are typical slash and burn methods used for subsistence production. The area of traditional (Taungya) shifting cultivation on hillsides has been declining and is being replaced by a dryland crop-rotation system with a much shorter fallow period. The current rice area grown under upland dryland cultivation constitutes only about 6 percent of current national production with almost all of it consumed locally.

In lowland, rain-fed, wet rice cultivation, the rice is kept partially submerged from transplanting to harvest with three distinct types of growing conditions:

1) the plant is kept at least partially submerged by natural rainfall during most of the growing season, such as on low-lying swampland;
2) the plant is kept at least partially submerged as a result of natural drainage or irrigation in addition to natural rainfall; and
3) the plant is grown on land bordering lakes or rivers that are subject to flooding but may be produced with successive plantings, level by level, as the floodwater subsides.

Another common distinction in rain-fed, lowland cultivation is whether the paddy field has a bund or not. Most lowland rice fields have a bund except in some areas subject to flooding.

Rice was traditionally produced once a year in the wet monsoon season, and short-duration pulse crops were planted following rice harvest in some of the heavy clay soil areas in the delta. Residual soil water after rice harvest helped to sustain these short-duration pulse crops in the dry season. Dry-season rice production is generally not feasible without irrigation.

Preparations for the annual monsoon rice crop in Myanmar generally began with the plowing and seeding of rice nurseries on about 10 percent of the rice production area after the first rains in late April and early May. The nursery area is plowed and harrowed several times, and weeds are removed before planting. Sprouted seed is planted in the nursery area. Other unplanted rice fields are then plowed and harrowed to be ready for transplanting at 4 to 5 weeks (June to July) after the nursery is planted. Plowing and harrowing are still largely done with a pair of bullocks or buffaloes. Animal manure may be incorporated in the soil in the above tillage operations. A recent Myanmar study of paddy field cultivation reported that it took 14.7 hours per ha with an 8.5-hp power tiller versus 22.7 hours per ha with two buffalo for plowing and 8.7 compared to

21.9 hours per ha for harrowing (Palis et al., 1989). However, few farmers are able to afford power tillers.

Rice producers in Myanmar traditionally have little work taking care of their monsoon paddy after transplanting except for replanting seedlings that may have failed through flood or drought. Some work may be needed to prevent the water in paddy fields from stagnating by periodically opening and closing the bunds and to keep the drainage channels clear.

Rice harvest for the monsoon crop in Myanmar usually commences around the end of November and continues for 5 to 6 weeks. Threshing floors are prepared by each farmer near his house on a square of about 20 yards by leveling the ground, plastering it with cow dung and trampling it flat. The paddy is cut by hand, bundled in sheaves and left in the field a few days to dry. Paddy sheaves are then transported to the threshing floor and laid around a central stake with the heads pointed inward. The grain is trampled out by cattle, winnowed by hand and returned to the threshing floor for sale or stored by the farmer for home consumption. Traders and millers traditionally visited different threshing floors of the farmers after harvest to make their purchases.

The current major rice ecosystems include the traditional rain-fed, lowland crop that is grown in the monsoon season (about 52 percent of total ricelands), deep-water submerged rice (about 24 percent), irrigated lowland rice (about 18 percent) and rain-fed upland rice (about 6 percent).

Rain-fed lowland and deep-water rice are mostly produced in the lower Ayeyarwady-Pegu Delta region and the coastal strip of Rakhine State. Irrigated lowland production is concentrated mainly in the central dry areas of Mandalay, Sagaing and Bago Divisions. The current rain-fed upland area is mostly in Mandalay, Sagaing and Shan states (see Fig. 2).

As reported earlier, the rice farming system was almost entirely monoculture rice in the British Colonial period with most of the land left fallow between monsoon crops. However, in some parts of Upper Myanmar, particularly where irrigation was available, farmers traditionally practiced some double cropping, e.g. rice-pulse or rice-sesame. Most rice farmers own at least a pair of draft cattle that are used in all tillage operations as well as for threshing and carting products to market. Farmers supplement pasture feeding their cattle with rice straw, rice bran and other crop byproducts.

Cropping intensity of all field crops with rice as the dominant monsoon crop increased gradually from 107 percent in the 1930s to 124 percent by 1985 but then accelerated to 134 percent by 1993/94 (Ministry of National Planning and Economic Development, 1994). Factors that contributed to higher cropping intensity were as follows:

1) increased irrigation;
2) increased use of modern varieties (MYVs) with short growth duration;

3) increased harvest mechanization and tractor tiller facilities; and
4) higher crop prices, e.g., for edible oil-bearing crops, to make double-cropping more profitable.

Recent innovations in rice production include multiple rice cropping, rice ratooning, rice gardening and rice-fish farming in deep water areas (Maung, 1995). These recent innovations have helped to intensify rice production. As shown in Table 4.1, paddy is the dominant field crop, covering about two-thirds of the total planted area. Since 1989, the government has developed additional irrigation facilities to produce more summer (dry-season) paddy with a planned area of 1.6 million ha in the 1993/94 crop year (Fig. 4). Total paddy production comprised a new record of 16.7 million mt in the 1995/96 crop year, including about 14 million mt of monsoon and 3 million mt of summer paddy. About two-thirds of the summer paddy is produced in Ayeyarwady and Pegu divisions.

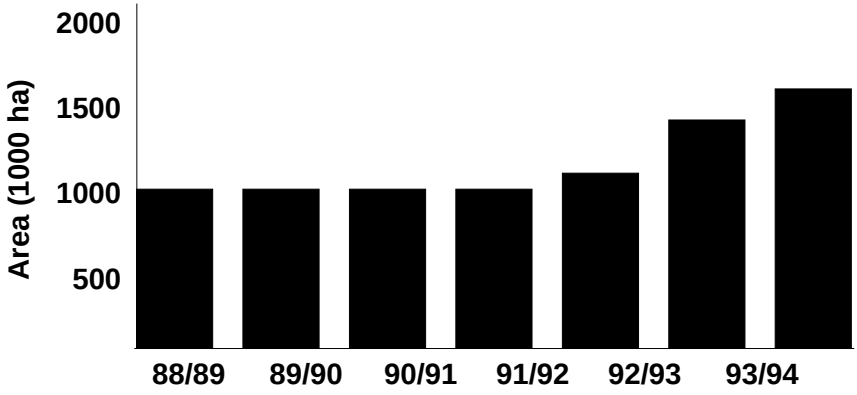


Figure 4. Change in irrigated area in Myanmar.

4.2 Rice Variety Use and Production Constraints

More than 2,000 different rice varieties have been used in Myanmar. Many varieties are identical although they are called various names in different areas of the country. All varieties were classified during British Colonial times (as shown in Appendix Table 2) to facilitate trade. Average paddy yield with these traditional varieties was typically in the range of about 1,700 kg per ha from 1830 to 1913 (Win, 1991). There was virtually no improvement in the average national yield after 1913 until new HYVs were systematically introduced in the 1970s. Traditional varieties were segregated according to their life length or maturity period, including the following:

1) short-duration early rices (seed to seed in 100 to 150 days);
2) medium-duration rices (150 to 170 days); and
3) long-duration rices (170 to 200 days).

Rice growers have typically planted a mixture of all three different maturity period varieties for security against varying monsoon rainfall periods and to spread their workload.

The first introduction of a HYV to Myanmar was IR-8 (a dwarf, stiff-strawed, high-yielding variety released by IRRI) in 1967. IR-8 produced high yields but had unacceptable grain quality. The Agriculture Corporation of the Socialist Republic Government then imported IR-5, which had less yield capability but better quality than IR-8. Other HYVs were subsequently introduced, as shown in Table 4.2. Total use of HYVs peaked at about 53 percent of the total rice sown area in 1986-87. The use of HYVs declined in the later 1980s due to reduced input subsidies and shortages of fertilizer that reduced the yield advantage of HYVs (Fig. 5).

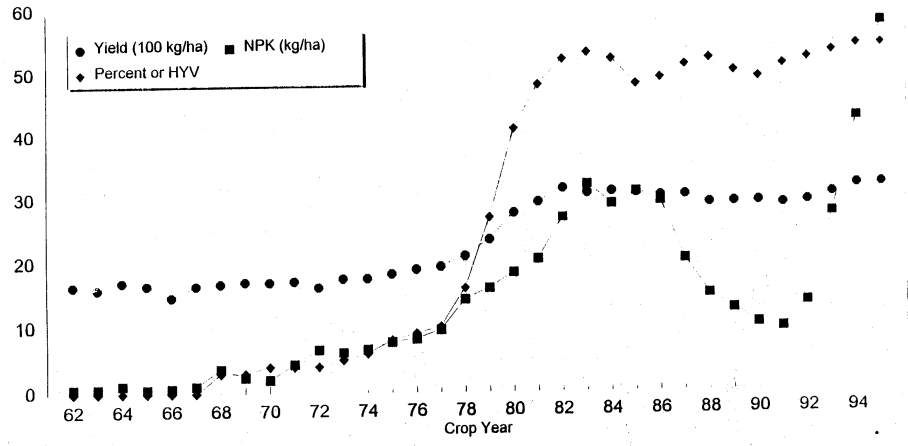


Figure 5. Change in use of HYVs and other inputs.

Information on the use of rice cultivars and technology application under various growing conditions in the monsoon season was obtained in a diagnostic survey conducted by IRRI and the Central Agricultural Research Institute in Myanmar in 1991 (Fujisaka et al., 1992). Representative rain-fed, lowland areas surveyed included Taikkyi and Hlegu in the delta near Yangon. Other representative ecological sites included 1) upland rain-fed areas located near Aungban and Kyaukme in Shan State; 2) deep-water rice areas in Danubyu and Thanatpin Township near Yangon; and 3) an irrigated area at Kyaingtong in Shan State.

Taikkyi is the more favorable (better drained) of the two rain-fed, lowland sites surveyed in 1991, with all rice transplanted. Hlegu is a submergence and flood-prone area where direct seeding (both wet and dry) as well as transplanting are used.

Hlegu farmers transplanted the better-drained upper fields and wet-seeded lower fields with a serious deep-water problem. Transplanting is preferred to direct seeding if adequate labor and fertilizer are available to "take advantage of fertilizer before it is lost." Fertilizer is generally not used in flood-prone areas.

Rice varieties used at Taikkyi in 1991 (shown in Appendix Table 5) were all HYVs on the upper, better-drained fields. Traditional varieties were planted on the middle and lower slopes at Taikkyi subject to problems of prolonged submergence and where less double-cropping was done. Traditional varieties were dominant at the more poorly drained Hlegu rain-fed, lowland site due to problems of seedling submergence, prolonged flooded conditions and difficulties in producing a second crop after rice. In addition to use in flood-prone areas, traditional varieties are used because they have special eating qualities and command a relatively high price.

Irrigated cultivars used at Kyaingtong in Shan State were mostly improved varieties (Appendix Table 6). Continuous planting of the same improved cultivar was reported to reduce yield, shorten plant height and shorten panicle length; thus Kyaingtong farmers generally changed cultivars every three years or selected seed stock from other fields. Kyaingtong farmers applied fertilizer only to parts of the field where irrigated rice plants showed poor development as they claimed they were constrained by an inadequate supply and high cost of fertilizers (Fujisaka et al., 1992).

Most rice varieties planted in deep-water rice areas surveyed near Yangon were traditional cultivars. Characteristics desired for deep-water conditions included stem borer resistance, good elongation and good eating quality. Some deep-water areas too wet to plant in the monsoon season were used to produce a dry-season crop as the water level receded. The onset of monsoon rains was often too rapid in deep-water areas for land preparation and dry seeding. Farmers surveyed in deep-water areas used few inputs because of the high risk of crop failure.

Upland dryland rice farmers surveyed in the Aungban area of Shan State typically used a potato-rice-fallow rotation while Kyaukme upland farmers planted a peanut-rice-fallow sequence (Fujisaka et al., 1992). Aungban farmers used a rotation of two to four years of cropping followed by one to four years of fallowing. Kyaukme farmers generally planted two years of crop followed by a 10-year fallow. All upland farmers planted traditional rice cultivars but generally used some inorganic fertilizer.

4.3 Risks in Deep-Water Rice Farming

Deep-water rice production constitutes about 11 percent of the rice area and is found primarily in low delta areas, particularly Yangon, Ayeyarwady, Tanintharyi and Bago divisions and in the river basins of Kayin, Mon and

Rakhine states (Table 4.3). Rain-fed, lowland rice comprises about 62 percent of the rice area. The average yield in deep-water areas ranges from 1 to 2 mt per ha (Maung et al., 1990). Most deep-water rice farmers do not currently apply commercial fertilizer or agricultural chemicals for pest control to the main monsoon rice crop because of the risk of crop failure. As well as deep-water areas, many lowland, rain-fed areas are also subject to flooding in the monsoon period, restricting the use of HYVs, fertilizer and other inputs in production.

The major production constraint in deep-water areas and poorly drained, rain-fed lowlands is the excessive floodwater during the monsoon season (Maung et al., 1990). Water depth cannot usually be controlled due to poor drainage and insufficient embankments along the river banks and coastal waterways. In addition to the runoff floodwater, the average precipitation during six months of monsoon ranges from 2,000 to 5,000 mm. The accumulated water level can rise gradually or abruptly, depending on the drainage system, location and amount of rainfall received. The total rice crop can be lost in some deep-water areas due to an abrupt rise of water. The rice nursery may also be damaged, resulting in delayed planting. Other production constraints include difficulties in land preparation, labor and power shortages in some areas during peak demand periods and problems of weed control. Another problem is that the heavy soils typically found in deep water areas are difficult to plow with animal-drawn implements when they dry, leaving a limited window of opportunity for cultivation after rice harvest. Communication and transport facilities are often hampered during flood periods, preventing the timely application of inputs, such as fertilizer.

Rice producers in deep water and flood-prone, rain-fed, lowland areas cope with the high risk of production by using dry seeding (in some areas) instead of transplanting to reduce labor cost, by using minimal fertilizer or other chemical inputs in production and by diversifying their sources of income. Direct seeding of rice is a common practice in areas where the accumulated water level can reach more than 100 cm, since the water in these areas is not likely to subside to a level suitable for transplanting during the mid-monsoon period. Rice establishment by direct seeding, however, requires dryland preparation before the monsoon. Under heavy clay soil conditions found in many deep-water areas, land preparation often requires the use of farm tractors. Transplanting of traditional, late-maturing, photoperiod-sensitive rice varieties is commonly practiced where the maximum water depth is less than 100 cm.

Because of the flooding risks involved in the main monsoon rice crop, many farmers have follow-up crops of food legumes, oil crops or fibre crops after rice harvest. Some farmers pump water for a second rice crop after monsoon rice where water is available. Farmers also supplement their crop income by raising fish and livestock.

4.4 Problems in Input Supply

Paddy yield per ha has not improved since the early 1980s due to restrictions on chemical fertilizer supply and an apparent leveling off in the use of HYVs (Table 4.4). The production increase that has occurred since 1991/92 is due largely to increased irrigation, enabling additional paddy to be produced in the dry season to supplement the monsoon rain-fed crop (Oo, 1993). Dry-season, irrigated paddy production was first initiated in the 1992/93 crop season with a beginning area of 0.1 million ha. The dry-season paddy area was gradually expanded with further irrigation development to a planted area of 1.62 million ha in the 1995/96 crop year (FAS, 1996).

Fertilizer use for paddy has been restricted since it was subsidized in the early 1980s with a major reduction in use from 1985/86 to 1992/93 (Table 4.4). There was also a sharp fall in foreign aid to Myanmar in the early 1990s that reduced the government supply of fertilizers and other inputs. This reduction has contributed to the static yield problem and leveling off in use of HYVs, although the increased irrigation is beneficial to crop yield. Data on fertilizer use are poorly documented for 1993/94 and 1994/95 to estimate the quantity actually used for rice. There was also a data problem with determining fertilizer use in former years due to reported large-scale diversions of government-supplied fertilizer and other inputs from rice to non-rice crops before farm-input import restrictions were removed in 1992. Fertilizer supply has improved since the government has allowed private imports, but the private market price has been steeply higher than the government price. For example, the Myanmar Agriculture Service under the Ministry of Agriculture supplied about 5.26 kg per ha of paddy at a fixed price of Kyats 800 (about US$8.00) per 50-kg bag of urea in 1995 whereas the private market price per bag was as high as Kyats 3,300 (US$33) in the fall of 1995. Similar problems occurred for other inputs, such as diesel fuel.

The foreign exchange required to pay for imported fertilizer and other farm inputs is accumulated by the private sector from exporting commodities such as sesame and vegetable oil meal. Rice exports by the private sector are not permitted; however, some rice as well as other agricultural commodities are smuggled across the border, particularly to China. These illegal exports contribute to the data collection problem in Myanmar.

The private sector is generally free to purchase farm commodities without government intervention; however, the government maintains a strict procurement system for rice to assure an adequate supply for government use. The input supply by government at subsidized prices for rice production partially compensates producers for the intervention in rice marketing.

When the fertilizer price accelerated in 1995, rice producers found it profitable to sharply increase their use to a new record of 356,000 mt for the 1995/96 paddy crop year due to the extremely high market price offered for paddy.

The average free market price of fertilizer in 1995 was Kyats 1,500 per bag of urea compared with a free market paddy price of Kyats 11,500 - 12,500 per mt (FAS, 1996).

5.0 RICE MARKETING IN MYANMAR

5.1 Farm Marketing

Rice farmers have a fixed quota for annual delivery to Myanmar Agricultural Produce Trading (MAPT), a government procurement agency, at government-determined prices. Their surplus rice can be sold in the free market (Fig. 6). The annual MAPT procurement at below-market prices is currently about 12 percent of paddy production, about 2 million mt for 1994/95. The maximum quantity of each farmer's annual delivery obligation to MAPT is 30 baskets (618 kg) per ha to a specified procurement depot, normally before the end of April each year.

The government has also started to buy additional rice from the market since 1994 for export, and this trend is expected to continue as long as surplus rice is available and exports are profitable. The MAPT occasionally sells surplus government rice in the domestic market to help curb high market prices. The general MAPT stock policy is to hold a three-month supply to help stabilize prices.

Farmers generally have their rice milled at local village mills. They sell rice to local traders or to private mills. It is common for local traders to advance money for farmers to guarantee purchase at harvest time. Farmers reportedly depend heavily on traders for credit as the local banks lend only about Kyats 2,471 per ha whereas the estimated cash production cost for hired labor and materials is up to Kyats 10,000 per ha for HYV rice and Kyats 5,000 per ha for local rice varieties. The average farm paddy price in May 1995 was reported to be about Kyats 10,000 per mt, returning about Kyats 34,600 per ha for HYV paddy and Kyats 22,200 per ha for local paddy. Given the unofficial exchange rate of about Kyats 104 per US$1.00 in May 1995, the farm paddy price was equivalent to US$96 per mt or $4.36 per cwt. The domestic rice market for rice has been insulated from international price movements as a direct effect of the government export monopoly.

Post-harvest losses in reaping, sun-drying of stalks in the field, threshing, winnowing, on-farm storage and transport to procurement centers are estimated at 8 to 13 percent of production (Oo, 1994). Losses are often severe for off-season and summer paddy harvested during the rainy season as few farmers have access to artificial dryers. Rice stored in the rainy season is subject to further losses. There are significant losses in paddy quality in terms of milling recovery and excessive brokens, particularly when there are delays in harvest-

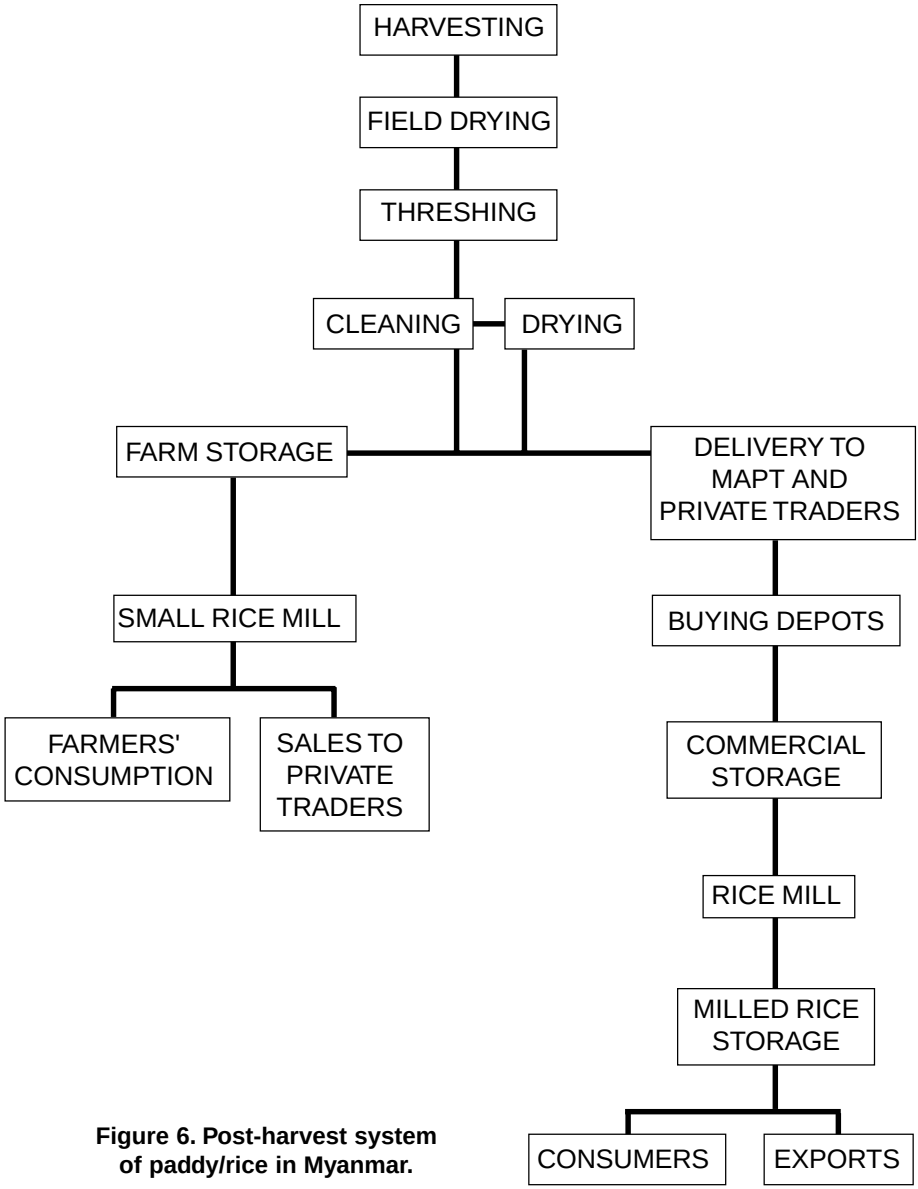


Figure 6. Post-harvest system of paddy/rice in Myanmar.

ing and field drying. Drying paddy bundles on the ground is the main cause of discolored grains. The normal milling recovery of Myanmar export quality 25 percent broken rice is about 62 percent, but it can be as low as 40 percent if there are lengthy delays in harvesting, field drying and threshing or prolonged exposure of paddy piles to morning dew and frequent showers at procurement centers (Oo, 1994). This recurrent wetting and drying causes extensive sun

cracks, resulting in excess brokens during milling. Farmers currently have low incentive to produce quality rice as the existing grading system in Myanmar does not grade strictly on the basis of milling quality. Other Asian countries such as Thailand commonly grade on the basis of "head rice" yield. It would likely be difficult to establish a reliable rice quality inspection system in Myanmar to improve rice quality due to the many different rice varieties produced, the lack of modern testing equipment and the large volume handled after harvest with inadequate drying and storage facilities.

5.2 Rice Milling

Types of rice mills commonly found in Myanmar include small village rice mills with a capacity of 0.6 to 0.8 mt per hour and large commercial mills that were generally constructed during the colonial period. About 97 percent of the total milling capacity, 2,189 registered rice mills with a milling capacity of 50,000 mt per day, is located in the private sector (Table 5.1). About 54 percent of the milling capacity is used to process rice at the farm level (Fig. 6). Except for cleaning and grading, the small village mills perform steps in milling similar to those of the larger commercial mills, although they are usually made fairly crudely by local manufacturers. Hullers are not permitted except in some remote areas of Myanmar. All rice mills need to be registered with MAPT if they have a capacity of 0.6 mt per hour or more. Average millers operate at only about 33 percent of capacity. Milling standards in Myanmar declined in the latter part of the colonial period, since demand came mainly from India and other markets wanting low-quality rice. Rice quality deteriorated further after independence because of increased government intervention, e.g., controlling rice milling and underpaying millers for services.

Most private commercial mills have a paddy milling capacity of 50 mt per day with a maximum of 70 mt per day. There are three size categories of government mills, with most having a capacity of 50 mt per day, about 15 mills of 100 mt per day and two or three of 150 mt per day (V. Win Aye Pe, Bago private miller, personal communication, May 1995). Most private mills have about four months' storage, but few have artificial dryers as they were designed to mill rice from December to March after the monsoon crop harvest period when the weather is normally dry.

Only 277 rice mills in the country with a reported milling capacity of 12,876 mt of paddy per day are capable of milling "super quality" 5 to 10 percent broken rice (Table 5.2). Thus, only 25.8 percent of the total milling capacity in Myanmar is suitable to mill high-quality rice. The power source for 57 percent of the milling capacity is rice husks. Higher-efficiency husk-fired boilers are used at 10 state-owned, relatively modern rice mills. Other conventional disk-sheller, husk-powered mills constructed before World War II use low-efficiency boilers and aging steam engines (Oo, 1994). Private mills generally operate

about 100 days per year from December to March before the wet monsoon period begins.

The 64 state-owned mills are included among the more modern mills capable of milling high-quality rice. The newest mills were recently constructed with financial assistance from various donors. The new government mills include 1) 12 cone-type mills constructed in 1962/63; 2) three Asian Development Bank (ADB) financed "Satake type" mills with 50-mt per day capacity (each) constructed in 1978; 3) one rubber roller mill (not Satake) financed by China in 1983 of 100-mt per day capacity; and 4) 12 Satake mills of 1000-mt per day capacity financed by the ADB in 1986 (U. Saw Aung, MAPT, personal communication, May, 1995). Since there are few modern mills to export high-quality rice, the milling sector can generally supply only low-quality 25 percent broken rice for export. The major deficiency is in cleaning equipment and color sorters to produce quality rice as well as the need for more rubber roller equipment. Few mills currently have artificial dryers. Some of the modern parboiled rice mills, e.g., at Hlegu, are capable of producing high-quality parboiled rice, but they have a capacity of less than 400 mt per day. The poor post-harvest practices also caused discoloration of parboiled milled rice. A further problem of the current grading system is that Myanmar farmers are not sufficiently compensated for the extra effort in supplying paddy with a safe moisture content, with less impurities and with less mixing of foreign grains to provide a high milling yield and high-quality milled rice.

The milling recovery for a modern 100-mt-per-day government-owned, rubber-roller mill at Hlegu was reported by the factory manager to be as follows:

1) Hulling Paddy (husks = 22%, cow bran = 1.9%, points = 0.045%, impurities = 2.055%, brown rice yield = 74%)
2) Milling Brown Rice (white rice yield = 62% of paddy rice yield including 40% brokens and 60% head rice, bran = 7.3%, small brokens = 4.7%)

The 40 percent total milled brokens included 25 percent big brokens (larger than 0.6 grain) and 15 percent small brokens. This Hlegu government mill produced mainly 25 percent brokens Emata long grain for the export market. Other older, sheller-type mills in Myanmar have less-efficient milling equipment than the Hlegu modern mill but often mill higher-quality paddy since the procured government paddy at below market price is generally of the lowest quality. Farmers tend to keep the best paddy for their own consumption or sell it to traders for a higher price.

Myanmar has a total of 18 different white rice grades that are specified by variety names and different contents of brokens. Whole kernels or head rice are 0.75 whole grain size or larger, big brokens are 0.65 to 0.74, and small brokens are 0.38 to 0.64. Small brokens are divided into different classes, ranging in

sieve size from larger than no. 8 to less than sieve size 6. The very minute pieces of kernels are called points. The milled moisture standard is 14 percent for all varieties.

Rice standards for each variety in Myanmar are mostly based on grain composition of three types: whole kernels or head rice (0.75 and above), big brokens (0.65 and above) and small brokens (0.35 and above). Most milled rice contains 15 percent big brokens in the head rice content, and the brokens percentage is usually expressed in small brokens (see Appendix Table 7). For example, the grade of Emata Super 10% means white rice milled from Emata or special Emata varieties, and the 10% indicates the content of small brokens (Oo, 1994).

5.3 Transport and Storage

Farmers have traditionally stored their paddy and other food grains in bulk in a circular bamboo bin called a "poke" that is sealed with cow dung and mud. The paddy is stored for 5 to 9 months at 13 to 14 percent moisture in pokes by most farmers for annual home use (Oo, 1994). Commercial storage of paddy is also done in bulk, and milled rice is stored in 50-kg bags. For example, the government rice mill at Hlegu has a milling capacity of 100 mt per day, a bulk paddy warehouse storage capacity of 5,000 mt and a white rice storage capacity of 1,000 mt in 50-kg gunny bags. This mill was reported to be representative of most government mills.

The maximum length of paddy storage is considered to be about nine months, of which four months generally fall in the wet season. To handle government procurement requirements, MAPT is reported to have available paddy storage of 1.5 million mt and 0.4 million mt storage for white rice (Oo, 1994). There are currently few artificial grain dryers in use, but some are being manufactured in Myanmar to operate with a husk-fired furnace. Most of the commercial paddy storage capacity is located by rice mills or at procurement depots. Some additional storage is reported to be needed because the locations of existing storage warehouses are not evenly distributed according to the paddy production (Oo, 1994).

Major transport requirements are for paddy transport from farms to procurement depots, from procurement depots to mills and warehouses, for movement through private marketing channels, for movement to deficit areas and for movement for export. The transport system for rice includes a network of roads, railways and waterways (Table 5.3).

The road network includes about 15,000 miles of road that is generally oriented north-south, paralleling main roads, rivers and rail lines. There are 2,922 miles of rail line, and much of the country is traversed by navigable rivers and creeks (Oo, 1994). Both the roads and rail lines are in poor condition, resulting in high transport costs and frequent downtime for repairs. The farmers deliver paddy to market and to procurement centers by small boats or

bullock carts. Paddy is often stored in open piles for long time periods at procurement centers. Paddy is transported mostly from procurement depots to warehouses by truck or by cargo barges. All procured paddy to be transported needs to be put under cover before March near the end of the dry season to avoid excessive deterioration; thus, most of the transport from country areas is concentrated within a few months of the year. The transport requirement for export depends on the timing of arrival of export vessels and the stock of rice at the Yangon Port. There is normally limited export during the wet monsoon season due to the high risk of deterioration. Long distance transport is often not reliable as most of the trucks, rail cars and barges used for rice transport in the country are old and subject to frequent breakdown. Other constraints in transport include frequent fuel shortages during the peak transport period each year. The Yangon Port is also reported to have frequent congestion problems and requires continuous dredging to keep ship lanes open. A new export port across the river from the current port is planned for future construction.

Transport costs could not be obtained for milled rice in Myanmar. Some estimates were obtained for bagged fertilizer from Myanma Agricultural Service having a similar transport and storage cost. Quoted transport costs for bagged fertilizer in 1995 were as follows:

Rail:	not available
Waterway:	1.62 Kyats/mt/mile
Road:	5 Kyats/mt/mile for flat areas
	8 Kyats/mt/mile for hilly areas
	30 Kyats/mt/mile for special problem areas

Charges at the Yangon Port included a port tax of 45 Kyats per mt, transport from port to storage of 180 Kyats per mt for a range of 5 to 10 miles and loading and unloading cost of 20 Kyats per mt. Port storage was quoted as free for the first 72 hours and 3 Kyats per mt per day thereafter.

5.4 Production Costs and Marketing Margins

The major market for rice in Myanmar is for Emata (short-duration variety), a cheap rice of relatively low quality, as the vast majority of consumers are poor. Only a few wealthy people demand high-quality rice, particularly pawsanhmwe (long-maturity variety). The poorest-quality paddy is generally delivered to the MAPT to meet procurement requirements and for export. The better-quality paddy is sold to traders or consumed by farmers. Some glutinous rice is also produced for local food preparations, and about 5 to 10 percent of the rice is processed into rice noodles. The only high-quality rice sold for export includes Prome Special Emata (grown only in the Prome region) that is both high yielding and high quality, some traditional high-quality aromatic rices and some Basmati produced under contract. These higher-quality rices are generally exported to the Middle East. Most of the available, cheaper, 25

percent brokens rice was exported to Indonesia in 1995 or smuggled to China with barter for consumer products at the border. The government charges a 5 percent export tax on all exported commodities. Rice is the most important exchange earner next to teak.

MAPT currently purchases about 2 million mt of paddy under the procurement requirement each year to yield about 1.2 million mt of milled rice for distribution to special target groups (military, government service and social institutions) and for export sale. Additional purchases of 200,000 mt medium-grade rice were made by MAPT from the private market for export in the 1994-95 crop year. Procurement prices paid in 1995 were Kyats 3,750 per mt for long-grain Emata paddy and Kyats 3,500 per mt for short-grain Ngasein paddy.

MAPT contracts private commercial mills to mill government rice at a fixed milling charge of Kyats 125 per mt, equivalent to only about US$1.25 per mt at the unofficial exchange rate. MAPT allows millers to keep about 13.6 kg points (small broken rice) and 50 kg cow bran worth Kyats 50 per mt of paddy milled. Estimated milling cost is Kyats 150 per mt, equivalent to US$0.06 per cwt (U Saw Aung, personal communication, May, 1995). Private traders were reported to pay Kyats 250 to 500 per mt of paddy for milling charges (U Win Aye Pe, Bago Miller, personal communication, May, 1995).

Differences between the farm gate paddy price and the wholesale price and retail price of Ngakywe (a premium local variety), Emata and Ngasein milled rice for 1984-1995 are shown in Table 5.4. The estimated gross margins between wholesale and retail level have dropped from about 100 percent in the 1984-87 period to less than 15 percent after 1987, according to reported statistics.

Prices vary for different types of rice. As shown in Table 5.4, the average Yangon 1993 retail price per kg was Kyats 21.56 for Ngakywe 38, compared to Kyats 18.28 for Emata 35 percent and Kyats 17.03 for Ngasein 35 percent. All farm and wholesale rice prices were controlled prior to 1987. The 1995 free market prices published by the Central Statistical Organization in Yangon were Kyats 10.24 per kg (US$98.56/mt) for average farm paddy and Kyats 18.37 per kg (US$176.63/mt) for Ngasein 35 percent milled rice at the unofficial 1995 exchange rate of Kyats 104 per US$1.00 (Table 5.4).

As shown in Table 5.5, the estimated marketing costs from the farm gate to FOB mill were about 15 percent of the paddy cost in 1987 (Sein, 1987). These marketing costs were reestimated by the authors for 1995 by adjusting Sein's 1987 cost estimates for inflation and using current milling charges to account for a current wholesale milled rice price of Kyats 17,169 (US$165) per mt based on free market paddy prices prevailing in 1995. Estimated marketing costs are currently only about 10 percent of the paddy cost.

Rising free market farm prices for paddy shown in Table 5.4 have encouraged increased production as well as the recent government infrastructural im-

provements supporting rice production. Average production cost in the 1994/95 crop year is reported to be in a range of Kyats 14,719 to 16,941 per ha (Table 5.6), with an average of Kyats 15,979 per ha, making paddy very profitable at the 1995 free market price of about Kyats 10,000 per mt. Irrigated summer (dry-season) paddy is reported to have about 1.5 times the cost per ha of the monsoon crop due mainly to increased fertilizer costs, increased labor costs and the cost of diesel oil for pumping water to the field from government canals. Most of the summer paddy is HYV with a relatively high yield, providing about Kyats 30,000 to 50,000 return per ha (FAS, 1995).

5.5 Rice Consumption

Rice is Myanmar's staple food, consumed by virtually all of the population. Annual per capita white rice consumption in 1994-95 is estimated at 152.5 kg, about the same as in the previous year, and is expected to remain stable, with expenditures on rice accounting for at least 25 percent of the average consumer's income (FAS, 1995). Available government data on consumption have been over estimated because of the unrecorded border trade. Reported annual per capita paddy utilization, including losses, has ranged from 234 to 355 kg in the past 20 years (Table 5.7).

The most recent household expenditure survey published in 1993 (Table 5.8) showed that the average consumer allocated 30 percent of total household spending in 1989 on rice purchases and 74 percent of total spending on all food purchases. Since 1989, there has been continued rapid inflation of over 20 percent per year due largely to a major increase in the money supply and excessive government spending (Table 5.9). The living standards of most consumers have not improved due to these macroeconomic problems as well as the severe capital shortage and limited industry growth in the country. The reported wage rate in Myanmar has been extremely low by world standards at about Kyats 50 per day for unskilled agricultural labor and about Kyats 3,000 per month for higher-income, skilled, government-salaried employees.

Rice demand was estimated for the total population from 1979-92 time series data by Hossain and Oo (1995); however, their estimated relationships are somewhat unexpected since they have estimated a negative income elasticity and positive price elasticity for rice in Myanmar. Other demand estimates with the Arkansas Global Rice Model are presented in Chapter 7.

Retail prices for Emata rice (Table 5.10), consumed by the majority of the population, ranged from Kyats 20 to 21 per kg from 1994 to February 1995 when they started to increase sharply to about Kyats 30 per kg. Farm paddy prices also increased in March 1995 from Kyats 9,000 to 10,500 per mt. Broken rice consumed by the poorest segment of the population had increased to Kyats 17 per kg by early 1995. The sudden price increase in 1995 was due to the strong surge in exports.

5.6 Rice Exports

The State Law and Order Restoration Council (SLORC) has liberalized food grain trade since 1989 by allowing the private traders, cooperatives and joint-venture companies to engage in grain trade activities, including export of most commodities; however, the government has maintained strict control over rice exports. Prior to government takeover by the SLORC in 1988, the national economy had been deteriorating rapidly due to a major fall in grain exports, particularly rice, causing a severe debt crisis. The SLORC government made a concerted effort in 1989 to revitalize export industries and increase foreign exchange earnings by providing the following export incentives (Soe, 1994b):

1) Extending new agricultural loans in addition to routine seasonal (cultivation) loans to growers of export crops, especially rice, pulses and beans, maize and oilseed;
2) Encouraging imports of officially prioritized production inputs by giving exemption or reduction of import tariffs, etc.;
3) Conducting public workshops, seminars and lectures by the Ministry of Transport to assist private entrepreneurs in improving their skills and knowledge of marketing and business management practices; and
4) Opening branches of the Myanmar Agricultural and Rural Development Bank (MARDI) servicing at the village level to encourage farmers to save and mobilize capital.

In spite of these production incentives, however, the export growth was limited prior to the recent spurt in rice exports in 1994-1995 as the SLORC has maintained various restrictions on exports and imports such as the rigid and inflexible exchange rate policy. The prevailing overvalued official exchange rate does not realistically reflect the relationship between domestic prices of tradables and their border prices. The government has also been forced to follow a deficit financing policy due to large, persistent imbalances in both trade and current accounts, restricting its capability to maintain funding for the export incentives initiated in 1989. For example, the subsidies and import exemptions for fertilizer have had to be sharply curtailed because of foreign exchange constraints. Expenditures on fertilizer imports declined in nominal terms from Kyats 87 million in 1989-90 to only Kyats 2.4 million in 1994 (Ministry of National Planning and Economic Development, 1994b).

Additional rice purchases from the domestic market in 1994/95 have enabled the government to sharply increase rice exports to 409,075 mt from January 1 to March 31, 1995, with further outstanding export commitments for 1995 of 309,925 mt as of March 31, 1995. The government target for 1994/95 rice exports was set at 1 million mt, but the actual exports were far short of the target (Table 5.11) and the government discontinued contract shipments in November - December 1995 due to difficulties in obtaining sufficient supply to

meet the outstanding export commitments. Most of the 1994/95 exports were Emata 25% brokens destined for Indonesia.

Myanmar's rice exports are of low quality that compete with Vietnamese rice. In crop year 1994/95, 98 percent of the exports was 25 percent brokens and just over 1 percent was 5 percent brokens.

Rice exports are sold at the official exchange rate although reported by the Central Statistical Organization (CSO) in terms of local currency value. The quantities exported and export values in Kyats shown in Table 5.12 are CSO-reported numbers. The reported CSO export values in Kyats seem unrealistic as they are significantly less than the domestic values of rice measured in retail market prices for the lowest rice type, Ngasein 35 percent. When converted to U.S. dollars at the official exchange rate, the export value per mt ranged from US$206 to $242 per mt from 1989/90 to 1992/93 but dropped to US$167 per mt in 1993/94. The export price increased sharply in 1995/96 to an average of US$225 per mt. The net export earnings to the government have been especially high for procured rice, e.g., the procurement price for paddy was less than half the free market value in 1995. The government is also able to contract milling and other marketing services for a relatively low cost.

Use of a grossly overvalued exchange rate would normally discourage exports and encourage imports; however, both are largely controlled by the Myanmar government. This continued form of central planning obstructs development of private enterprise and is a major cause of price distortion in the economy.

Myanmar rice supply and utilization data obtained from a 1996 FAS Agricultural Attache report indicated that exports would likely be about 700,000 mt in 1996 but could reach up to 1 million mt in 1997 (Table 5.13). Rough rice production was forecast to increase from 17 million mt in 1995 to 18 million mt in 1996. A subsequent report from the FAS Agricultural Attache showed that Myanmar actually exported 265,000 mt in 1996 and would export only 500,000 mt in 1997 (FAS, Feb. 1997).

The Myanmar Export and Import Service (MEIS) under the Ministry of Trade has been the only state enterprise authorized to export rice. The MEIS export target for 1994/95 was originally only 0.25 million mt. Subsequently, the Ministry of Agriculture was also authorized to export rice in 1994/95 and set its export target at 1 million mt. The export price had increased from US$145-165 per mt in January 1994 to US$181-200 per mt by August 1994 as a result of increased import demand due to drought in Indonesia and flooding in Vietnam. The export price continued to increase to US$220-226 in February 1995 for Emata 25 percent brokens. As a result, the Myanmar government made an extraordinary effort in 1995 to increase rice exports to take advantage of the unusual world demand for low-quality rice and ran short of stocks by November of 1995.

6.0 CAPACITY OF LAND AND WATER RESOURCES TO INCREASE RICE PRODUCTION

6.1 Capacity of Land Resources to Increase Rice Production

The potential agricultural uses of land resources, including rice production, has been estimated by Hla Aye (1990). Estimated land uses are for wet rice cropping on flat lowlands, annual dry cropping on uplands such as groundnuts, sesame, other oilseeds, garden crops, seasonal cultivation of garden crops on exposed silt and sand flats along rivers in the low water season and forest land. The major parameters used by Hla Aye to classify potential land use are slope, soil thickness, soil texture, soil permeability, gravel content and pH (Appendix Table 8). Soil nutrient factors such as organic C, N, P and K were also included in Hla Aye's land use classification; however, they may be modified by soil management practices.

Slope is an important consideration for land use as most of the land in Myanmar is hilly and mountainous with only a limited flatland area. The country is generally surrounded by mountains on the west and north and by a high plateau on the eastern boundary. The only appreciably large areas of flat lowlands are located along the Arakan Coast, the Kaladan-Lemyo Delta, the Ayeyarwady Delta, the Sittang-Salmon River Valley and the Salween Estuary. Other minor flat land areas exist along smaller rivers. The variegated relief of mountains causes many different local micro-climatic zones to exist in the country.

Some erosion damage has already occurred in the hilly areas and the dry zone of Myanmar, as reported by Hla Aye (1990). Conservation practices to sustain cropping are needed in hilly areas, including replacement of current shifting cultivation with permanent agriculture.

Other soil hazards requiring special management practices for sustained crop production include salinity in the dry zone and coastal regions (0.6 million ha), alkalinity in the dry zone (52,600 ha), acid sulphate and mangrove swamps (8,000 ha) in coastal tidal areas, hyperacidity in some high rainfall areas and peat lands around lakes and swamps (243,000 ha) (Aye, 1990).

Given the land use classification of Appendix Table 8 and assumed resolution of current major land use hazards, Hla Aye estimated that the total rice area in Myanmar could potentially be increased to 7.0 million ha (Appendix Table 9). To achieve this potential land area, about 1 million ha would need to be modified as shown in Table 6.1. Most of the rehabilitated area would be devoted to rice. Given the improbable rehabilitation of these hazard areas, at least in the near term, Hla Aye estimated that the potential land area available for rice would be constrained to about 6 million ha. The current paddy seeded area includes about 5 million ha in the monsoon season and 1 million ha in the dry season.

The national total arable surplus land as of 1993/94 is estimated at 1.4 million ha of fallow land and 8.1 million ha of cultivable waste land (Table 6.2); however, only a small part of this area is recommended for rice cultivation (Maung, 1995). Only the surplus areas in Bago (0.3 million ha) and in Ayeyarwaddy divisions (0.4 million ha) include rice as a recommended crop in addition to perennial crops. Only perennial crops are currently recommended on the estimated remaining surplus land.

In comparison with Hla Aye's estimated total potential rice growing area of 6 million ha without rehabilitating hazardous areas and of 7 million ha with rehabilitation of 1 million ha, the actual 1994-95 planted rice area in Myanmar was only 4.8 million ha in the monsoon season and 1.3 million ha in the dry season (FAS, 1996). Thus the monsoon rice crop area could potentially be increased by 25 to 46 percent by using all land suitable for rice. The rice area may also be increased further in the dry season with additional irrigation development.

6.2 Capacity of Water Resources to Increase Rice Production

Myanmar has the physical capacity to potentially increase paddy production by using both additional land and water resources. As of 1993/94, only about 1.53 million ha or 17 percent of the total sown area in all crops was irrigated, with rice comprising over 80 percent of irrigated crops (Table 6.3). The available water resources in the country are estimated to be 870 million acre feet, of which less than 5 percent had been utilized in 1993/94. Current government plans are to increase the irrigated area to 25 percent of the total sown area by 2000. The potential long-term irrigable area for all crops has been estimated at 10.5 million ha or 57 percent of the total arable land (Ministry of Foreign Affairs, 1992). The irrigation requirement for 10.5 million ha is estimated at only 26 percent of the country's potential irrigation water supply.

To further expand the current irrigated area, the government has reported that a number of planned irrigation projects could be implemented fairly rapidly if sufficient funds are available. Eight new dams are proposed in the divisions of Mandalay, Magwe, Sagaing and Bago as well as in Shan State (Table 6.4). These dam project areas identified for future irrigation development have normally erratic and insufficient rainfall. If developed, these eight dam projects would add over 400,000 ha additional irrigated land at a reported cost by the government per ha of only Kyats 40,908 (about US$393 at the unofficial exchange rate). In addition to the dam projects, the Irrigation Department has been expanding the irrigated area by constructing various canals and tanks as well as increasing flood protection of existing irrigated areas in lower Myanmar with embankments and drainage work (Ministry of Agriculture and Forests, 1984). An example of a planned lower Myanmar flood control project is shown in Table 6.5. Individual farmers have also been increasing the use of tube wells

for irrigation in the dry season. Only about 15 percent of the net cultivated land is currently provided with effective flood protection and drainage (Ministry of Foreign Affairs, 1992).

The major governmental strategy since 1988 to increase rice production with restricted capital and local labor has been through further intensification such as multiple cropping. The Ministry of Agriculture set a target to increase the dry-season irrigated rice crop area to 1.6 million ha in 1994/95. Although only about 1.3 million ha was achieved, it did represent an increase of 47 percent over the previous year (FAS, 1995). Increased irrigation development will support multiple cropping and enable a larger area of dry-season rice to be produced (Table 6.6). All dry-season irrigated rice is currently produced using modern varieties with a significantly higher yield than the average monsoon rice crop. There is also good short-term potential for increased double cropping in the monsoon season with the available rainfall, particularly in the major rice-producing areas such as Ayeyarwady, Pegu, Yangon and Mon State. These four areas produced 30 percent, 21 percent, 10 percent and 5 percent, respectively, of the 1994/95 monsoon rice crop. The government made a special effort to increase monsoon double cropping in 1995, but major harvesting and quality problems were experienced due to prolonged wet weather and lack of drying equipment.

6.3 Importance of Developing Irrigation

There is short-term potential to further increase dry-season rice production by using local labor and restricted capital to expanded irrigation development. However, infrastructural improvements are also needed, such as additional drying facilities to support more dry-season production. Rice yield can also be improved with more intensive input use if the input supply system is expanded. However, use of purchased inputs has been constrained by the shortage of foreign exchange.

If adequate capital were available for development, the technology recently used to intensify rice production in Vietnam could potentially be applied in Myanmar to dramatically increase rice production. Vietnamese technical experts are currently assisting the Myanmar government in irrigation development. Vietnam had nearly an identical total rice area in 1990—4,771 million ha compared to 4,858 million ha in Myanmar. About 75 percent of the cultivated land area in 1990 was devoted to rice in Vietnam compared to 59 percent for Myanmar. Since 1989 Vietnam has consistently been producing a rice surplus for export of about 2 million mt (milled equivalent), although the population is about 50 percent larger than in Myanmar. Annual domestic per-capita rice consumption is 143 kg in Vietnam compared to about 152 kg in Myanmar.

A comparison of the types of rice production in Vietnam and Myanmar in 1990 is shown in Table 6.7. The major difference is in cropping intensity and

the amount of irrigated rice in Vietnam that is about equal in area for both the wet monsoon season and the dry winter season. The 1990 irrigated rice area constituted over 61 percent of the total annual rice area in Vietnam compared to only 14.5 percent in Myanmar. Myanmar has a similar range of rice production conditions compared to Vietnam, including deep-water rice and comparable climatic conditions.

Myanmar's current average paddy yield averages about 2.8 mt per ha compared to about 3.6 mt per ha in Vietnam. Chemical fertilizer use per ha is less than half of that in Vietnam. Attainment of 3.6 mt per ha would increase Myanmar's annual paddy production to over 20 million mt with a corresponding potential increase in exports. Assuming that the government's current plan is achieved to increase the irrigated part of the net sown total crop area from 17 percent in 1994/95 to 25 percent by AD 2000 (Ministry of Agriculture, June 1994a), the dry-season paddy crop would potentially increase by about 50 percent, representing a further production increase of over 2 million mt of paddy. Increased irrigation capacity would also benefit monsoon season rice production in the dry zone of Myanmar and monsoon season double cropping in other rice growing areas.

In addition to increasing rice yield and the level of irrigation, other technologies to increase rice production are currently being evaluated in Myanmar including producing two short-duration HYV rice crops in the rainy season in place of the one long-duration crop and planting three rice crops a year in some irrigated areas. Increased drainage investment would help to stabilize production in the deep water and flood-prone, rain-fed, lowland areas, providing incentive to use more HYVs and fertilizer application. However, the infrastructural development as well as other input supply needed to support increased rice production has been severely restricted by the limited government budget and the shortage of private capital to invest in agriculture.

7.0 COMPARATIVE ADVANTAGE OF MYANMAR RICE PRODUCTION

7.1 Production Response to New Technology

Only two former production response studies of Myanmar rice production were found, including a 1977-78 to 1983-84 regression study by U Khim Win (1991) and a longer-term 1960 to 1991 study by Hossain and Oo (1995). The first study evaluated response relationships between input use and rice yield. Hossain and Oo (1995) used separate area response and yield response functions to allow the use of different explanatory variables as follows:

(1) $AREA_t = (a_0 + a_1 P_{t-1} + a_2 I_t + a_3 R_t) HYV_t + (A_0 + A_1 P_{t-1} + A_2 I_t + A_3 R_t)$
$(1 - HYV_t) + u_t$

(2) $YIELD_t = (b_0 + b_1 N_t + b_2 N_t^2 + b_3 R_t + b_4 R_t N_t) HYV_t + (b_0 + b_1 N_t +$
$b_2 N_t^2 + b_3 R_t + b_4 R_t N_t) (1 - HYV_t) + v_t$

(3) $PRODUCTION_t = AREA_t * YIELD_t$

where $AREA_t$ = the area sown in year t (1000 ha),
$YIELD_t$ = the average paddy yield in year t (kg/ha),
$Q_t = AREA_t * YIELD_t$,
HYV_t = the proportion of rice area sown with HYVs in year t,
P_{t-1} = procurement price deflated by wholesale price index in year t,
I_t = proportion of rice area irrigation in year t,
R_t = annual rainfall in year t (mm),
N_t = chemical fertilizer use in year t (mt/ha), and u_t and v_t are stochastic disturbance terms.

Results of applying the model to time-series data for Myanmar from 1960-1991 were as follows:

(1) $AREA_t = (121.1 - 2.90 P_{t-1} + 0.161 I_t + 0.058 R_t) HYV_t +$
(4.23) (-0.97) (4.51) (4.45)

$(4030 + 1.08 P_{t-1} + 1.68 I_t - 0.104 R_t) (1 - HYV_t)$
(-0.24) (7.41) (5.97) $R^2 = 0.67$

(2) $YIELD_t = (284.8 + 7.906 N_t + 0.173 N^2 + 0.129 R + 3.59 R_t N_t) HYV_t +$
(7.34) (26.9) (11.11) (7.23) (26.9)

$(1804 + 7.28 N_t + 0.168 N_t^2 - 0.105 R_t + 3.292 R_t N_t) (1 - HYV_t)$
(6.25) (6.83) (-8.10) (5.96) $R^2 = 0.96$

where figures within parentheses are estimated t values.

These regression results, reported by Hossain and Oo (1995), indicate that paddy production was responsive to the proportion of land irrigated, the use of high-yield varieties and the use of chemical fertilizers but was not responsive to procurement prices. Area of HYVs increased with higher rainfall, and the area of non HYVs increased with lower rainfall. There was also positive interaction between the use of chemical fertilizer and rainfall. The yield response (Equation 2) was evaluated only for fertilizer, excluding irrigation, because of the problem of multicollinearity using both inputs together in the same regression equation. We did not have access to continuous long-term annual rainfall and fertilizer use data to update the analysis by Hossain and Oo beyond 1991. However, except for continued irrigation development, the technology use has not changed since Hossain and Oo conducted their study. The major change is

that farmers are more responsive to free market prices and only market part of their crop at regulated procurement prices. Their model and regression results were considered the best available to evaluate the production response to increases in irrigation and input use.

The regression results were used to estimate production elasticities evaluated at the sample mean for the period 1960-72 and 1973-91, as well as for the entire time series period, as shown in Table 7.1. Irrigated area was the most important factor causing an increase in rice area and in rice production in the 1960-72 period as HYVs acceptable to farmers were not widely distributed until the 1970s. With a large portion of the rice area devoted to HYVs and increased fertilizer use starting in the 1970s, both of these yield factors became the major source of growth in rice production. Increased use of chemical fertilizer was necessary to obtain the yield advantages of HYVs over traditional varieties. The annual growth rate of rice production averaged 0.9 percent from 1960-72 and 3.5 percent from 1973-91. The annual growth increase from 1960-72 included 0.7 percent due to increased rice area and only 0.2 percent due to increased yield. In the 1973-91 period, the rice sown area declined by about 0.6 percent; thus, all of the production increase was due to increased yield.

Over the total period, 1960-91, Hossain and Oo (1995) estimated that the change in HYV area contributed 37.1 percent to the increase in total rice production, increased irrigated area contributed 12.2 percent, and increased use of chemical fertilizers contributed 49.2 percent. Other remaining changes were due to rainfall and input interaction effects. There was an estimated negative interaction effect between the increased use of HYVs and rice area. As the demand for rice could be met with less land using HYVs, additional land was devoted to other crops. A further benefit of HYVs is that the use of short-duration HYVs enables farmers to harvest the monsoon rice crop earlier, thus making a second non-rice crop more feasible with residual soil moisture from the monsoon season.

The estimated parameters from the Hossain and Oo (1995) regression analysis, particularly the elasticity estimates for production response to use of HYVs, to increase irrigated area and chemical fertilizer use, are of value for evaluating the rice production potential for Myanmar. The estimates of most interest for making projections of the rice production potential with increased technology use are determined from the second period, 1973-91, when HYVs were introduced, including the production elasticity estimate of 0.15 for HYVs, 0.19 for irrigated area and 0.26 for chemical fertilizers (Table 7.1). For example, the estimated production elasticity with respect to proportion of area irrigated is 0.19. This indicates that if the proportion irrigated were to increase by 10 percent, rice production could increase by 1.9 percent. However, the likely effect would be less since the elasticity estimate assumes that increases in proportions irrigated are small and near the mean. There is increasing error when

projections are made beyond these assumed limits.

Since the farm gate prices for paddy were controlled by government up to 1987, there was no rice production response to price found in the regression analysis by Hossain and Oo (1995). However, price response has become more important as free farm gate prices have increased rapidly since 1987 while the amount procured by MAPT at below market prices has declined (Table 7.2). The opportunity to market an increased proportion of rice production for the private market at a much more favorable price than the MAPT procurement price should provide a further stimulus for increased rice production to complement the use of more technology.

A high response to input use has been estimated from experimental studies in Myanmar. Estimated yield response to increased chemical fertilizer use per hectare is 16 kg of paddy per kg increase in urea use and 18.5 kg per kg increase in triple superphosphate use (Oo, 1989). The estimated yield response to other input use is 0.8 mt per ha with 100 percent replacement of local varieties with HYVs, 0.46 mt per ha with recommended population density and 0.46 mt per ha with recommended seedling age for transplanting (Oo, 1989). The use of inorganic fertilizer recommended by Tin Htut Oo is 93 kg of urea, 21 kg of TSP and 12 kg of potash per ha for HYV rice and 31 kg of urea and 15 kg of TSP per ha for local rice. The average yield of HYV paddy is currently about 3.6 mt/ha compared to 2.3 mt/ha for traditional paddy (Kyi, 1993) with minimal fertilizer use for traditional paddy and about 50 kg per ha for HYV paddy.

7.2 Constraints to Increase Technology Use in Rice Production

As mentioned earlier, technology use in the rice sector is restricted by the continued problem of scarce public and private capital for investment and poor infrastructural support. A reduction in the government's current high expenditures to maintain security and national stability and to support the subsidies of government employees is considered highly unlikely in the immediate future (Soe, 1994a). As noted formerly in Table 5.9, the government currently spends over twice as much on defense as on the whole agricultural sector although the agricultural sector contributes nearly 40 percent of GNP and employs more than two-thirds of the labor force. To maintain its present spending level, the government has been forced to follow a deficit financing policy and to generate additional revenue by eliminating subsidies, extending taxable sources and bases and raising tariff rates and fees. Significant controls and regulations have also been continued. These activities are important sources of inflation and distortions in the economy.

Although the limitations in the government budget and shortage of foreign exchange have restricted development of the rice sector, some recent progress has been made in increasing paddy production, particularly by promoting dry-season paddy production with expansion of irrigation. The supply of imported

inputs such as fertilizer, fuel and machinery has not been adequate in the past to support the use of improved technology; e.g., only about half of the rice varieties currently sown are HYVs because of limited fertilizer and loan funds as well as other infrastructural support problems. Farmers also have difficulty multi-cropping because of the shortage of mechanized tillage equipment, fuel and artificial dryers. Development of the private sector has been constrained because of the lack of incentives and governmental intervention. Private enterprise has had to compete with some continued government subsidized inputs such as fertilizer and diesel fuel and with the cooperatives and joint-venture companies that operate as parastatal bodies with special privileges (Soe, 1994b). The overvalued official exchange rate is also a constraint for private investment, particularly when imported items are required.

Although Myanmar has the capacity to potentially increase rice production with further infrastructural development and greater use of technology, the overall economy and political system continue to have too many problems to expect that technology use and required infrastructure support will grow rapidly.

7.3 Rice Supply Cost

7.3.1 Farm Gate Cost. Reported 1994/95 production costs and returns of principal crops (Table 7.3) indicate that HYV rice and sugar cane are currently the most profitable crops. The reported net return for HYV paddy with a farm gate price of Kyats 10,257/mt is Kyats 21,569 per ha compared to Kyats 13,941 per ha for local paddy. Production cost per metric ton is Kyats 4,401 for HYV paddy and Kyats 4,247 for local paddy. In terms of U.S. dollars at the unofficial exchange rate of Kyats 104 per U.S. dollar prevailing in 1995, the reported production cost is only US$42.32 for HYV paddy and $40.84 for local paddy per metric ton. The reported production cost includes the value of both family and hired labor inputs plus all purchased materials but not other overhead costs. The excluded farm overhead costs are considered minimal because of the low mechanization level and minor land rental cost in Myanmar. Given the reported production cost, both HYV and local paddy were clearly profitable to produce at the 1994/95 average free market price range of Kyats 12,500-13,500 per mt (US$120-$130 per mt at the unofficial exchange rate of Kyats 104 per dollar).

Since labor cost is cheap and relatively plentiful, Myanmar rice producers continue to use low-cost technology. As previously mentioned, the typical farmer still uses a pair of bullocks and a few simple tillage implements with almost no mechanization. Because of the high cost and frequent shortages of chemical fertilizer and other imported inputs, farmers also use few chemical inputs. Examples of the 1995 free market prices of inputs included Kyats 1000 or more per 50-kg bag of chemical fertilizer and a minimum of about Kyats 150 per gallon for diesel oil with higher prices prevailing outside the city of Yangon. The government still sells some subsidized inputs to support rice production

but with limited distribution of only about 5 kg per ha for fertilizer. Only 11,000 tractors were used for all crop production in 1993/94 compared with 6.6 million draft animals. Despite the high cost of fertilizer, chemical fertilizer distribution for all monsoon paddy production in 1995/96 increased sharply to 195,000 mt for 4.9 million ha planted in the monsoon season and 161,000 mt for 1.3 million ha planted in summer paddy (FAS, 1996). This major increase in fertilizer use was due to the extremely high rice prices prevailing in 1995/96 and may not be sustained. For example, only about 150,000 mt was used in 1992/93 for all paddy when international rice prices were significantly lower.

7.3.2 FOB Export Cost. Assuming a farm production cost of 4,401 Kyats per mt (US$42) for HYV paddy, as reported in Table 7.3, and a milling yield of 644 kg of marketable 25 percent broken rice per mt of paddy (64.4 percent milling yield), the estimated cost in 1994/95 to supply milled rice in 50-kg bags at the Yangon Port is only Kyats 12,203 or US$117.44 per mt at the unofficial exchange rate of Kyats 104 per U.S. dollar (Table 7.4). This cost estimate includes 1.56 mt of farm paddy to yield 1 mt of milled rice, a net marketing margin of 5 percent, and the 5 percent government export tax. The estimated export supply cost of US$117.44 per mt derived from production cost and other marketing costs is significantly less than the reported Myanmar export price of US$145 to 165 per mt prevailing in January 1994 before the 1995/96 price surge. However, the export supply cost would be higher with a milling yield less than 64 percent or if the brokens content exceeded the 25 percent export standard for milled rice. For example, 10 percent more paddy would be needed for a metric ton of milled rice with only 58 percent milling yield compared to 64 percent milling yield.

Prior to the 1994/95 crop year, all of the paddy milled for export had been procured by the MAPT at below market price. The fixed paddy procurement price for both 1993/94 and 1994/95 crop years was only Kyats 3,500 per mt for Ngasein paddy and Kyats 3,750 for Emata paddy. The free market price of paddy increased from Kyats 9,500 - 11,000 per mt in 1993/94 to Kyats 12,500 - 13,500 (US$120 - $130) in 1994/95, over three times the reported production cost of paddy. MAPT purchased about 200,000 mt of rice from the free market in 1994/95 to supplement the procured rice supply for export. The paddy procurement price for 1993/94 to 1994/95 per mt is less than the estimated average production cost, making the government cost of exported milled rice actually slightly less than the Kyats 12,203 or US$117.44 shown in Table 7.4. However, as mentioned earlier, rice producers receive some subsidized production inputs as compensation to supply the procurement requirements.

Assuming that the government paid the highest reported free market price of paddy, Kyats 13,500 per mt for Emata in 1995, the estimated export supply cost to government, including 5 percent net marketing margin and 5 percent

export tax at the port, would be Kyats 27,233 or US$261.86 per metric ton. On the other hand, using the 1995 procurement price of Kyats 3,750 per mt of Emata paddy, the estimated cost to government at the port is only Kyats 10,330 or US$99.33 per mt, including the net marketing margin and export tax.

The increased 1994/95 domestic free market price level of Kyats 12,500 to 13,500 per mt for Emata paddy would obviously not be sustainable if the export price of Emata 25 percent brokens were to drop back to the early 1994 level of about US$165 per mt. However, rice production should continue to be profitable as long as the export price remained above US$117 per mt. The reported marketable milling yield is 64.4 percent out of a potential 70 percent total milled yield with modern rice mills such as are used in the United States; thus, a possible yield gain could be made by improving post-harvest practices and milling equipment. For example, the milling standard for U.S. #2 paddy is currently 70 percent overall milling yield with a 55 percent head yield from paddy, allowing for about 22 percent loss in weight for the hulls and 8 percent for the bran and germ. The U.S. export-quality milled rice normally contains 4 percent brokens, and the remaining 11 percent brokens are used for brewing at a value of about half that of the 4 percent broken milled rice in the U.S. domestic market. Milled brokens in Myanmar currently have greater relative value than in the United States as they are consumed by the poorest segment of the population. For example, in March 1995, the retail price of Emata 25 percent brokens in 1995 was Kyats 22 per kg, whereas the price for 100 percent brokens was Kyats 17 per kg.

Even with the existing poor post-harvest practices and antiquated milling industry, the estimated supply cost per mt of bagged milled rice at the port of Kyats 12,203 (equivalent to US$117.44 at the unofficial exchange rate) is relatively low compared to other rice-exporting countries. In comparison, reported 1995 Vietnam production costs are US$60 to $130 per mt of paddy (Khiem et al., 1996). The Thai FOB export price of 35 percent brokens has only rarely been below US$200 per mt in the past 10 years. The continuing high rate of inflation in Myanmar is of important concern in controlling future rice production cost; however, the domestic rice production cost has remained comparatively low by world standards so far as farm wage rates have been relatively static and few purchased inputs are used in rice production. HYV rice production also continues to be the most profitable crop on the basis of 1994/95 production costs and returns.

8.0 PROJECTIONS FOR THE FUTURE

8.1 Factors Determining Growth of Rice Production

The future time frame for increased rice production and export is difficult to project for Myanmar as governmental intervention in the rice sector distorts operation of the free market and the serious financial problems faced by the government constrain economic development. Despite these constraints, the present government appears to be seriously committed to increasing rice production and export and has been making visible progress towards this goal in the past couple of years. The rate of expansion in the future will depend largely on the government's continued willingness and ability to invest in the rice sector by improving the infrastructure as well as providing adequate economic incentives for rice production. Although the present procurement price does not cover production cost, the government offsets this apparent inequity to some degree by providing subsidized inputs. This intervention has been reduced over time as the procurement requirement is now only about 12 percent of production. On the other hand, the free market price for the remaining paddy appears to provide a strong incentive for rice production, e.g., it was over three times the reported farm production cost per metric ton in 1995. Thus, the current main constraint to expanding production seems to be the poor infrastructural support system, including continued problems with the timely and sufficient supply of key inputs for HYV production, such as chemical fertilizer.

As discussed earlier, the major factors other than market price that will likely determine rice production within the next decade are 1) continued irrigation and drainage development to expand the area of dry-season paddy and to support multi-cropping; 2) increased use of HYVs, now only about half of rice production; and 3) increased use of chemical fertilizer and other modern inputs to achieve a higher yield. In the long term, the irrigation and drainage development potentially could be increased to cover virtually all of the rice production areas, multi-cropping potentially could be increased to three crops per year, more land area could be reclaimed or converted from wasteland to possible rice cultivation, post-harvest practices could be improved to reduce waste and increase milling yield, and the milling industry could be modernized to produce a higher-quality milled rice with an improved milling yield. It is doubtful if the determinants of rice quality involving post-harvest practices and the milling industry will be improved much within the present decade because of the low profit margins as well as severe capital constraints; thus Myanmar will probably continue to produce mostly low-quality rice. Post-harvest practices are not likely to be improved rapidly except in some isolated cases involving contracting with rice producers. Direct contracting is currently done only on a small scale for Basmati rice. Without donor assistance, the government has limited funds to assist the milling industry. The limited government budget

also constrains the use of multi-cropping and land reclamation that can be accomplished over the next decade. Measurable progress has been made in irrigation and other similar infrastructural development despite the capital and equipment shortage by relying on labor-intensive construction methods.

Potential growth in rice exports will be largely governed by the increase in rice supply and population growth. Per capita consumption is already near a saturation level.

8.2 Evidence of Possible Short-Term Increased Production

As reported earlier, rice production has been on an upward trend in the past few years due largely to increased irrigation development. Irrigated area is projected to increase by about half from 17 percent of total crop area in 1994/95 to 25 percent by the year 2000 according to the government plan. Based on the estimated production elasticity of 0.19 by Hossain and Oo (1995), this added irrigation development could increase paddy production from 16 million mt (estimated for 1994/95) to 17.5 million mt. Achieving this outcome by 2000 is considered unlikely as government planning has not been reliable, and the 0.19 elasticity projection is subject to increased error for projections made above the historic mean level. Thus, the 17.5 million mt projection for 2000 is an optimistic projection.

The increased irrigated area and an improved supply of modern inputs would in turn support the increased use of HYVs. Irrigated dry-season paddy production is currently almost all in HYVs. Use of traditional varieties has continued to be important in some production regions due to the higher market price for particular varieties; however, the main reason is that they are strongly preferred in areas with high-risk production, such as flood-prone areas. Many HYVs are too short statured to grow well in the flood plain, and they often mature too quickly. If they ripen before the monsoon rains are finished, they are difficult to harvest and store with the present use of sun drying. HYVs have accounted for about 51 percent of the sown area and 57 percent of total paddy production in recent years.

Assuming that the sown area of HYVs were to be increased by half, in proportion to the planned increase in irrigated area, and using the estimated production elasticity of 0.15 by Hossain and Oo (1995) for the effect of area sown in HYVs, the projected production increase is 7.5 percent, providing an additional 1.2 million mt of paddy over the next decade. Again, this is a best-case scenario because of the problem of using an elasticity estimate to make a projection.

Chemical fertilizer use was low, prior to 1995/96, in the range of 30 to 60 kg per ha for HYVs, and minimal for most traditional varieties. Chemical fertilizer is normally not used at all in high-risk production areas. Fertilizer use increased sharply in 1995/96 from the normal use level to about 40 kg per ha

for the monsoon paddy crop (less than half HYVs) and to 120 kg per ha for the dry-season irrigated paddy crop (all HYVs) in response to the extremely high prices prevailing for paddy. Assuming that future chemical fertilizer use is maintained at 100 kg per ha for all HYV rice (about double the normal use), the total use for rice would be increased by about 50 percent if the HYV rate increased by 50 percent. Using the production elasticity coefficient for fertilizer input of 0.26 estimated by Hossain and Oo (1995) from 1973-91 data, the projected potential production increase is 39 percent with increased fertilizer use, equivalent to 6.2 million mt. Again, this is a best-case scenario due to the limitation of projecting with historic period, calculated, elasticity coefficients and the further problem of maintaining adequate fertilizer supply in Myanmar due to the shortage of foreign exchange.

Given all of these assumptions, paddy production potentially could increase from 16 million mt in 1994/95 to 24.9 million mt over the next decade. The potential production increase includes 1.5 million mt due to planned irrigation development, 1.2 million mt due to possible expanded HYV production and 6.2 million mt due to possible increased chemical fertilizer use on the expanded HYV area with the available production elasticity coefficients estimated by Hossain and Oo (1995).

The above projections of possible production response to irrigation development, to use of HYVs and to use of chemical fertilizer also assume that producers in Myanmar will continue to have a strong market incentive to increase rice production. This is an important issue because the domestic market for rice consumption is currently saturated and the government has a limited budget to assist rice producers in disposing of surplus production.

As noted in Table 8.1, the Ministry of Agriculture has a very aggressive plan to increase paddy production from 21.7 million mt in 1996/97 to 26.71 million mt in 2000/2001 by improving paddy yield by 23 percent from 3.36 mt per ha in 1996/97 to 4.13 mt per ha in 2000/2001. The milled rice surplus above domestic needs is projected to increase from 3.66 million mt in 1996/97 to 6.05 million mt in 2000/2001. This projection assumes one monsoon crop planted to higher-valued, long-maturing varieties equal to 5 million ha and 1.5 million ha planted as a dry-season summer crop. The actual 1995/96 paddy yield is currently estimated at 3.11 mt per ha for the monsoon crop.

8.3 Outlook for Myanmar Export Market

The dramatic paddy price increases in the 1994/95 crop year to over Kyats 12,500-13,500 per mt have occurred because of the unusually high export demand for low-quality rice. These market price increases were reported to have been further exacerbated by the government's decision in 1994/95 to purchase additional rice from the free market above the normal procurement level to earn extra export revenue. Overall, this recent export activity has had a major

disruptive effect on the domestic market. The increased domestic price is highly disruptive to the economy by contributing to further inflation pressure because of the importance of rice in the consumer's budget. Furthermore, the new price level in the domestic market is likely to be short lived as the export price would need to be maintained at about US$262 per mt for milled rice at the unofficial exchange rate to sustain this domestic price level for the producers' paddy. It may be recalled that prior to the export demand surge starting in August of 1994, the normal trading range of exported Emata 25 percent brokens rice had been only about US$145-165 per mt. It is doubtful whether the world price and demand for low-quality rice will continue to be sufficient to accommodate further planned increases in Myanmar's production without disrupting world rice trade.

A Myanmar submodel component was incorporated in the Arkansas Global Rice Model (AGRM) to evaluate the global price implications of increasing rice production. The AGRM is a multi-country econometric model that provides projections for a set of 22 major rice producing and/or trading countries and an aggregate rest-of-the-world region. Projections include national levels of production (area harvested and yields), utilization, net trade (exports less imports), stocks and prices (Wailes et al., 1997).

The current AGRM, a representation of the world rice economy, includes the United States, Thailand, Pakistan, China, India, Myanmar,Vietnam, Australia, Japan, South Korea, Taiwan, Indonesia, the European Community, Spain, Italy, Egypt, Iran, Iraq, Saudia Arabia, Argentina, Uruguay and Brazil. Remaining countries are grouped in the rest-of-the-world (ROW) category. Countries and regions identified individually account for 87 percent of world rice production, 85 percent of consumption, 95 percent of exports, 41 percent of imports and 83 percent of world rice stocks.

Rice supply in typical country submodels of the AGRM is determined by profit-maximizing producers. Harvested acreage is generally expressed as:

$$HA_t = f_1 (HA_{t-1}, P_t^e, W_t^e, e_{1t})$$

where HA_t is harvested acreage, P_t^e is expected producer price, W_t^e is expected input price, and e_{1t} is the error term. Yield is specified as

$$Y_t = f_2 (P_t^e, W_t^e, T_t, e_{2t})$$

where T_t is the time trend and e_{2t} is the error term

Rice demand is assumed to be determined by utility-maximizing consumers. Per capita demand is specified as:

$$D_t = f_3 (M_t, RP_t, WP_t, e_{3t})$$

where D_t is per capita demand, M_t is per capita real income, RP_t is retail price, WP_t is wheat price, and e_{3t} is the error term.

Export demand is specified as:

$$EXP_t = f_4 (RESD_t, FOB_t, e_{4t})$$

where EXP_t is exports, $RESD_t$ is total production less consumption, FOB_t is the FOB export price, and e_{4t} is the error term.

Price linkages include farm price as a function of the retail price, retail price as a function of the export price and export price as a function of the Thai export price. Ending stocks are treated as a residual of supply and demand as determined by the above functions. The functions are constrained in some countries by policy variables (e.g., the farm price in Myanmar is a fixed procurement price for part of the rice production).

By computation, the simulation model solves for the set of farm, retail and export (import) prices that simultaneously clears all markets in each year for given exogenous factors. The international price, Thai (5 percent brokens), is solved to close the model such that world imports and exports are in balance for each year.

The current Myanmar submodel in the AGRM has estimated statistics as follows:

price elasticity	0.00 (for consumption)
income elasticity	0.66 (for consumption)
price elasticity	0.003 (for area harvested)
price elasticity	0.0018 (for rice yield)
export FOB price	99% of Thai (35% B) FOB price

A baseline model projection for the Myanmar rice sector based on past trends evaluated in the previous chapter and current growth assumptions is shown in Table 8.2. Paddy production is projected by the model baseline estimate to increase from 17.9 million mt in 1996 to 19.5 million mt in 2000. The AGRM for Myanmar assumes that overall average milling recovery increases from 57 percent in 1995 to about 59 percent in 2005. This milling recovery value used in the model is a more conservative estimate than the often quoted "39.5 baskets of milled rice per 100 baskets of paddy" (equivalent to 64.4 percent) due to prevailing poor post-harvest practices and relatively inefficient milling equipment. Milled rice consumption is projected to increase from 9.8 million mt in 1996 to 10.4 million mt in 2000, assuming a relatively modest annual increase of 1 percent in per capita consumption and about 2 percent annual growth in population. Exports are projected to increase from about 0.5 million mt in 1996 to 0.8 million mt in 2000 (Table 8.2).

The above paddy production projection with the AGRM baseline model of 19.5 million mt in 2000 is much less than what was projected with the most recent government plan, shown in Table 8.1. However, the Myanmar government generally has not achieved its production plans on schedule. The AGRM baseline projection did not include any production response from increasing

fertilizer use, because fertilizer use had been declining in Myanmar prior to 1995/96.

The Myanmar rice-sector model was linked to other country rice models incorporated in the AGRM to evaluate price adjustments over the period 1996 to 2000. This involved making baseline projections for all rice-exporting countries in the AGRM, including the United States, Thailand and Vietnam. The projected baseline model FOB export prices for Thai low-quality and Thai high-quality milled rice shown in Table 8.2 indicate a gradual increase (about 1 percent per year) over the next five years including an export increase of 0.3 million mt from Myanmar. World rice exports are projected to increase from about 16.5 million mt in 1996 to 18.9 million mt in 2000 with Myanmar's share increasing from 0.5 million mt (3 percent) to 0.8 million mt (4 percent). Thailand is the dominant world exporter, and the Thai export price is generally regarded as the most important world price indicator.

The annual baseline model export prices projected for Myanmar are substantially above the 1995 reported production and marketing cost of rice; thus production for the export market should continue to be profitable for the Myanmar rice sector at the export level projected in the baseline model.

An aggressive and dubious five-year plan for 1996/97 to 2000/2001 proposed in 1996 by the Ministry of Agriculture would expand annual paddy production by 23 percent from 21.7 million mt to 26.7 million mt over the next five years by making significant increases in paddy yield (Table 8.1). The total planted area is assumed to be held constant at 6.48 million ha, including 4.86 million ha of monsoon paddy and 1.62 million ha of irrigated dryland paddy with only one crop produced in the monsoon season. However, no explanation of this plan was available for our study on how the input supply and technology use could possibly be improved at the rate required to achieve the proposed major yield increase in the next five years. With the new five-year government plan, the annual surplus milled rice supply would potentially rise to 6.0 million mt in 2000/2001 with 3.0 million mt proposed for export.

Assuming that this unlikely event would happen, i.e., the government would achieve this planned production target from 1996/97 to 2000/2001 and place the projected surplus on the export market, there could be a dramatic effect on the world rice market, as shown in Table 8.3. Incorporating this additional export flow in the AGRM, the major world rice price indicator, Thai 5 percent high-quality rice is projected to fall steadily by 7.7 percent in 1997/98 to 16.6 percent in 2000/2001 compared to the baseline model projection due to the potential increased supply of Myanmar rice on the world market. The export price of U.S. high-quality rice would also fall in a similar manner as that of the Thai high-quality rice. The price of Thai low-quality 35 percent brokens rice is projected to be less affected, only falling from 5.2 to 15.3 percent from 1997/98 to 2000/2001 (Table 8.3). The AGRM used to make this projection pre-

dicted that the major price effect of the increased export volume would be on the high-quality rice market rather than on the low-quality rice market as many of the current low-quality rice exporters such as Vietnam would shift to more high-quality rice exports due to increased competition in the low-quality rice market. Thailand recently shifted to the high-quality market and began to compete with U.S. rice following Vietnam's entry as a major low-quality rice exporter. Myanmar currently has a low cost structure to compete strongly in the low-quality world rice market but is unlikely to compete in the high-quality market without making major infrastructure improvements.

The projected 1996/97-2000/2001 Thai low-quality 35 percent brokens export prices for rice are projected to range well above US$200 per mt even with a possible massive increase in Myanmar rice exports added to the world market. Therefore, the export price for similar low-quality Myanmar rice should continue to be attractive for Myanmar producers if the government is successful in increasing exports according to the 1996 five-year plan. The possible annual rice surplus generated in Myanmar with the 1996 government plan could place Myanmar in the lead, above Thailand, as the dominant world rice exporter. However, this is unlikely to occur due to continued constraints on input supply and technology use.

9.0 SUMMARY AND CONCLUSIONS

Myanmar has a total land area of 67.7 million ha with 17 million ha cultivable area. Only 8.2 million ha of the cultivable land is currently used for farming with about 80 percent in rice. It is the largest country on the southeast Asian mainland, equivalent to 7.4 percent of the United States in total area and about five times the size of the state of Arkansas.

The status of the rice sector was the major focus of interest in this study. Myanmar was the dominant world rice exporter during the first half of this century, accounting for nearly three-fourths of the world market. Production was severely curtailed during World War II. Myanmar experienced repeated difficulties regaining its status as a major world rice exporter after independence in 1948 with ill-conceived experiments in central planning and social policy. Thailand rapidly emerged as the dominant world rice exporter in the 1960s, and Myanmar's position declined due to restricted rice production, inferior quality and uncompetitive prices. Both rice production and rice exports have again been on the upsurge in Myanmar since 1990 as a result of the government's current thrust to expand the cultivated area and multiple cropping of rice. However, most observers of Myanmar's historical, political and economic progress remain skeptical as to whether this new growth phase in rice production will be sustainable under the current military government.

The major rice-producing regions are in the delta, including Ayeyarwady, Pegu, Yangon and Mon State. These four areas produced 66 percent of the 1994/95 monsoon crop. Major rice ecosystems include rain-fed lowland rice (about 52 percent of total rice lands), deep-water submerged rice (about 24 percent), irrigated lowland rice (about 18 percent) and rain-fed upland rice (about 6 percent). Total estimated paddy production in 1994/95 was 16 million mt on 5.5 million ha including 1.3 million ha of dry-season paddy that is mostly irrigated. Only 10 percent of the main monsoon paddy crop is irrigated.

Myanmar's overall paddy yield has averaged about 2.8 mt per ha with an estimated average fertilizer application rate of 50 kg per ha for HYVs and minimal application for traditional varieties. Use of HYVs is about half of the rice area. Technology use has been limited because of the shortage of foreign exchange to import inputs, such as chemical fertilizer and fuel, and the risk of investment with hazardous production conditions in flood-prone areas and areas with erratic rainfall. Most of the chemical fertilizer use is for HYVs produced on the more favorable production sites and in irrigated areas. The overall cropping intensity was 134 percent in 1993/94 with 17.3 percent irrigated.

The Minister of Agriculture in Myanmar has been recently promoting increased rice production by introducing improved cultivation practices, greater use of HYVs and increased input supply. However, there has been little change in the reported average paddy yield in recent years. The major increase has been in cultivation of dry-season paddy. Total irrigated crop area increased from 12.7 percent in 1992/93 to 17.3 percent in 1993/94 and is targeted to increase to 25 percent by 2000. Dry-season irrigated paddy increased from 0.9 million ha in 1993/94 to 1.3 million ha in 1994/95.

Paddy production in Myanmar has increased from 14 million mt in 1990/91 to 16 million mt in 1994/95. The main source of production increase has been the expanded public irrigation development that is essential for increased dry-season paddy production as well as of benefit for dry-zone, wet-season production. The irrigation development has been largely concentrated in low rainfall areas. Only 5 percent of the national water resources had been utilized in 1993/94. Additional investment in flood control is needed in the delta and coastal areas to increase rice production and to support high technology use.

Increased paddy production has enabled Myanmar to sharply increase the level of rice exports since 1993/94. Virtually all exports have been low-quality 25 percent brokens, long-grain rice. The government export target for 1994/95 was 1 million mt; however, the apparent difficulties in meeting this target caused an upsurge in domestic rice prices. There are relatively few modern rice mills and serious problems with quality control to export high-quality rice.

Although Myanmar has developed cultivation on only 8 million ha out of a total estimated arable area of about 19 million ha, only a small part of the estimated surplus arable area is recommended for rice production. Major rec-

ommended uses of this idle arable area are rubber, oil palm and orchard crops. There is general agreement that the greatest potential to increase rice production is through further intensification, such as increased double cropping and dry-season irrigated production. Increased infrastructural development in irrigation and flood control will facilitate greater use of HYVs and other technology to improve yield.

Infrastructural development has been severely constrained by governmental budget problems, particularly the shortage of foreign exchange, and the general lack of investment capital in Myanmar. These financial constraints are expected to continue because of limited foreign investment and the difficulties in controlling government spending. Most of the current public infrastructural development in progress, including irrigation development, is labor intensive, often using unpaid labor.

Reported rice production costs per metric ton are low by world standards at only US$42.32 for HYV paddy and $40.84 for local paddy. Rice production was clearly profitable at the 1994/95 average, free-market paddy price of US$120-$130 per mt. However, producers are obligated to deliver part of their crop to the government at a fixed procurement price of about US$34 per mt, which is less than the reported production cost. The estimated export-supply cost of bagged milled rice at the Yangon Port in 1993/94 was US$117.44 per mt, based on the reported paddy production cost, reported average milling out turn and other marketing costs from the farm gate to export position. The local retail price of milled rice increased from US$172 per mt in 1994 to US$208 in early 1995 due to a surge in export demand.

Rice production increased at an average annual growth rate of 0.9 percent from 1960-72 and 3.5 percent from 1973-91. Over the total period, 1960-91, Hossain and Oo (1995) have estimated that the change in HYV area contributed 37.1 percent to growth, increased irrigated area as a percentage of the total area contributed 12.2 percent and increased fertilizer use contributed 49.2 percent. Population growth has been about 2 percent per year. Estimated production elasticities for the second period, 1973-91, were 0.15 for use of HYVs, 0.19 for the portion of irrigated area and 0.26 for chemical fertilizer use. Production growth was not responsive to price over most of this period because of the restricted free market. Market restrictions have been substantially reduced since 1991, resulting in better price incentives for production.

Major factors other than price incentives that will determine production over the next decade are irrigation development and other infrastructural improvements, increased use of HYVs, now only half of production, and increased fertilizer use. The AGRM baseline projection of the Myanmar rice sector, which includes growth factors since 1991 and likely infrastructural development constraints, projects that paddy production will increase to 19.5 million mt in 2000 with exports increasing to 0.8 million mt. The major export surge and rapid

price increase in 1994/95 was triggered by a major drought in Indonesia and flooding problems in Vietnam. Only a modest price increase of about 1 percent per year over the next decade is projected for Myanmar's rice exports with the baseline model. World rice exports are projected to increase only slightly from 18.4 million mt in 1996 to 18.9 million mt in 2000.

Although highly improbable, a 1996 five-year government plan to aggressively increase rice yield was also evaluated with the Arkansas econometric model. The 1996 plan projected a massive increase in paddy production from 15.6 million mt in 1996/97 to 26.7 million mt in 2000/2001 with the annual rice surplus increasing to 6.0 million mt. Assuming that this annual surplus from Myanmar was sold on the world market, the AGRM model projected that the Thai high-quality rice price would fall by 7.7 percent in 1997/98 to 16.6 percent in 2000/2001 compared to results in the baseline projection. The Thai low-quality rice price was projected to be less affected than the Thai high-quality rice price as a result of the proposed massive increase in Myanmar low-quality rice exports. Other rice-exporting countries were assumed to switch from low-quality to high-quality rice exports in response to the increase in Myanmar low-quality rice exports. Former Myanmar government production plans have seldom been successful; thus, it is doubtful if increased Myanmar rice exports will have an important impact on the world price level in the near term.

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TABLES

Table 2.1 Rainfall and Temperature Range in Myanmar.

State/Division	Average Annual Rainfall		Temperature Range			
			Minimum		Maximum	
	mm	in.	^{0}C	^{0}F	^{0}C	^{0}F
Kachin State	2,311	91.0	7.0	44.6	41.5	106.7
Kayah State	1,011	39.8	10.8	51.4	37.0	98.6
Kayin (Karen) State	4,110	161.8	9.4	48.9	40.3	104.5
Chin State	1,740	68.5	2.4	36.3	33.3	91.9
Sagaing Division	1,341	52.8	7.0	44.6	43.3	109.9
Tanintharyi (Tenasserim) Division	4,895	192.7	10.0	50.0	38.0	100.4
Bago (Pegu) Division	1,953	76.9	10.0	50.0	40.3	104.5
Magway Division	879	34.6	8.9	48.0	46.0	114.8
Mandalay Division	965	38.0	8.0	46.4	43.6	110.5
Mon State	4,780	188.2	10.8	51.4	39.0	102.2
Rakhine (Rakah) State	4,069	160.2	20.1	68.2	40.0	104.0
Yangon Division	2,639	103.9	10.0	50.0	40.0	104.0
Shan State	1,283	50.5	0.3	32.5	32.9	91.2
Ayeyarwady Division	2,395	94.3	10.0	50.0	40.0	104.0

Source: Ministry of Agriculture (1995b).

Table 2.2. Myanmar National Land Use, 1993-94.

Land Use Category	Million ha	Million Acres	Percent of Total
Net sown area in agricultural crops	8.5[1]	21.0[1]	12.6
Fallow land	1.6	3.9	2.3
Cultivable waste land	8.2	20.2	12.1
Reserve forests	10.2	25.3	15.1
Other forests (unclassified)	22.1	54.7	32.7
Other lands (not suitable for crops)	17.0	42.1	25.2
Total land area	67.7	167.2	100.0

Source: Ministry of Agriculture (1995b).

[1] Includes 61 percent lowland and 26 percent upland crops.

Table 2.3. Size of Holding in 1993-94.

Size of Land Holding	Peasant Families & Societies		Acreage	
	(1000)	(Percent)	(1000)	(Percent)
Under 5 acres	2,744	61.8	6,530	26.7
5 to 10 acres	1,105	24.9	7,791	31.8
10 to 20 acres	490	11.0	6,732	27.5
20 to 50 acres	100	2.2	2,720	11.1
50 to 100 acres	2	0.04	97	0.4
100 acres and above	1	0.02	608	2.5
Total	4,442	100.0	24,478	100.0

Source: Ministry of Agriculture (1995b).

Table 3.0. Government Procurement and Free Market Price for Farm Paddy, 1961/62-1994/95.

	Paddy Price for Ngasein (kyats/mt)				
	Procurement Price		Free Market Price		Ratio of Free Market
Year	Nominal	Real[1]	Nominal	Real[1]	to Procurement Price[2]
1961-62	149	149	151	151	1.01
1962-63	149	143	166	160	1.12
1963-64	149	138	159	147	1.07
1964-65	149	133	155	138	1.04
1965-66	149	128	147	126	0.99
1966-67	163	135	165	137	1.01
1967-68	171	137	209	167	1.22
1968-69	171	132	228	176	1.33
1969-70	177	132	244	182	1.38
1970-71	177	127	281	202	1.59
1971-72	183	127	538	374	2.94
1972-73	210	141	582	390	2.77
1973-74	431	273	729	461	1.69
1974-75	431	257	744	444	1.73
1975-76	431	243	679	382	1.58
1976-77	431	229	579	308	1.34
1977-78	431	216	732	367	1.70
1978-79	446	211	464	219	1.03
1979-80	446	199	464	207	1.03
1980-81	472	199	466	196	0.98
1981-82	472	187	466	185	0.98
1982-83	439	164	466	175	1.07
1983-84	450	159	466	165	1.05
1984-85	450	150	474	158	1.06
1985-86	450	142	474	149	1.05
1986-87	450	134	450	134	1.00
1987-88	850	201	1150	272	1.35
1988-89	850	160	1100	207	1.29
1989-90	1250	187	3070	460	2.46
1990-91	2350	280	4380	522	1.86
1991-92	2350	223	3830	363	1.63
1992-93	2350	178	4200	317	1.79
1993-94	3500	211	8630	519	2.46
1994-95	3500	168	11,460	549	3.27

Source: Win (1991), Hossain and Oo (1995) and Ministry of National Planning and Economic Development (various issues).

[1] Deflated by price changes for all sectors of the economy, 1961=100.

[2] Free market prices were controlled after 1977-78 until 1988-89.

Table 4.1. Sown Acreage of Selected Crops in Myanmar by State and Division, 1992-93 (1000 ha)

	Cereals			Oilseeds				Pulses	
				Groundnuts		Sesame			
State/Division	Paddy	Wheat	Maize	Rainy Season	Winter Season	Early Season	Late Season	Matpe (Black Gram)	Pedisein (Green Gram)
Kachin	97.0	-	3.2	1.4	5.6	0.6	0.6	-	-
Kayah	25.2	-	7.0	3.0	-	1.9	-	-	-
Kayin	169.2	-	0.9	1.1	5.4	0.4	3.6	-	0.4
Chin	34.7	0.1	37.2	0.2	0.3	3.2	-	-	-
Sagaing	510.4	117.8	42.3	35.6	64.3	269.0	70.9	9.9	56.2
Tanintharyi	84.7	-	0.2	0.1	0.1	0.1	-	0.1	0.1
Bago	898.8	-	12.1	9.1	64.3	23.8	66.9	119.2	87.7
Magwe	163.9	0.5	49.3	87.6	23.2	407.4	35.8	1.0	17.6
Mandalay	297.4	16.0	32.4	87.4	41.7	406.3	4.9	64.8	12.2
Mon	275.9	-	1.1	1.7	6.4	0.1	1.4	1.2	1.7
Rakhine	335.5	-	0.8	0.5	5.8	1.3	0.4	0.4	0.1
Yangon	502.8	-	0.8	-	7.7	-	7.8	15.0	28.8
Shan	350.9	14.9	55.8	24.5	0.6	7.1	0.4	-	-
Ayeyarwady	1387.9	1.9	8.1	4.7	27.8	-	10.0	171.9	49.2
Union Total	5133.2	151.3	239.0	256.9	236.9	1121.2	246.8	325.3	254.1

Source: Ministry of National Planning and Economic Development, 1994a.

Table 4.2. Introduction of Modern Rice Varieties, 1970-1994 (1,000 ha).

	Total Modern Varieties		Types of Modern Varieties (% all MVs)							
Year	(1000 ha)	(% rice)[1]	IR-5	Ngwetoe	C4-63	IR-5 Mutant	Mashuri	Shwe-ta-soke	Others	Total
1970-71	190	4	91	9	-	-	-	-	-	100
1971-72	187	4	79	8	13	-	-	-	-	100
1972-73	203	4	74	7	19	-	-	-	-	100
1973-74	253	5	70	8	22	-	-	-	-	100
1974-75	328	6	72	7	21	-	-	-	-	100
1975-76	331	7	76	9	15	-	-	-	-	100
1976-77	450	9	57	8	8	3	24	-	-	100
1977-78	512	10	42	9	7	7	31	2	2	100
1978-79	721	14	25	8	7	16	34	6	4	100
1979-80	1244	25	16	5	4	25	26	19	5	100
1980-81	2046	40	9	3	3	34	24	22	5	100
1981-82	2755	46	7	3	3	36	26	22	3	100
1982-83	2278	47	7	3	3	37	22	25	3	100
1983-84	2343	48	5	2	2	37	23	24	7	100
1984-85	2557	52	4	2	2	37	21	21	13	100
1985-86	2597[2]	53	4	2	2	37	18	20	17	100
1986-87	3421[2]	49	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]
1987-88	2970[2]	51	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]
1988-89	2912[2]	52	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]
1989-90	2918[2]	50	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]
1990-91	2658[2]	49	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]
1991-92	2720[2]	51	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]
1992-93	3083[2]	53	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]
1993-94	2967[2,3]	52	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]	na[4]

Source: Win, 1991 for data from 1970-71 to 1985-86, Ministry of National Planning and Economic Development (MNPED) (1994) for data after 1985-86.

[1] Percent of planted rice area.

[2] Defined as high yield varieties after 1986 by Ministry of National Planning and Economic Development (MNPED) p. 82.

[3] Provisional estimates.

[4] na = not available.

Table 4.3. Rice Area Sown in Deep-water Areas of Myanmar, 1987-88.

State/Division		Total Rice Sown Area (ha)	Deep Water Rice Area (ha)	Percent Deep Water Area of Total
1	Kachin	119,838	0	0
2	Kayah	25,117	113	0.5
3	Kayin	110,959	3,181	2.9
4	Chin	37,247	0	0
5	Sagaing	502,977	0	0
6	Tanintharyi	80,541	7,955	9.9
7	Bago	852,461	79,777	9.4
8	Magway	143,889	0	0
9	Mandalay	258,235	0	0
10	Mon	246,445	59,828	24.3
11	Rakhine	343,509	19,845	5.8
12	Yangon	494,823	107,229	21.7
13	Shan	348,583	0	0
14	Ayeyarwady	1,315,385	268,621	20.0
Total Union		4,880,008	546,544	11.2

Source: Maung et al., 1990.

Table 4.4. Changes In Paddy Planted Area, Yield, Irrigation and Fertilizer Use, 1966/67 to 1995/96.

Crop Year	Planted Area (1000 ha)	Paddy Yield (mt/ha)	Paddy Production (million mt)	HYV Area (%)	Fertilizer NPK (kg/ha)	Irrigation (% of Paddy)
1966/67	4,989.1	1.47	6.6	—	0.79	13
1967/68	4,934.4	1.65	7.8	—	1.12	14
1968/69	5,019.0	1.68	8.0	3	3.70	15
1969/70	4,954.7	1.71	8.0	3	2.45	15
1970/71	4,975.3	1.70	8.2	4	2.00	15
1971/72	4,977.7	1.72	8.2	4	4.36	15
1972/73	4,862.0	1.62	7.4	4	6.64	15
1973/74	5,089.0	1.76	8.6	5	6.18	16
1974/75	5,177.3	1.76	8.6	6	6.63	17
1975/76	5,203.6	1.83	9.2	8	7.75	17
1976/77	5,077.7	1.90	9.3	9	8.20	16
1977/78	5,135.6	1.94	9.5	10	9.6	17
1978/79	5,243.6	2.10	10.5	16	14.2	17
1979/80	5,026.3	2.35	10.4	27	16.0	17
1980/81	5,126.7	2.77	13.3	41	18.4	17
1981/82	5,103.2	2.94	14.1	48	20.4	17
1982/83	4,882.2	3.15	14.4	52	27.0	16
1983/84	4,831.2	3.07	14.3	53	32.1	17
1984/85	4,917.4	3.10	14.3	52	29.0	18
1985/86	4,902.5	3.07	14.3	52	31.0	17
1986/87	4,843.4	3.03	14.1	49	29.4	18
1987/88	4,666.5	3.04	13.6	51	20.3	17
1988/89	4,778.2	2.91	13.2	52	14.8	17
1989/90	4,879.4	2.92	13.8	50	12.5	17
1990/91	4,945.4	2.93	14.0	49	10.2	18
1991/92	4,830.0	2.89	13.2	51	8.0	17
1992/93	5,091.5	2.94	14.7	53	9.3	19
1993/94	5,674.1	2.77	15.1	52	n.a.	n.a.
1994/95	5,928.1	2.90	16.0	n.a.	n.a.	n.a.
1995/96[1]	6,253.6	3.11[2]	17.0	n.a.	57.0	n.a.

Source: Myanma in Agricultural Service and American Embassy, Bangkok (1995-1996).
[1] Provisional estimate
[2] Yield for 1995 monsoon crop
n.a. = not available

Table 5.1. Number of Rice Mills by Ownership

Ownership	Quantity	Capacity (mt/24 hr.)
State owned	64	4,694
Cooperative	15	432
Private	2,110	44,841
Total	2,189	49,967

Source: Oo, 1994.

Table 5.2. Milling Capability of Myanmar Rice Mills

Milling Capacity	Number of Mills	Capacity (mt/24 hr.)
Type "A"[1]	118	6,988
Type "B"[2]	159	5,888
Type "C"[3]	406	10,799
Type "D"[4]	1,498	25,907
Type "E" and "F"[5]	8	385
Total	2,189	49,967

Source: Oo, 1994.

[1] Type "A" has capability to process Super 5% rice.
[2] Type "B" has capability to process Super 10% rice.
[3] Type "C" has capability to process Myanmar 25% rice.
[4] Type "D" has capability to process Small Mill Special 35% rice.
[5] Type "E" and "F" have capability to process parboiled rice.

Table 5.3. Myanmar Transport Statistics, 1989-1993.

Item	1989	1990	1991	1992	1993
Railroads:					
Track mileage	2,796	2,821	2,892	2,909	2,909
Locomotives (no.)	393	393	363	355	318
Box cars (no.)	6,698	6,392	6,279	6,353	6,676
Paddy transport (1000 ton-miles)	2,507	912	1,108	1,137	1,413
Watercraft:					
Private vessels (no.)	1,375	1,501	1,576	1,278	1,659
Public vessels (no.)	496	495	582	579	585
Road Transport:					
Road miles	14,596	14,901	14,967	15,057	15,118
Light trucks (no.)	10,521	10,300	10,718	11,900	13,853
Other trucks (no.)	29,860	22,100	22,718	23,813	25,207
Transport (mil. ton-miles)	66.3	73.5	75.3	84.1	123.5

Source: Ministry of National Planning and Economic Development, 1994a.

Table 5.4. Average Farm Gate Paddy Prices and Wholesale and Retail Prices of Three Types of Milled Rice in Yangon, 1984-1995 (Kyats/kg)[1]

	Farm Gate	Ngakywe (38%B)[2]		Emata (35%B)[3]		Ngasein (35%B)[4]	
Year	Paddy	Wholesale	Retail	Wholesale	Retail	Wholesale	Retail
1984	0.45	1.00	2.53	0.92	1.86	0.86	1.64
1985	0.45	1.00	3.38	0.92	2.06	0.86	1.75
1986	0.45	1.00	3.20	0.92	2.12	0.86	2.08
1987	0.45	1.00	3.69	0.92	2.37	0.86	2.04
1988	1.10	5.02	5.51	3.74	4.04	3.60	3.71
1989	3.07	8.04	8.26	6.98	7.19	6.42	6.67
1990	4.38	6.46	6.74	5.34	5.63	4.66	4.77
1991	3.83	7.68	8.54	5.50	6.48	5.10	5.68
1992	4.20	13.52	14.22	9.80	10.68	8.98	9.99
1993	8.63	21.10	21.56	17.34	18.28	15.88	17.03
1994	11.46	n.a.	n.a.	n.a.	n.a.	n.a.	16.86
1995	10.24	n.a.	n.a.	n.a.	n.a.	n.a.	18.37

Source: Ministry of Planning and National Economic Development, 1994a.

[1] Wholesale milled rice is sold in 50-kg bags, and retail rice is sold in one-pyi bags equal to 4.69 lb or 2.13 kg per pyi. Farm gate prices are for average quality paddy sold in the free market in bulk at 46 lb or 20.87 kg per basket measurement. B = Percent content of broken rice.

[2] Local variety with good elongation and taste, commanding a high market price in Myanmar.

[3] Long hard grain rice.

[4] Short bold hard grain rice.

n.a. = not available

Table 5.5. Estimated Ex Mill Wholesale Costs for Myanmar Rice, 1987 and 1995 (Kyats)

Item	1987	1995
Purchase Cost:		
a) Purchase price of 100 baskets paddy	900.00	21,372
b) Purchase depot expenses	27.50	-
c) Handling, transport and storage costs	52.39	241
d) Other costs	10.71	49[1]
Milling cost:		
a) Milling	34.50	250[2]
b) Labor	4.97	-
c) Other costs	1.80	-
Subtotal:	1,031.26	21,912
Value of Rice By-products	-48.64	-224[1]
Value of Milled Rice (39.5 baskets)[3]	982.62	21,688
Value of rice per metric ton	742.75	16,185
Other Mill Costs:		
a) weighing, bagging and piling	2.75	12.65
b) re-milling	0.08	0.37
c) service cost (4%)	29.82	647.40
d) loss allowance (1%)	7.46	161.85
e) profit margin (1%)	7.46	161.85
Factory (ExMill) cost per metric ton	790.32	17,169.12

Source: 1987 cost data from Sein Pe, 1987.

[1] Adjusted by CPI changes from base year 1986 = 100.

[2] Government contract milling charge paid to private mills.

[3] Milling recovery was assumed to be 39.5 baskets milled rice at 75 lb per basket from 100 baskets paddy at 46 lb per basket. The milling recovery is therefore 64.4 percent.

Table 5.6. Cost of Paddy Cultivation (1994-95) in Kyats per Hectare.

State/Division	Family Labor	Hired Labor	Material Costs at private market price (Kyats)	Total Costs (Kyats)
Ayeyarwaddy	6,573	3,111	5,035	14,719
Bago	7,623	3,645	4,689	15,957
Yangon	6,511	3,645	4,689	14,845
Mon	6,793	4,075	5,429	16,297
Mandalay	7,957	4,295	4,689	16,941
Tanintharyi	6,904	4,112	5,429	16,445
Shan	5,399	3,645	7,605	16,649
Simple Average	6,823	3,790	5,366	15,979

Source: Soe Win Maung, Myanmar Agricultural Service, personal communication, June 1995.

Table 5.7. Paddy Production and Utilization, 1973/74 - 1993/94.

Crop Year	Paddy (million mt) Production	Waste	Seed & Export	Domestic Consumption	Population (million)	Per Capita Consumption (kg of paddy)
1973/74	8.6	1.0	0.3	7.2	29.2	247
1974/75	8.6	1.1	0.3	7.2	29.8	242
1975/76	9.2	1.1	0.6	7.5	30.4	248
1976/77	9.3	1.0	0.9	7.3	31.0	236
1977/78	9.5	1.1	1.0	7.4	31.6	234
1978/79	10.5	1.1	0.3	9.1	32.3	283
1979/80	10.4	1.0	1.3	8.1	32.9	246
1980/81	13.3	1.1	1.4	10.9	33.6	324
1981/82	14.1	1.1	1.3	11.8	34.3	345
1982/83	14.4	1.0	1.0	12.4	35.0	355
1983/84	14.3	1.0	1.3	12.0	35.7	336
1984/85	14.3	1.0	0.9	12.3	36.4	339
1985/86	14.3	1.0	0.9	12.4	37.1	336
1986/87	14.1	1.0	0.7	12.4	37.8	328
1987/88	13.6	1.0	0.3	12.3	38.5	320
1988/89	13.2	1.0	—	12.1	39.3	309
1989/90	13.8	1.0	0.3	12.5	40.0	313
1990/91	14.0	1.0	0.2	12.7	40.8	313
1991/92	13.2	1.0	0.3	11.9	41.6	287
1992/93	14.8	1.1	0.3	13.5	42.3	318
1993/94	16.8[1]	1.2	0.4	15.2	43.1	351

Source: Win, 1995.

[1] The 1993/94 estimate was planned production. Actual production was 15.1 million mt in 1993/94 and 16.0 million mt in 1994/95.

Table 5.8. Average Monthly Household Expenditures on Rice, Food and Beverages and Non-Food Groups in 1989 (Kyats).

State/ Division	Household Size	Total Spending	Rice Value	Rice %	Food and Beverages Value	Food and Beverages %	Non-Food Value	Non-Food %
Kachin	6.55	1993	743	37	1480	74	513	26
Kayah	5.52	1908	697	37	1423	75	485	25
Kayin	5.68	1815	594	33	1312	72	503	28
Chin	6.15	1695	818	48	1282	76	414	24
Sagain	5.36	1646	616	37	1280	78	366	22
Tanintharyi	5.30	2001	698	35	1509	75	492	25
Bago	5.17	1723	469	27	1275	74	448	26
Magway	5.32	1773	544	31	1351	76	422	24
Mandalay	5.11	1824	625	34	1347	74	478	26
Mon	5.77	1755	515	29	1293	74	463	26
Rakhine	5.89	1851	645	35	1398	76	453	24
Yangon	5.07	1929	340	18	1336	69	593	31
Shan	5.15	1832	645	35	1341	73	491	27
Ayeyarwady	4.97	1747	449	26	1296	74	451	26
Myanmar	5.27	1796	540	30	1329	74	466	26

Source: Ministry of National Planning and Economic Development, 1993.

Table 5.9. Myanmar Financial Statistics, 1988-89 to 1995.

Item	1988-89	1989-90	1990-91	1991-92	1992-93	1994	1995[2]
Value of Imports (million Kyats)[1]	3,443	3,395	5,523	5,337	5,365	5,242	1,017
Value of Exports (million Kyats)[1]	2,169	2,834	2,953	2,926	3,590	4,010	1,162
Currency in Circulation (million Kyats)	19,926	29,211	39,289	54,429	68,670	79,523	95,988
Demand Deposits (million Kyats)	1,610	3,122	4,448	5,753	7,241	7,674	8,251
Increase in Money Supply (%)	35.1	50.1	35.3	37.6	26.1	14.9	19.6
International Reserves (million Kyats)	1,139	1,567	1,313	1,628	1,773	na	na
Population (million)	39.3	40.0	40.8	41.6	42.3	43.1	na
Government Expenditure (million Kyats):							
Defense	2,131	4,615	5,436	6,086	9,127	na	na
Agriculture	1,986	2,118	2,416	2,497	4,006	na	na
Total	31,452	45,656	58,981	66,379	75,693	na	na
GNP (deflated billion Kyats)[3]	47,141	48,883	50,260	49,933	54,572	na	na
CPI (Yangon)[4]	184.2	216.6	286.5	349.3	460.4	571.3	658.8
Change in CPI (%)	27.2	17.6	32.3	21.9	31.8	24.1	15.3

Source: Ministry of National Planning and Economic Development, 1994a.
1959/60–1994/95 [1]Values are CIF for imports and FOB for exports.
[2] Values for first two months of 1995 from Selected Monthly Economic Indicators.
[3] Value of net output, services and trade in 1985-86 constant producer prices.
[4] Base year 1986=100.
na = Not available.

Table 5.10. Change in Quarterly Retail Rice Prices, Myanmar, 1994 - 1995.

	Average Quality[1]		High Quality[2]	
Year/Quarter	Kyats/kg	US$1.00/kg[3]	Kyats/kg	US$1.00/kg[3]
1994:				
Jan-Mar	19.7	$0.19	29.0	$0.28
Apr - Jun	19.6	0.19	30.5	0.30
Jul - Sep	21.1	0.21	33.7	0.33
Oct - Dec	21.1	0.21	33.3	0.33
Average	20.4	0.20	31.6	0.31
1995:				
Jan-Mar	21.3	0.21	32.1	0.31
Apr - Jun	24.6	0.24	35.2	0.35
Jul - Sep	26.0	0.25	42.3	0.41
Oct - Dec	29.0	0.28	52.0	0.51
Average	25.2	0.25	40.4	0.40

Source: FAS (1996).
[1] Emata variety (short maturity)
[2] Ngakywe variety (long maturity)
[3] Priced at unofficial exchange rate of Kyats 104 per US$1.00

Table 5.11. Myanmar Bimonthly Rice Exports, By Destination, 1995-1996 (1000 mt).

	1995/Months						1996/Months
Destination	1-2	3-4	5-6	7-8	9-10	11-12	1-2
Indonesia	192.7	207.3	36.6	48.2	19.9	—	6.1
Sri Lanka	20.3	—	—	—	—	—	—
Africa Ports	35.4	29.1	—	—	—	—	—
Madagascar	1.0	—	—	—	—	—	—
Cuba	9.9	—	—	—	—	—	13.5
Maldives	2.0	—	—	—	—	—	—
Chittagong	—	3.1	24.6	—	—	—	—
Camaroon	—	—	12.9	2.3	—	—	—
China	—	—	—	—	—	—	8.2
Phillipines	—	—	—	—	—	—	23.3
Total	248.4	252.5	74.1	50.5	19.9	—	37.6

Source: FAS (1996).

Table 5.12. Value of Myanmar Rice Exports, 1983/84 to 1994/95.

		Purchase Value			Export Value/mt	
Crop Year	Quantity (1000 mt)	(Kyats/mt[1])	(Million Kyats)	Export Value (Million Kyats)	Kyats[2]	US$
1983/84	906	1,640	1,485	1,397	1,542	180
1984/85	634	1,750	1,110	1,024	1,615	220
1985/86	594	2,080	1,236	763	1,285	193
1986/87	604	2,040	1,232	523	866	135
1987/88	320	3,710	1,187	254	794	119
1988/89	47	6,670	313	54	1,149	181
1989/90	166	4,770	792	266	1,602	242
1990/91	132	5,680	750	172	1,303	209
1991/92	180	9,990	1,798	251	1,394	222
1992/93	199	17,030	3,389	249	1,253	206
1993/94	262	16,860	4,417	267	1,018	167
1994/95	1,004	18,370	18,370	na	na	na

Source: Ministry of National Planning and Economic Development, 1994a, p. 148 and Selected Monthly Indicators, 1995.

[1] Retail prices for ngasein (35%) used to estimate value of purchases (see Table 5.4).

[2] Export value in Kyats per mt as reported by Central Statistical Organization but actually sold at official foreign exchange rate for foreign currency.

[3] Converted from Kyats at exchange rate in Kyats/US $1.00 of 8.57 for 1983/84, 7.33 for 1984/85, 6.65 for 1985/86, 6.39 for 1986/87, 6.70 for 1987/88, 6.34 for 1988/89, 6.63 for 1989/90, 6.22 for 1990/91, 6.27 for 1991/92, 6.08 for 1992/93, 6.11 for 1993/94 and 5.88 for 1994/95.

[4] Government official export target for 1994/95.

na = Not available.

Table 5.13. Myanmar Rice Supply and Disposition, 1994-1997.

Item	1994	1995	Preliminary 1996	Forecast 1997
Area harvested (1000 ha)	5,443	5,517	5,666	5,700
Beginning stocks (1000 mt)	781	801	591	651
Rough production (1000 mt)	15,100	16,000	17,000	18,000
Milled production (1000 mt)	8,758	9,280	9,860	10,440
Milling recovery (%)	58	58	58	58
Imports (1000 mt)	0	0	0	0
Total milled supply (1000 mt)	9,539	10,081	10,451	11,091
Exports (1000 mt)	500	645	700	1,000
Domestic consumption (1000 mt)	8,160	8,845	9,100	9,200
Ending stocks (1000 mt)	879	591	651	891
Total milled distribution (1000 mt)	9,539	10,081	10,451	11,091

Source: FAS, 1997.

Table 6.1. Recommended Land Use Potential From Reclamation.

Type of Land Use	Area (1000 ha)
1. Potential cultivated crops in current condition:	
Rice	6,105
Dryland crops	3,687
Seasonal dryland crops	450
Garden crops	1,100
Grazing land	405
Forest	32,898
Total	44,642
2. Potential additional cultivated area after modification:	
Saline land	611
Alkaline land	53
Acid sulphate affected land	8
Hyperacid land	8
Degraded land	40
Peat land	-
Swamp land	243
Total	960

Source: Aye, 1990.

Table 6.2. Unused Land Availability in Myanmar, 1993/94.

State/Division	Fallow Land (1000 ha)	Cultivable Waste Land (1000 ha)
Sagaing	216.4	378.8
Mandalay	206.4	118.4
Magway	101.8	148.4
Bago	83.6	225.2
Yangon	39.6	63.6
Ayeyarwady	158.8	220.0
Taninthayi	27.2	361.2
Kachin	33.6	2,091.6
Chin	1.2	1,556.8
Shan	347.2	2,513.2
Kayah	5.6	58.4
Kayin	65.2	150.8
Mon	24.4	115.6
Rakhine	108.8	135.6
Total	1,419.8	8,137.6

Source: Maung, 1995.

Table 6.3. Irrigation Development in Myanmar, 1992/93 to 1996/97.

Year	Net Sown Area (1000 ha)	Irrigated Area (1000 ha)	Irrigated Area % Sown Area
1992/93	8,714	1,109	12.2
1993/94	8,867	1,534	17.3
1994/95	9,000	1,712	19.0
1995/96 (Plan)	9,126	2,036	22.3
1996/97 (Plan)	9,200	2,300	25.0

Source: Maung, 1995.

Table 6.4. Future Irrigation Projects to be Implemented.

Project Name	State/Division	Area Irrigated (ha)	Project Cost (Million Kyats)
Zawgi Dam	Shan	44,000	1,200
Paunglaung Dam	Mandalay	21,270	4,385
Yenwe Dam	Bago	47,400	3,068
Mone Dam	Magway	4,320	1,640
Mu Valley Dam	Sagaing	200,000	2,599
Sinthe Dam	Mandalay	4,900	560
Swa Dam	Bago	27,600	1,094
Kabaung Dam	Bago	54,000	1,960
Total		403,490	16,506

Source: Maung, 1995.

Table 6.5. Proposed Lower Burma Paddylands Development Project, Phase III (1000 ha).

Land Use	Present	Future
a) Flood free or shallow flooded paddy land suitable for HYVs	51.3	89.9
b) Medium flooded paddy for local varieties	28.9	2.2
c) Deep flooded paddy	5.3	—
d) Very deeply flooded fallow land	5.3	0
e) Other planting, grazing, etc.	0.4	0.4
f) Saline scrub land	1.6	—
g) Area loss due to project	—	0.3
h) Villages, roads, creeks, etc.	3.2	3.2
Total	96.1	96.1

Source: Personal communication on 1984 proposal by Irrigation Department of the Ministry of Agriculture to include parts of three townships in the lower delta southwest of Yangon, May 1995.

Table 6.6. Irrigated Crop Area from 1990/92 to 1993/94 (1000 ha).

	1990/91		1991/92		1992/93		1993/94[1]	
Crop	(1000 ha)	(%)	(1000 ha)	(%)	(1000 ha)	(%)	(1000 ha)	(%)
Paddy	869	75	835	71	957	73	1,507	82
Wheat	17	1	26	2	21	2	23	1
Maize	4	-	6	1	5	-	6	-
Chick pea	27	2	38	3	33	3	32	2
Sesame	71	6	75	6	75	6	70	4
Cotton	14	1	15	1	21	2	14	1
Jute	28	2	25	2	41	3	23	1
Sugarcane	8	1	8	1	7	1	5	-
Chillies	18	2	23	2	29	2	25	1
Onions	15	1	17	1	17	1	17	1
Other crops	91	9	95	10	102	7	105	7
Total	1,162	100	1,163	100	1,038	100	1,827	100

Source: Ministry of National Planning and Economic Development, 1994b.

[1] Provisional estimate.

Table 6.7. Comparison of Rice Production in Myanmar and Vietnam by Culture Type in 1000 ha.

Country/Region	Upland Dryland	Deep Water	Irrigated Wet Season	Irrigated Dry Season	Rainfed Lowland Rice	Total Rice
Myanmar:						
Sagaing	16.9	0.0	174.0	28.3	276.1	495.3
Mandalay	3.9	0.0	124.6	20.8	106.3	255.6
Magwe	3.4	0.0	57.9	7.2	75.1	143.6
Pegu	20.3	79.8	9.0	13.0	730.6	852.7
Yangon	10.1	122.7	0.0	0.0	358.3	491.1
Ayeyarwady	23.2	264.0	0.0	0.0	1,018.5	1,305.7
Tenasserim	5.7	8.0	0.3	0.0	61.5	75.5
Kachin State	19.0	0.0	60.7	0.0	36.0	115.7
Chin State	31.6	0.0	0.0	0.0	4.3	35.9
Shan State	131.2	0.0	188.3	0.0	27.5	347.0
Kayah State	7.9	0.1	14.8	0.0	2.3	25.1
Karen State	23.4	2.8	0.4	0.0	88.2	114.8
Mon State	22.2	59.8	0.0	0.0	160.7	242.7
Rakhine State	2.9	19.8	0.0	0.0	312.0	334.7
Total Myanmar	321.7	557.0	630.0	69.3	3,257.2	4,835.2
Vietnam:						
Northern Vietnam	179.0	0.0	1,006.0	1,006.0	379.0	2,570.0
Southern Vietnam	228.0	410.0	558.0	610.0	821.0	2,627.0
Total Vietnam	407.0	410.0	1,565.0	1,616.0	1,201.0	5,197.0

Source: Huke and Huke, 1990.

Table 7.1. Estimated Elasticities of Rice Area, Yield and Production for Myanmar, 1960-91.

Elasticity Response	1960-72	1973-91	1960-91
Area elasticity with respect to:			
HYVs	—	-0.053	-0.043
Irrigated area (% of total)	0.22	0.19	0.21
Yield elasticity with respect to:			
HYVs	—	0.20	0.19
Chemical fertilizers	0.027	0.26	0.14
Production elasticity with respect to:			
HYVs	—	0.15	0.15
Irrigated area (% of total)	0.22	0.19	0.21
Chemical fertilizer	0.027	0.26	0.14

Source: Hossain and Oo, 1995.
HYV = High yielding varieties of rice.

Table 7.2. Comparison of MAPT Procurement and Private Market Paddy Prices, 1975/76 to 1994/95 (Kyats/mt).

	MAPT Price for Ngasein Paddy		Private Market Price for Avg. Quality Paddy		Procurement[2]	
Year	Nominal	Deflated[1]	Nominal	Deflated[1]	(1000 mt)	Percent of Production
1975/76	450	n.a.	464	n.a.	695	27.0
1976/77	450	n.a.	464	n.a.	742	30.5
1977/78	450	n.a.	464	n.a.	577	23.4
1978/79	450	n.a.	464	n.a.	975	36.1
1979/80	450	n.a.	464	n.a.	90	3.3
1980/81	450	n.a.	466	n.a.	1,082	31.2
1981/82	450	n.a.	468	n.a.	1,106	30.0
1982/83	450	n.a.	468	n.a.	1,042	28.3
1983/84	450	n.a.	474	n.a.	1,049	28.1
1984/85	450	525	474	554	942	25.4
1985/86	450	492	474	518	1,201	32.2
1986/87	450	450	474	474	926	25.1
1987/88	850	686	1,150	928	—	—
1988/89	850	587	3,214	2,220	613	11.8
1989/90	1,250	652	4,578	2,388	519	9.5
1990/91	2,350	1,006	4,000	1,712	594	10.8
1991/92	2,350	778	4,389	1,454	615	11.8
1992/93	2,350	636	9,025	2,445	651	11.1
1993/94	3,500	710	11,977	2,430	882	12.8
1994/95	3,500	532	10,704	1,625	n.a.	n.a.

Source: Various reports of Ministry of Planning and Finance, Central Statistics Organization and Myanmar Agricultural Service.

[1] Deflated by Yangon Consumer Price Index with 1986 = 100.

[2] Procurement in milled equivalent.

n.a. = not available

Table 7.3. Production Costs and Returns of Principal Crops in Myanmar, 1994/95 (Kyats/acre).

	Production Cost				Revenue			
Principal Crop	Family Labor	Hired Labor	Material Cost	Total Cost	Yield/ acre[1]	Price/ unit[1]	Total Revenue	Net Revenue
Rice (HYV)[2]	2,925	2,075	1,435	6,425	70	214	14,980	8,555
Rice (Local)	2,194	1,242	552	3,988	45	214	9,630	5,642
Wheat	2,033	1,283	2,466	5,783	12	967	11,604	5,821
Maize	2,575	900	933	4,408	25	366	9,150	4,742
Groundnut	2,650	817	2,737	6,204	33	332	10,956	4,752
Sesame	1,100	675	1,253	3,028	4	1,233	4,932	1,904
Sunflower	2,000	1,700	950	4,650	21	500	10,500	5,850
Cotton	1,467	1,623	1,983	5,073	175	40	7,000	1,927
Jute	1,600	2,360	913	4,873	220	23	5,060	187
Sugar cane	2,250	4,125	3,270	9,645	18	1,000	18,000	8,355
Chick pea	1,367	750	404	2,521	8	1,164	9,312	6,791
Green gram	1,300	533	905	2,738	7	1,021	7,147	4,409
Mung bean	1,050	883	605	2,538	9	927	8,343	5,805
Pigeon pea	1,300	517	368	2,185	8	1,119	8,952	6,767

Source: Production cost data compiled by Tin Maung Shwe, Planning Division, MAS, May 1995. Yield data are national averages except for rice. The actual national rice yield in 1994/95 was 59.24 baskets/acre for all types of rice.

[1] Units of yield are in baskets, e.g. paddy weighs 46 lb/basket, except for cotton and jute measured in Viss (3.6 lb), and sugar cane measured in metric tons.

[2] HYV = High yielding variety.

Table 7.4. Estimated Supply Cost per mt for Milled Rice at the Yangon Port, 1994/95.

Item	Unit	Number of Units	Cost per Unit (Kyats)	Total Cost/Metric Ton Kyats	Total Cost/Metric Ton U.S. Dollars[1]
Farm Supply:					
Production cost[2]	mt (paddy)	1.56	4,401	6,866	66.02
Transport to mill	mt (paddy)	1.56	200	312	3.00
Subtotal				7,178	69.02
Mill Costs:					
Milling charge[3]	mt (paddy)	1.56	500	780	7.50
Weighing and bagging	mt (milled)[4]	1.00	1,000	1,000	9.62
Value of by-products[5]				–	–
Storage (90 days)	mt (milled)	1.00	30/month	300	2.88
Subtotal				2,080	20.00
Other costs:					
Transport to port storage[6]	mt (milled)	1.00	1,000	1,000	9.62
Loading/unloading[7]	mt (milled)	1.00	80	80	0.77
Port storage (60 days)	mt (milled)	1.00	180	180	1.73
Port tax	mt (milled)	1.00	45	45	0.43
Subtotal				1,305	12.55
Total cost:					
Total to port	mt (milled)	1.00	11,103	11,103	106.76
Export tax (5%)				555	5.34
Profit margin (5%)				555	5.34
Subtotal				12,203	117.44

Source: Authors.

[1] Assumed unofficial rate of 104 Kyats per U.S. dollar.

[2] Based on reported average production cost of HYV paddy in 1994/95 and a milled rice yield of 64.4% of paddy with 25% broken.

[3] Based on reported price paid by private traders for milling service.

[4] Cost of poly bags included for 50-kg bags to export.

[5] Assumed that farmers retain by-products to feed cattle.

[6] Assumed flat land transport of 200 miles at 5 Kyats/mt/mile.

[7] Loaded and unloaded twice at 20 Kyats/mt for each operation.

Table 8.1. Myanmar Government Plan for Increased Paddy Production and Export, 1996/97 - 2000/2001.

Category	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001
A. Production:					
Planted Area (million ha)	6.48	6.48	6.48	6.48	6.48
Paddy Yield (mt/ha)	3.36	3.51	3.68	3.90	4.13
Paddy Production (million mt)	21.7	22.7	23.9	25.2	26.70
B. Consumption (million mt):	15.6	15.8	16.1	16.4	16.60
C. Estimated Surplus:					
Surplus Paddy (million mt)	6.1	6.9	7.8	8.8	10.1
Surplus Milled Rice (million mt)	3.7	4.1	4.6	5.4	6.0
D. Estimated Exports (million mt):	1.5	2.0	2.5	3.0	3.0

Source: Unofficial government data reported in FAS, 1997.

[1] Population projection for 1996/97 to 2000/2001 is 45.51, 46.33, 47.17, 47.98 and 48.81 million, respectively.

Table 8.2. AGRM Baseline Projections for Myanmar Rice Sector, 1996-2000.

Year	Production				Export Price (FOB)[1]	
	Paddy	Milled	Consumption Milled	Exports Milled	Thai 35% B	Thai 5% B
	- - - - - - - - - - - - - - - -		million mt - - - - - - - - - - - - - -		- - - - - US $/mt - - - -	
1996	17.9	10.4	9.8	0.5	256	328
1997	18.4	10.7	9.8	0.7	280	330
1998	19.0	11.0	10.0	0.7	276	327
1999	19.1	11.1	10.2	0.7	294	335
2000	19.5	11.3	10.4	0.8	293	334

Source: Wailes et al., 1997.

[1] Free on Board at Yangon Port.

B = Brokens content of rice.

n.a. = not available

Table 8.3. AGRM Projected Impact of Myanmar's Five-Year Planned Production on World Rice Prices (US$/mt)[1].

Price Comparison	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001
Thai HQ 5% (FOB Bangkok)[2] :					
Baseline Model	328	330	327	335	334
Myanmar 5-Year Plan	328	304	288	289	279
Change	0	-26	-39	-46	-55
Percent change	0.0	-7.7	-11.9	-13.7	-16.6
Thai LQ 35% (FOB Bangkok)[3]:					
Baseline Model	256	280	276	294	293
Myanmar 5-Year Plan	256	266	254	259	249
Change	0	-15	-22	-35	-45
Percent Change	0.0	-5.2	-8.1	-12.0	-15.3

Source: Estimated with University of Arkansas Global Rice Model (AGRM).

[1] Increases in Myanmar's planned production are phased in more gradually than in the government plan from 1996/97 to 2000/2001 but reach the same end point in 2000/2001 as in the government plan.

[2] Thai high-quality milled rice with 5 percent brokens.

[3] Thai low-quality milled rice with 35 percent brokens.

APPENDIX

Appendix Table 1. Rice Production Under British Colonization, by Rainfall Zone, 1931/32 to 1933/34 Average.

Rainfall Zone/ District or Paddy Zone[1]	Total Cultivated Area (acres)	Paddy Area (acres)	Paddy Yield (lb/acre)	Paddy Production (1000lb)
1. Northern Wet Zone:				
Myitkyina	105,024	96,971	1,450	140,608
Katha	210,170	201,946	1,400	282,724
Bhamo	7,902	37,834	1,300	49,184
Upper Chindwin	130,785	121,805	1,300	158,346
Subtotal	483,881	458,556		630,862
2. Upper Dry Zone:				
Lower Chindwin	546,532	113,096	1,000	113,096
Shwebo	663,726	567,066	1,200	680,479
Sagaing	459,617	74,599	1,000	74,599
Mandalay	188,937	116,101	1,500	174,152
Kyaukse	214,136	129,515	1,450	187,797
Meiktila	393,396	141,117	1,100	155,229
Yamethin	446,223	272,188	1,250	340,235
Myingyan	800,603	49,183	1,000	49,183
Pakakku	533,783	109,555	1,000	109,555
Minbu	306,887	131,135	1,600	209,816
Magwe	694,635	123,567	1,000	13,567
Thayetmyo	220,273	103,535	1,150	119,065
Subtotal	5,468,748	1,930,657		2,336,773
3. Mid-Zone:				
Toungoo	511,596	457,122	1,400	639,971
Prome	405,159	356,899	1,250	446,124
Subtotal	916,755	814,021		1,086,095
4. Coastal Wet Zone:				
Akyab	735,543	697,671	1,550	1,081,390
Kyaukpyw	184,968	185,109	1,350	249,897
Sandoway	112,615	98,494	1,300	128,042
Thaton	762,109	682,480	1,300	887,224
Amherst	626,697	545,614	1,300	709,298
Tavoy	169,329	120,511	1,300	156,664
Mergui	176,932	98,077	1,250	122,596
Subtotal	2,768,193	2,427,956		3,335,111
5. Ayeyarwady Delta:				
Henzada	687,101	571,277	1,650	942,607
Hanthawaddy	859,378	816,474	1,650	1,347,182
Tharrawaddy	608,099	548,581	1,700	932,588
Pegu	1,025,927	1,011,908	1,650	1,669,648
Insein	561,033	528,742	1,500	793,113
Yangon	5,759	4,358	1,500	6,387
Maubin	546,212	480,759	1,600	769,214
Pyapon	730,425	715,892	1,700	1,217,016
Myaungmya	925,687	881,782	1,700	1,499,029
Bassein	898,939	836,005	1,550	1,295,808

Appendix Table 1. Rice Production Under British Colonization, by Rainfall Zone, 1931/32 to 1933/34 Average, (continued)

Rainfall Zone/ District or Paddy Zone[1]	Total Cultivated Area (acres)	Paddy Area (acres)	Paddy Yield (lb/acre)	Paddy Production (1000lb)
Salween	30,198	25,327	1,300	32,925
Subtotal	6,878,758	6,421,105		10,505,517
6.Total Myanmar	16,516,335	12,052,295		17,894,358

Source: Department of Agriculture, 1958.

[1] Some of the names of districts or zones have been changed since independence from Great Britain.

Appendix Table 2. Classes of Rice Established by the Department of Agriculture in British Colonial period.

	Dimensions of Grains			
	With Husk		Husked	
Group Name	Length (mm)	Length/Breadth	Length (mm)	Length/Breadth
Emata	over 9.40	over 3.30	over 7.00	over 3.00
Letywezin	8.40-9.80	2.80-3.30	6.00-7.00	2.40-3.00
Ngasein	7.75-9.00	2.40-2.80	5.60-6.40	2.00-2.40
Medon	7.35-8.60	2.00-2.40	5.00-6.00	1.60-2.00
Byat	9.00+	2.25-3.00	6.40-7.35	2.10-2.50

Source: Department of Agriculture, 1958.

Appendix Table 3. Rice Production in 1993/94 for Different Districts and States in Myanmar.

Rainfall[1] Zone/District or State	Total Sown Area Monsoon (acre)	Total Sown Area Dry (acre)	Yield/Acre Monsoon (lb)	Yield/Acre Dry (lb)	Paddy Production Monsoon (1,000 lb)	Paddy Production Dry (1,000 lb)
1. Northern Wet Zone:						
Kachin State	250,700	8,069	2,148	2,047	515,890	16,514
Sagaing Division	1,102,138	150,201	2,317	3,086	2,410,906	453,974
Subtotal	1,352,838	158,270			2,926,796	470,488
2. Upper Dry Zone:	87,892	145	1,516	2,529	132,802	460
Magwe (Magway) Division	378,406	30,346	2,435	3,396	743,774	101,384
Mandalay Division	55,201	150,219	2,463	3,654	1,107,450	539,810
Shan State	859,067	33,028	2,181	3,372	1,864,150	109,204
Kayah State	61,335	3.793	2,195	2,864	134,136	10,442
Subtotal	1,441,901	217,531			3,982,312	71,300
3. Mid-Zone[2]						
4. Coastal Wet Zone:						
Rakhin State	843,880	8,175	2,467	3,343	2,070,782	26,864
Karen (Kayen) State	324,917	121,591	2,041	2,374	661,572	283,176
Mon State	645,547	71,994	2,572	2,971	1,633,828	209,530
Tanasserim (Tanintharyi) Division	208,173	6,841	2,362	2,526	483,046	16,790
Subtotal	2,022,517	208,601			4,849,228	536,360
5. Ayeyarwady Delta:						
Ayeyarwady Division	3,231,991	1,120,375	2,883	3,352	9,290,574	3,538,320
Pegu (Bagu) Division	2,159,775	290,755	2,962	2,478	6,275,090	715,254
Yangon Division	1,165,565	154,530	2,842	3,094	3,263,654	339,296
Subtotal	6,557,331	1,565,660			18,829,318	4,592,870
6. Total Myanmar	11,870,587	2,150,062	2,653	3,138	30,587,792	6,360,926

Source: Ministry of Agriculture (Feb. 1995).

[1] Following zones of similar classification in Appendix Table 1.

[2] Area not defined currently.

Appendix Table 4. Annual Rice Production, Exports and Domestic Prices During British Colonial Rule in Myanmar, 10-Year Periods, 1830-1948 and 1949-1962.

Year	Sown Area in Myanmar (million ha)	Paddy Production (million mt)	Rice Exports (million mt)	Domestic Rice Price in Rupees/mt (2,100 kg)[1]
1830	0.027	0.044	—	—
1845	0.143	0.231	—	4
1855	0.402	0.649	—	21
1860	0.539	0.870	0.126	21
1870	0.702	1.133	0.381	33
1880	1.255	1.989	0.807	48
1890	2.329	3.761	1.208	45
1900	3.460	5.588	2.097	45
1910	4.026	6.502	2.381	52
1920	4.172	6.008	2.107	86
1930	5.006	7.295	2.839	62
1940	5.066	6.894	3.104	50
1948	3.965	5.164	1.049	153
1949	3.649	4.581	—	155
1950	3.703	5.403	1.184	166
1951	3.828	5.601	1.268	158
1952	4.016	5.842	1.260	150
1953	4.034	5.579	0.970	151
1954	3.975	5.651	1.461	160
1955	4.051	6.025	1.639	155
1956	4.077	6.282	1.864	155
1957	3.986	5.423	1.753	162
1958	4.087	6.882	1.410	167
1959	4.200	7.183	1.692	172
1960	4.217	7.085	1.722	183
1961	4.597	6.798	1.591	190
1962	4.837	7.550	1.744	157

Source: Win, 1991.

[1] Average trader price for Yangon quoted in Indian rupees until 1940 and Kyats thereafter. Rupees had the same value as Kyats from 1845-1930.

Appendix Table 5. Rice Varieties Used in Rainfed Lowland Areas, Myanmar, 1991.

Location/Ecosystem	Cultivar Names[1]	Characteristics of Cultivars
Taikkyi Lowland Rainfed		
Upper Terrace	Manawhari (M)	135 days, non dormant
	Shwewartun (M)	IR-5 Mutant, 150-160 days
	Sinayekari 2 (M)	130 days, non dormant
Middle Terrace	Inmayebaw (T)	190 days, submergence tolerant
	Shwewartun (M)	similar to Inmayebaw
	Wayetun (T)	175 days
Lower Terrace	Inmayebaw (T)	defined above
	Kaukhyin (T)	glutinous (for sweets)
	Kaukkyi (T)	175 days, submergence tolerant
	Shwetasoke (T)	good eating quality
	Taungpyan (T)	200 days, flood tolerant
Hlegu Lowland Rainfed		
Upper Terrace	Inmayebaw (T)	defined above
	Kyaukhyin (T)	defined above
	Kyawzeya (T)	125 days
	Nagaya (T)	good eating quality
	Shwewartun (T)	125 days
Lower Terrace	Inmayebaw (T)	defined above
	Kamarkyi (T0	seedling submergence tolerant
	Nagaya (T)	defined above
	Ngakywe (T)	180 days, submergence tolerant
	Padan Ngasein (T)	170 days
	Pawsanbaigyar (T)	165 days
	Pokawgyi (T)	similar to Padan
	Sabanet Taungbyan (T)	180 days, submergence tolerant

Source: Fujisaka et al., 1992.

[1] M=modern variety, T=traditional variety.

Appendix Table 6. Rice Varieties Used in Irrigated Areas, Myanmar, 1991.

Ecosystem	Cultivar Names[1]	Characteristics of Cultivars
	Manawhari (M)	120 days, 7.2 mt/ha., good for noodles, nondormant
	Sintheingyi (M)	145 days, 3.0 - 9.6 mt/ha, good for noodles or rice wine
	Sinakare-3 (M)	135-140 days, up to 15.6 mt/ha, good eating quality aromatic
Middle Terrace	Manawhari (M)	as above but 4.8 mt/ha
	Sintheingyi (M)	as above but 7.2 mt/ha
	Kao Kyin Law (T)	145 days, glutinous short grains
	Hmawbi-2 (M)	lodging problem
	Sinakere-3 (M)	as above but 8.4 mt/ha
Lower Terrace	Kao Mwe Naung (T)	sticky rice
	Sintheingyi (M)	as above but 3.0 mt/ha without fertilizer
	Sinakere-3 (M)	as above

Source: Fujisaka et al., 1992.

[1] M=modern variety, T=traditional variety.

Appendix Table 7. Myanmar Rice Standard Specifications.

Grade	Grain Composition (%) Whole/Kernal Head Rice	Brokens Big	Brokens Other	Milling Standard
Emata Super 100%	96	4	—	Extra well milled
Zeera Super 100%	95	3	2	Extra well milled
Zeera Super 5%	78	15-17	3-7	Well milled
Emata Super 5%	80	13-17	3-7	Well milled
Emata Super 10%	75	13-17	8-12	Well milled
Zeera Super 10%	75	13-17	8-12	Well milled
Emata Myanmar 15%	65	18-22	13-17	Well milled
Zeera Myanmar 15%	65	18-28	13-17	Well milled

Source: Oo, 1994.

Appendix Table 8. Land Use Classification Parameters.

Land Use	Class	Soil Parameters: Slope %	Thickness (inches)	Texture (% <0.002)	Permeability (mm/hr)	Gravel (%>1")	pH
LE - rice wet cropping on flat lowlands (bunded)	1	<1	>60	>80	2-4	<1	6.5-7.0
	2	<1	>40	60-79	4-8	<1	5.5-6.5 7.0-7.5
	3	<1	>30	30-50	>8	<1	4.5-5.5 7.5-8.0
	4	<1	>20	<15	>8	<1	<4.0
YA - annual dry cropping on uplands (not bunded)	1	1-7	>40	>30	10-20	<1	6.0-7.0
	2	1-7	>30	>20	20-30	<5	5.5-6.0 7.5-8.0
	3	1-7	>20	>15	30-40	<10	4.5-5.5 7.5-8.0
	4	1-7	>10	>10	>40	<15	4.5-5.5 7.5-8.0
UYIN - garden land	1	7-15	>40	>30	10-20	<5	6.0-7.0
	2	7-15	>30	>20	20-30	<20	5.5-6.0 7.0-7.5
KAING -seasonal cultivation on exposed sand and silt flats along rivers in the low water season	1	<1	>20	>20	<10	<1	6.0-7.0
	2	<1	>10	<10	>40	>10	5.5-6.0 7.0-7.5
Grazing land	1	>45	>20	>30	<30	<5	6.0-7.0
	2	>45	>10	<10	>40	>40	4.5-6.0 7.0-8.0
Forest land	1	>15	>30	>30	20-30	<10	<5.5 to >7.5
	2	>15	>10	<10	>40	>10	<5.5 to >7.5

Source: Aye, 1990.

Appendix Table 9. Current and Recommended Land Use in Myanmar, 1984-85 (1000 ha[1])

Land Use Zone	Rice Paddy Land	Upland Crops	Low Water Season Crops	Garden Crops	Palm Land	Shifting Hillside Cultivation	Forest Land
Coastal:							
Current	1,092	11	17	221	23	15	6,095
Recommended	1,537	33	51	303	39	—	5,905
Ayeyarwady Delta:							
Current	1,071	8	86	92	21	—	910
Recommended	1,417	1,828	207	89	13		728
Southern Wet							
Current	1,164	16	16	78	3	—	935
Recommended	1,561	60	14	121	1		1,457
Transitional							
Current	606	221	65	36	—	—	2,386
Recommended	637	468	14	50	—		1,974
Dry Zone							
Current	644	2,092	160	7	—	14	4,377
Recommended	993	1,417	121	23	—		2,638
Northern Wet:							
Current	730	52	77	9	—	6	6,975
Recommended	538	794	40	123	—		6,961
Western Hills:							
Current	6	1	1	2	—	88	641
Recommended	10	82	—	34	—		1,203
Eastern Hills:							
Current	263	504	4	85	—	118	8,003
Recommended	475	810	1	43	—		13,955
Northern Hills:							
Current	10	6	—	1	—	10	1,883
Recommended	30	30	—	8	—	—	1,681
Union Total:							
Current	5,582	2,909	428	529	45	251	32,205
Recommended	6,955	3,728	450	901	52	—	32,898

Source: Aye, 1990.

[1] Totals may not add up precisely. Recommended by Myanmar government.

[2] Estimated on a national level only.