CHAPTER III

GENERAL FEATURES OF LOWLAND-RICE CULTURE

RICE IN LAND UTILIZATION

The dominance of rice in the agriculture of Monsoon Asia is suggested by the following tabulation, showing for most of the producing countries the rice acreage as percentage of *total crop-producing area*:[1]

French Indo-China	86	Java	45
Burma	65	Chosen	30
Philippines	64	India	23
Taiwan	54	China	21
Japan	45		

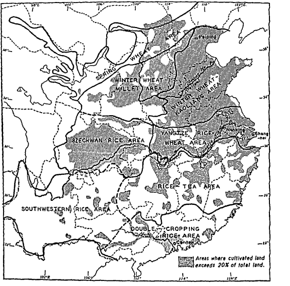
In no country is the area in rice (lowland and upland together) less than a fifth of the crop-producing area, and in some countries the rice area exceeds four-fifths of the total acreage under crops.

Within each country, of course, the importance of rice varies from region to region. In China, for example, 21 per cent of the total crop-producing area of the country is in rice, but only 2 per cent in the provinces north of the valley of the Yangtze as against 42 per cent in and south of that valley. Within this "rice region" the importance of the crop also varies from province to province, increasing as one moves either from north to south or from east to west. Thus, of the total crop-producing area of Kiangsu province in the extreme northeast of the Chinese rice region, only 21 per cent is rice

[1] Figures for French Indo-China, and the Philippines, calculated or derived from data in International Institute of Agriculture, *International Yearbook of Agricultural Statistics, 1938–39* (Rome, 1939), pp. 192–93, 202–06, 211–13; for the Japanese Empire, from R. B. Hall, "Agricultural Regions of Asia. Part VII, The Japanese Empire," *Economic Geography* (Worcester, Mass.), April 1935, XI, 144–45; for Java, from Samuel Van Valkenburg, "Agricultural Regions of Asia. Part IX, Java," *ibid.*, January 1936, XII, 33–36; for India and Burma, from India Dept. Commercial Intelligence and Statistics, *Agricultural Statistics of India, 1936–37, Vol. I, Area, Classification of Area, Area under Irrigation, Area under Crops, Live-Stock, Land Revenue Assessment and Harvest Prices in British India* (No. 3553, 1939), pp. 2–7; for China, Chang, *An Estimate of China's Farms and Crops*, p. 21.

acreage; the corresponding figures are 36 per cent for Szechwan on the northwest, 41 per cent for Yünnan on the southwest, and 86 per cent for Kwangtung which lies in the extreme southeast, adjacent to Indo-China where rice has about the same dominance in the crop-producing area.

MAP 2.—AGRICULTURAL AREAS AND CULTIVATED LAND OF CHINA*



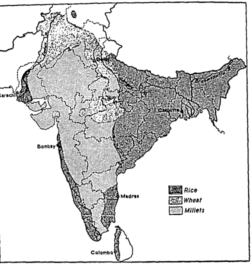
* After J. L. Buck, *Land Utilization in China: Atlas* (Nanking, 1937).

Map 2, based mainly on Buck's investigations, illustrates the use of land in China. Shaded areas indicate the approximate location of places where cultivated land exceeds 20 per cent of the total land area. Cultivated land constitutes a much larger fraction of total land area north of the Yangtze than it does in the south where the terrain is so much more irregular (Map 1, facing p. 24). Regions wherein specific crops dominate in land use are indicated by the heavy boundary lines. In the north, the dominant crops or crop combinations are given as spring wheat, or winter wheat and millet, or winter wheat and kaoliang (a sorghum). Rice appears as one of the dominant crops only in and south of the Yangtze Valley.

Similarly in India rice looms much larger in some regions than in others. If one groups all of the provinces and states where appreciable densities of rice culture are shown in the endsheet map, rice covers on the average about 32 per cent of the cropped area, as compared with 5 per cent in other parts of the country and 23 per cent in India as a whole. Rice constitutes on the average about 52 per cent of the cropped area in those portions of the rice region lying east of a line drawn north from Cape Comorin on the extreme south, but only 20 per cent in those portions of the rice region lying west of this line. Within the eastern part of the rice region, the proportion of the cropped land in rice rises to 73–75 per cent in Assam, Bengal, and Orissa in the northeast and adjacent to Burma. Map 3 (p. 34) shows approximate locations of regions where different crops dominate in land use. Rice dominates on the west only in the delta of the Indus, in a coastal strip of land south of Bombay, and on the extreme north in Kashmir province. In the south, rice dominates also on the eastern coastal territory around Madras. Elsewhere west of the 80° meridian, however, wheat is the dominant crop in the north and in parts of the central area, and the millets and sorghums are dominant in wide territories elsewhere. A more detailed map would show small regions where barley dominates, and others where maize is the leading grain crop. In the rice region east of the 80° meridian, the degree of dominance of rice is lower on the west than on the east. There are localities, especially in Bengal, where rice occupies more than 80 per cent of the cultivated land.

Java shows similar contrasts. Rice occupies 68 per cent

MAP 3.—CULTIVATION OF PRINCIPAL FOOD GRAINS IN INDIA AND CEYLON



of the cropped area in the western part of the island, 45 per cent in the central part, 28 per cent in the eastern part. Illustrations need not be multiplied. In most parts of Monsoon Asia, if one excludes the western part of India, and China north of the Yangtze Valley, agricultural operations center about rice; rice is by far the dominant crop, in the main occupying one-fifth up to nearly all of the crop-producing acreage.

Just as the importance of rice acreage in the total crop area varies from country to country and from region to region, the importance of the nonrice acreage varies, but inversely. By countries, the nonrice acreage is most important in India, China, and Chosen, where much land devoted to agriculture is too dry (and in China partly too cold) for rice production. Here the nonrice acreage constitutes 70–80 per cent of the total crop acreage. In Japan and Java, nonrice areas constitute somewhat more than half the total crop acreage, and in Taiwan somewhat less; in Burma and the Philippines, about a third; in Thailand and Indo-China, probably only around a fifth. Crops other than rice are thus of some importance everywhere—outstandingly so in what we have called the nonrice region of Monsoon Asia, and significant even within the parts of the rice region where rice is by far the dominant crop.

Within the rice region the nonrice crops are both numerous and difficult to classify. Table 3 (p. 36), however, gives an approximate indication of the uses made of crop land in major segments of the rice region. The data exclude the tree and bush crops, such as tea, coffee, coconuts, rubber, kapok, quinine, and others (except mulberry, which is included in the Japanese statistics). Land devoted to these crops does not loom large in the total arable area.[2]

The nonrice crops of the rice region are mostly used for food—grains, pulses, and vegetables among which cassava and sweet potatoes occupy much of the acreage. Relatively little land is sown to crops used wholly or mostly for fodder, to the fiber crops (chiefly cotton, with jute in eastern India) and tobacco, or to the oilseeds. Since the latter yield much edible oil, they might reasonably be counted as food crops.

Rice leads in acreage in each of the regions specified in Table 3. The nonrice crops of greatest relative importance vary from one region to another. In the northern part of the rice region of Monsoon Asia—the Japanese Empire and China in and south of the Yangtze Valley—small grains (chiefly barley and wheat)[3] are outstandingly dominant, and

[2] In Java, British Malaya, and Ceylon especially, the tree and bush crops are cultivated more largely in plantation agriculture than in native agriculture. Sugar cane is another prominent plantation crop. Mulberries and tea in Japan and China, however, are cultivated by peasant farmers.

[3] Oats are relatively unimportant, and hardly any rye is grown. Some writers, however, confuse rye with naked barley in the Japanese Empire, and list rye as a small grain of appreciable importance there.

TABLE 3.—APPROXIMATE DISTRIBUTION OF CROPPED ACREAGE IN THE RICE BELT OF MONSOON ASIA TO DIFFERENT CROPS, ABOUT 1935*

Crop	Japanese Empire[a]		Southern China[b]		Northeastern India[c]		Burma		Java and Madura	
	1,000 acres	Per cent	1,000 acres	Per cent	1,000 acres	Per cent	1,000 acres	Per cent	1,000 acres	Per cent
Rice	13,282	*40.3*	46,595	*42.1*	32,583	*77.3*	12,634	*67.7*	9,570	*45.6*
Other small grains[d]	7,661	*23.2*	29,338	*26.5*	750	*1.8*	447	*2.4*	0	*.0*
Millets and sorghums	2,919	*8.8*	5,305	*4.8*	1,166	*2.8*	832	*4.5*	57	*.3*
Maize	127	*.4*	5,153	*4.7*	104	*.2*	213	*1.1*	5,508	*26.2*
Vegetables[e] ...	2,750	*8.4*	3,687	*3.3*	1,401	*3.3*	1,040	*5.6*	3,237	*15.4*
Pulses[f]	2,941	*8.9*	11,884	*10.8*	983	*2.3*	564	*3.0*	1,408	*6.7*
Fibers and tobacco	2,725	*8.3*	5,639	*5.1*	2,827	*6.7*	624	*3.3*	445	*2.1*
Oilseeds[g]	270	*.8*	2,570	*2.3*	1,841	*4.4*	2,229	*11.9*	635	*3.0*
Sugar cane	311	*.9*	452	*.4*	490	*1.2*	90	*.5*	138	*.7*
Total considered	32,986	*100.0*	110,623	*100.0*	42,145	*100.0*	18,673	*100.0*	20,998	*100.0*

* Basic data for the Japanese Empire from R. B. Hall, "Agricultural Regions of Asia. Part VII, The Japanese Empire," *Economic Geography* (Worcester, Mass.), April 1935, XI, 144–45; for China, from C. C. Chang, *An Estimate of China's Farms and Crops* (Nanking, 1932), pp. 15–21; for northeastern India and Burma, from India Dept. Commercial Intelligence and Statistics, *Agricultural Statistics of India, 1936–37, Vol. I, Area, Classification of Area, Area under Irrigation, Area under Crops, Live-Stock, Land Revenue Assessment and Harvest Prices in British India* (No. 3553, 1939), pp. 6–7; for Java and Madura, from International Institute of Agriculture, *International Yearbook of Agricultural Statistics, 1938–39* (Rome, 1939), pp. 198–99.

[a] Japan Proper, Chosen, and Taiwan.

[b] Provinces of Kiangsu, Anhwei, Hupeh, Hunan, Kiangsi, Szechwan, Yünnan, Kweichow, Chekiang, Fukien, and Kwangtung. Data for Kwangsi, which lies within the same area, are not available.

[c] Assam, Bengal, and Orissa.

[d] Wheat, barley, oats, and buckwheat.

[e] Mainly sweet potatoes and cassava.

[f] Soybeans, other beans, peas, and other legumes.

[g] Peanuts, sesame, rapeseed, linseed, and others.

either pulses (beans and peas, including soybeans) or millets and sorghums rank second and third respectively. Either vegetables (mainly sweet potatoes) or fiber crops and tobacco are next in importance as to acreage occupied, while maize, oilseeds, and sugar cane are least important.

In the warmer parts of the rice region nearer the Equator, the relative importance of the various nonrice crops is quite different. Rice occupies so much of the crop acreage in northeastern India and Burma that no other type of crop is very important. Among the minor crops, the small grains are far less commonly cultivated than in the northern part of the rice belt, the pulses are considerably less important, and millets and sorghums, maize, vegetables, and fibers and tobacco somewhat less important. The oilseeds, on the other hand, occupy an appreciably larger, and sugar cane a slightly larger, proportion of the total crop acreage.

Less emphasis falls on the small grains in Java than even in northeastern India, as is true also in less marked degree of the millets and sorghums and the fibers and tobacco. The pulses each occupy a smaller fraction of the crop acreage than in the Sino-Japanese part of the rice belt, but a larger fraction than in northeastern India and Burma. The opposite is true in the case of oilseeds. Sugar cane constitutes only a small proportion of the total crop acreage here as elsewhere. But maize particularly, and vegetables (notably cassava) in lesser degree, loom larger in Javanese agriculture than in the other parts of the rice belt. Maize in Javanese agriculture is about of the same importance as the small grains in the Sino-Japanese part of the rice belt; it even becomes the dominant crop in eastern Java where rice occupies less of the crop acreage.

PADDIES AND IRRIGATION

Paddies are fields leveled and diked, often only with mud walls, in such a manner that for months water can be held in them after the fashion of a flat basin. Their major but not their sole use is to grow lowland rice. In flat country, ditches thread between them, for the purpose both of bringing water on and of draining it off the fields. In rolling country, many adjacent fields may be flooded and drained by opening or closing small outlets at the edge of the paddies, depending on the force of gravity for the desired flow of water.

In lowland-rice-growing districts where topography is irregular, paddies are typically small in size and irregular in shape. They are arranged along different levels frequently giving the effect of broad steps rising from the lower land to the higher. Above and sometimes between these fields may lie other cultivated areas, not leveled, diked, or flooded, upon which crops other than rice are grown. These fields comprise the "upland," but it is not usual to find upland rice in districts where water resources are sufficient for supporting the lowland form of culture. Other crops grow typically on upland areas in prediminantly lowland-rice regions; upland rice tends to appear in drier or poorer regions. Set down at fairly frequent intervals in the midst of numerous paddy fields are small, compact villages where the growers and their families live.

Paddies located in great river valleys where the land is level tend to be larger and more uniform in size, with little suggestion of the terracing effect produced by the arrangement of fields in areas with a more rugged topography. Upland fields are not interspersed with the paddies, but appear as the flat land terminates and the hill country begins. Villages tend to be farther apart, going back and forth to the fields is easier, and vegetative covering is more definitely spotted around and in the small communities.

Since a paddy must be level to be evenly flooded, the size of individual fields tends to vary with the slope of the land, the smaller and narrower paddies being found on the steeper slopes.[4] But some very small fields are found on flat land as well as in regions of more irregular topography. The explanation is usually to be found in the distribution of ownership. The paddies cultivated by a single family, and the upland fields as well, may be scattered throughout the growing district. Under these conditions, the farmer spends much time and effort in going to and from his tiny fields.

[4] Construction of paddies in some parts of Monsoon Asia has been pushed by terracing far up the sides of rather steep mountains. One of the most spectacular examples is to be found in northern Luzon in the Philippine Islands, where the famous Igorot terraces sometimes require retaining walls 75 feet high.

The unsystematic method of constructing paddies one after another over a long period of time has also led to inefficiency in the location of irrigation ditches, and consequent waste of labor and water. The governments of some countries have devised programs for remedying this situation, but very little real progress has been made except possibly in Japan.[5] The obstacles to redesigning land holdings to conserve labor and water supply are numerous and not quickly or easily overcome.[6]

The average size of farm operated by one family is very small, especially within the districts of the rice belt of Monsoon Asia where paddy fields predominate in the arable area. Only about 2.7 acres of "farm land" are operated by a farm family in Japan; only 3.8 acres in Chosen (and within Chosen, only 2.7 acres in the southern district where much rice is grown).[7] In the southeastern provinces of China where rice most strongly predominates, "cultivated acreage per fam-

[5] In Japan, if the landowners of the village desire, the government engineers take hold, redesign the whole irrigation system and the layout of the paddies, and rebuild, as it were, the whole cultivated area belonging to the village. Through a system of exchange, the villagers and individual landowners receive in the end consolidated pieces of land, sometimes with financial compensation. See C. L. Alsberg, "Japanese Self-Sufficiency in Wheat," WHEAT STUDIES, November 1935, XII, 71. Even though a large part of the expense is borne by the government, the Japanese program apparently has not been outstandingly successful. The difficulty seems to lie in the farmer's resistance to changes in his tax assessment resulting from a revaluation of his new plots of land. In Japan the land tax was for a long time levied on the basis of an assessment of 1873. Fundamental amendments were not effected until 1930 when rental values became the basis of tax assessments. New assessments are scheduled to be made every 10 years, the first amendment coming in 1938. Before this reform there were many cases of unfairness in the distribution of the tax burden. Although the Japanese authorities have been working on this problem for many years, very little has been done in other countries.

[6] Fragmentation of holdings is a serious problem particularly in old and densely populated countries. In some areas of India more than a third of the farmers hold more than 25 separate small plots within the same village, and holdings of a fraction of an acre in size are common in many parts of the country. See Great Britain Royal Commission on Agriculture in India, *Report* (Cmd. 3132, *Parl. Papers*, Commons, 1928, VIII), pp. 132–35. "Fragmentation of land is among the most important characteristics of Chinese agriculture. There are on an average 5.6 different parcels of land per farm . . . ." (J. L. Buck, *Land Utilization in China*, Nanking 1937, p. 181). These parcels average less than 1 acre in size. Also, numerous spaces reserved for burial mounds make cultivation difficult and inefficient. Another condition leading to inefficient cultivation in some places, e.g., Burma, is that "a surprisingly large proportion of the tenants cultivate a different plot of land each year" rather than lease and work the same land year after year. See J. S. Furnivall, *An Introduction to the Political Economy of Burma*, ed. by J. R. Andrus (2d ed., Rangoon, 1938), p. 77.

[7] Hall, *op. cit.*, p. 145.

ily" averages only about 2.1 acres.[8] Lava suggests similar figures for the Ilocos region of the Philippines.[9] In India, "Keatinge estimates the average holding of rice-land in Konkan in the Bombay Presidency as only two or three acres . . . ."[10] Since the above figures are averages of both larger and smaller farms found within regions concentrating on rice production, the typical farm family operates an even smaller holding. The average size of farm tends to be somewhat larger in the newer rice regions (as in Burma, Thailand, and Indo-China), and probably also in areas where the proportion of arable land devoted to paddy is smaller in relation to the acreage used for upland crops.

In a sense all paddy fields are "irrigated"; within them there is manipulation of the level of water in which the rice grows. Yet by no means all paddies are supplied with water brought in by ditches or pumps from points of impoundage or storage. Many are merely rain-fed and some are flood-fed. The rain-fed paddies simply catch and hold water as it falls, the excess being allowed to flow out. The flood-fed paddies in or near river bottoms receive and retain water brought to them by the rise in the level of the river; after the river level falls, any excess not needed is allowed to flow out.

Many paddy fields, however, are supplied with water in addition to rainfall or flood by various artificial means. In hilly country, diversion ditches are built from small streams, and the paddies fed by gravity. In flat valleys, water is pumped or lifted from large streams; or lifted from wells; or caught in open tanks during the season of rains or floods, and drained by gravity if the tanks are higher than the paddies, or lifted or pumped if the tanks are level with the paddies. In some places large storage dams permit water to be fed to the paddies by gravity through wide canals and smaller distributing ditches. Near the sea, advantage is sometimes

[8] Chang, *op. cit.*, p. 14.

[9] H. C. Lava, *Levels of Living in the Ilocos Region, Philippines* (unpublished Ph.D. thesis, Stanford University, Calif., 1939), pp. 100-01.

[10] Radhakamal Mukerjee, *The Rural Economy of India* (London, 1926), p. 39.

taken of high ocean tides to force fresh river water into the paddies.

The relative importance, respectively, of paddy land and of upland in the arable acreage of the rice belt of Monsoon Asia cannot be determined with precision. However, upland rice probably accounts for barely more than 10 per cent of the total rice acreage and upland fields are presumably less commonly double-cropped[11] than are paddy fields. If this is true, the importance of paddy fields in the total arable area would seem to be roughly similar to, or somewhat greater than, the importance of rice area in total area under crops. Our earlier discussion of the importance of rice acreage in total crop acreage (pp. 31–37) then provides something of a basis for the conclusion that paddy fields tend to constitute from two-fifths to over three-fourths of the total arable land in major subdivisions of the rice belt, with the heavier ratios of paddy to arable land occurring in northeastern India, Burma, probably Thailand and Indo-China, extreme south-eastern China, and western Java. Conversely, arable upland would be of relatively least importance in these areas. It is particularly in Burma, Thailand, and Indo-China—relatively the newest agricultural regions of this group—that one would expect to find possibilities for expansion of arable-upland acreage, and perhaps also in some parts of the Netherlands Indies aside from Java.

Similarly, an adequate account cannot be given of the relative prevalence of "naturally irrigated" and "artificially irrigated" paddies. Yet it seems probable that most paddy fields in the Sino-Japanese part of the rice region of Monsoon Asia are artificially irrigated, whereas natural irrigation prevails elsewhere. Buck states that "in China . . . . rice land . . . . is almost all irrigated";[12] Hall states that virtually "all of the paddy rice of Japan Proper is irrigated . . . . ," but that "probably 50 per cent of the wet rice area must depend

[11] On double cropping, see below, pp. 43–47.
[12] Buck, *op. cit.*, p. 186.

upon rainfall alone" in Chosen and Taiwan.[13] In contrast, Van Valkenburg says of Java: "One-third of the rice acreage is really technically controlled so far as irrigation is concerned. A minor part of the rest has a kind of casual type of irrigation, while the greater part depends entirely upon rain."[14] In Java the possibilities for extending irrigation are apparently becoming fewer and fewer, although in the Outer Provinces of the Netherlands Indies the opportunities for bringing new lands under irrigation are considered to be very promising.[15] In Assam, Bengal, and Orissa, provinces of eastern India which contain over a third of the total Indian rice area, official statistics indicate that the proportion artificially irrigated is less than 15 per cent. This is true in Burma as well, and probably in Thailand and Indo-China. In general, natural rather than artificial irrigation prevails where the rice acreage is largest in relation to crop acreage and paddy area largest in relation to total arable land.

Major irrigation projects involving huge dams and long and large canals are not important as the sources of irrigation water in most rice-producing regions,[16] nor is tide-water irrigation. The principal sources of irrigation water are streams, tanks, and wells, although canal systems built along great rivers and not involving the construction of expensive dams are important in some regions, especially China. In important river deltas, networks of canals fed by the river not only render rice growing safer and double cropping possible, but are a necessary link in the system of communications. The

[13] Hall, *op. cit.*, pp. 131–32. [14] Van Valkenburg, *op. cit.*, p. 34.

[15] W. A. van der Meulen, "Irrigation in the Netherlands Indies," *The Netherlands Indies: Bulletin of the Colonial Institute* (Amsterdam), June–August 1940, III, 152.

[16] India is the outstanding example of the development of major irrigation projects in Monsoon Asia, yet the systems that have been built are mostly located in regions where rice is a minor crop. In countries like Indo-China, the construction of major canals has progressed further than has secondary-canal development, though the latter are also necessary for bringing additional lands under rice. In the delta of the Mekong, major canals serve in place of roads. In Cochin China especially, the excavation of canals for transport preceded settlement much as railroads preceded the opening up of the western part of the United States and Canada. In the future, in many sections of Indo-China, the digging of canals will have to precede settlement (Gourou, *L'utilisation du sol en Indochine française*, p. 139).

relative prevalence of the various sources of irrigation water, or of the methods of application by gravity or by pumping or lifting, remains somewhat conjectural.

DOUBLE CROPPING

The practice of double cropping occurs in many parts of the rice belt. Commonly, this means two harvests from a given piece of land within a single year. On paddy land, the first or summer crop is almost invariably rice; the second or winter crop is sometimes rice, but often some other crop, especially a small grain, maize, pulse, or vegetables. On upland fields within the rice belt, practices seem much less easy to infer. The first or summer crop may perhaps be either upland rice, or more commonly maize, or millet or sorghum; the winter crops may perhaps be mostly pulses or vegetables. In regions close to the Equator and having a fairly even seasonal distribution of rainfall, the distinction between first and second or summer and winter crops tends to become meaningless.

Double cropping, taking paddy land and upland together, seems to be most prevalent in the Sino-Japanese part of the Asiatic rice belt. In Japan Proper, the area under crop exceeds the arable area by about 20 per cent, implying a considerable amount of double cropping; and the paddy land is double cropped to the extent of about 38 per cent.[17] Double cropping of paddies is considerably more common in the southern than in northern regions (Map 4, p. 44), suggesting that a limitation is imposed by low winter temperatures. For the Chinese rice belt, Chang gives data indicating that the total area under crop exceeds the arable area by about 23 per cent;[18] but here the excess tends to be larger in the tier of provinces along the Yangtze Valley than it does further south, suggesting some other influence than temperature. Presumably the double-cropped paddy acreage, as in Japan, would exceed the paddy land by a larger fraction than the total area in crops exceeds the total arable area. In Java also

[17] Hall, *op. cit.*, pp. 144–45.

[18] Chang, *op. cit.*, p. 12.

MAP 4.—RICE-CROPPING AREAS OF THE JAPANESE EMPIRE*

* Reproduced from *Economic Geography*, October 1934, X, 339.

there is excess of cropped area over arable area, but little suggestion that the excess is as large as in China or Japan. In northeastern India, total areas sown exceed "areas sown only once" by only about 17 per cent, and the figure is only about 7 per cent in Burma. Thus there can be relatively little double cropping, either of paddy land or of upland, in Burma; probably the same is true in Thailand and in Indo-China, except in the northern and eastern regions.

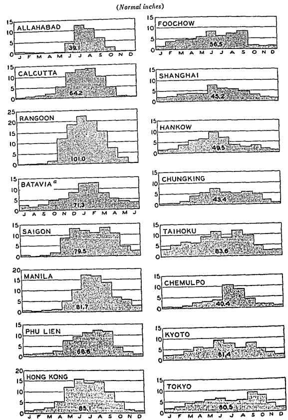
Conditions of temperature would necessarily limit the possibilities for double cropping either of paddy land or of upland, for cold winters would preclude successful growth of winter crops. This may constitute the principal explanation of the relatively small amount of double cropping of paddies in northern Japan, and possibly also in Chosen (see Map 4). In sufficiently warm regions, the principal factor limiting double cropping on arable upland would presumably be lack of winter rainfall, while on paddies the limiting factor might be either lack of rainfall or lack of irrigation.

Chart 1 (p. 46) shows the average seasonal rainfall distribution at various observation points scattered through the Asiatic rice belt from northeastern India to Japan. The stations lying nearest the Equator, in general the warmest, are those in the first column. All of these points have the typical monsoon distribution of rainfall—an abundance in the summer, from May or June to October or November (October or November to May or June in Java in the Southern Hemisphere), and very little from October or November through April. The summer rainfall provides adequate moisture either for rice in the paddies, or for upland crops. But in the relatively dry (and warm) winter, the upland fields receive too little moisture to bear crops. So also do the paddies unless they can be irrigated artificially from stored water. This goes far to explain why double cropping is relatively unimportant in the regions nearer the Equator. It cannot be practiced on upland, and, since only a small fraction of the paddies are artificially irrigated, it cannot be practiced on most of the paddy land.

The seasonal distribution of rainfall is more favorable to double cropping in the Sino-Japanese part of the rice belt. Here the rainfall of November–April, the relatively dry winter season, is considerably heavier than in the rice regions farther south. It is also cooler in the winter, so that less evaporation occurs. Winter crops can be grown both on upland and on naturally irrigated as well as on artificially irrigated paddy land. Since the last type is relatively prevalent (p. 41)—perhaps largely because there is enough rainfall in the winter

CHART 1.—SEASONAL DISTRIBUTION OF RAINFALL AT SELECTED STATIONS IN MONSOON ASIA*

(*Normal inches*)



* Basic data from *World Weather Records* (Smithsonian Misc. Coll., Vol. 79, Washington, D.C., Aug. 22, 1927, and Vol. 90, May 18, 1934); for China, from G. B. Cressey, *China's Geographic Foundations: A Survey of the Land and Its People* (New York, 1934).

[a] Note different arrangement of months, applying to Batavia only.

season to maintain water supplies in storage—the practice of double cropping is considerably more common in the Sino-Japanese part of the rice belt, except on the colder peripheries to the north and in the higher elevations where, in addition, low temperatures preclude the growth of winter crops.

Other factors tend to limit the extent of double cropping throughout the Asiatic rice belt. Even where there is sufficient winter warmth and ample winter moisture from rainfall or from artificial irrigation, fields cannot be double cropped indefinitely unless some means are devised for maintenance of soil fertility. In places this problem is perhaps solved by nature through annual deposits of silt brought down by the rivers. In other places, particularly in China and Japan, growers commonly apply either artificial fertilizers, or barnyard manure, or night soil. But data are not at hand to indicate the extent of the limitations maintenance of soil fertility places on double cropping of the arable land adequately supplied with moisture for both summer and winter crops.

LAND UTILIZATION RECONSIDERED

A basis has now been established for offering a better explanation of why the dominance of rice in the cropped area of the Asiatic rice belt varies so much from region to region, and why the secondary crops are different in different parts of the rice belt.

The circumstances most favorable for complete dominance of rice in the cropped acreage of a region are fairly clear. They are (*a*) prevalence of *naturally* irrigated paddy land in the total arable acreage, with scanty winter rainfall in a climate characterized by warm winters; or (*b*) prevalence of *artificially* irrigated paddy land in the total arable acreage in a climate warm enough to mature rice as the second crop. Under the first set of circumstances paddy land will be used for rice only; there can be no summer upland crops if all of the arable area is in paddy; and there can be no winter crops on paddy fields so long as they are dry. Under the second set of circumstances, practically all of the crop acreage must be in rice if rice is both first and second crop. Such extreme conditions are found locally, but not over wide areas. As the area considered increases, the cultivation of upland territory, and the production of nonrice crops, is bound to appear in greater or lesser degree.

Five areas may be selected for consideration: (1) northeastern India—Assam, Bengal, and Orissa; (2) the Indo-Chinese Peninsula—Burma, Thailand, and Indo-China; (3) Java; (4) the Chinese rice belt in and south of the Yangtze Valley; and (5) Japan Proper. Rice acreage constitutes 73–75 per cent of total crop acreage in northeastern India; 65–85 per cent in the Indo-Chinese Peninsula; 45 per cent in Java and Japan; and 42 per cent in southern China.

The heavy dominance of rice in both northeastern India and the Indo-Chinese Peninsula is explained by the prevalence of paddy land in the arable acreage, the scarcity of artificially irrigated paddy, and the relatively dry winter climate. In one respect, however, these two regions are different. Prevalence of paddy land in northeastern India means that almost all of the *potential* arable land has been occupied and was flat enough to convert to paddies. The Indo-Chinese area is demographically a newer territory. There only the relatively accessible arable land has been occupied and converted to paddy land, although it is likely that considerable acreage might still be devoted to upland crops. If this should occur, the dominance of rice in the total cropped area would diminish. Such a development has already occurred in Java, Japan, and southern China. Upland territory unsuited to paddy has been placed under crops to a large extent, diminishing the importance of rice in the crop acreage.[10] Artificial irrigation is more common in these three areas than in northeastern India and the Indo-Chinese Peninsula, permitting more cultivation

[10] Van Valkenburg (*op. cit.*, p. 34) observes for Java that the planted paddy-rice acreage (the great bulk of the total rice acreage) declined from 51 to 40 per cent of the total planted acreage between 1916 and about 1935.

of winter nonrice crops. These two factors go far to explain the lesser importance of rice in the planted acreage of Java, Japan, and southern China,[20] than in northeastern India and the Indo-Chinese Peninsula. The prevalence of artificial irrigation presumably has relatively larger influence in southern China and Japan than in Java, the prevalence of upland cultivation relatively more influence in Java than in China and Japan.

As to relative importance of crops secondary to rice, the small grains are conspicuous in China and Japan, while maize and cassava are conspicuous in Java. In general this is explained by relative temperatures and relative prevalence of upland-crop acreage. Maize and cassava thrive as summer upland crops in Java where upland is more prevalent, and maize as a winter paddy crop where paddies are artificially irrigated. The small grains cannot compete successfully with maize and cassava either as summer upland crops or as winter paddy crops, being less productive per acre under the prevailing conditions of temperature. In much of southern China and in Japan, on the other hand, there is relatively less upland for summer nonrice crops, and on paddy land the small grains as winter crops are more productive than maize or cassava which suffer from the relatively low winter temperatures. Other factors such as preference of populations for the different food crops, or familiarity of cultivators with one or another, doubtless help to explain these contrasts in land use. But relative temperatures and prevalence of upland cultivation seem to be influences of major importance.

PLANTING, HARVESTING, AND THRESHING

The typical Asiatic method of growing paddy rice is a distinctive form of agriculture. Practices vary somewhat in dif-

[20] In some parts of southern China, however, as in Kwangtung province, rice dominates the planted acreage to the extent of more than 75 per cent (Chang, *op. cit.*, p. 21). These are areas where most of the arable land is artificially irrigated paddy land; the prevalence of rice depends not only upon this but also upon the practice of planting rice as the second or winter crop.

ferent countries of the Orient and within the same country,[21] but the most pronounced differences in methods are between Asiatic practices and those of the more advanced rice-growing regions in the West.

In the United States, for example, rice is cultivated in essentially the same manner as wheat, oats, or barley, except that the crop is irrigated.[22] Farm machinery is used extensively. In some places, California especially, the production of rice is highly mechanized. In seeding on dry ground or in water, horses, tractors, or even airplanes may be used. Harvesting is commonly done with a combine which cuts, threshes, and sacks the rice in one operation.

In contrast, very little machinery is used in Asiatic rice-producing countries. Tools and implements are generally of the simplest type. Tractor cultivation has been attempted, but has not met with much success in the places where it has been tried. Harvesting and threshing are usually by hand with the aid of some simple device.[23]

Rice growing in the Orient is thus understandably one of the most labor-intensive types of agriculture known. In the more densely populated areas, land is not available for growing both food and feed; hence beasts of burden tend to be

[21] Over large areas (as in China), however, methods of transplanting, cultivating, and harvesting the rice crop are practically the same, and have been for generations. Thirty years ago, F. H. King (*Farmers of Forty Centuries, or Permanent Agriculture in China, Korea and Japan*, Madison, 1911, esp. pp. 271–310) made detailed observations of cultural practices in China, Korea, and Japan which are essentially the same as those recorded by more recent writers.

[22] "Contrary to popular opinion, rice is not grown in the United States on low marshy land but on irrigated level land of rather heavy texture, underlain at from 1½ to 5 feet from the surface by an impervious subsoil" (J. W. Jones, "Improvement in Rice," U.S. Dept. Agr., *Yearbook of Agriculture, 1936*, p. 419).

[23] The advanced technical methods and the extensive system of cultivation in California mean relatively low costs of production per unit of output. Costs per cwt. in Butte County, California, in 1931–35 were less than half those in Kauai County, Hawaii, in 1932–36, where intensive Asiatic methods prevailed. See *Rice Production in Hawaii: A Five-Year Summary of Cost and Efficiency Studies . . . .*, compiled by H. B. Cady, M. Maneki, and K. Murata (Hawaii Agr. Ext. Serv., Ext. Circ. 33, June 1937), p. 28. This difference in costs goes far to explain developments in Hawaii. Around 1910, before the California industry existed, about half of the rice consumed in Hawaii was produced locally and some of this was shipped to California, while the balance of local consumption was imported from Japan. As the California rice industry expanded, Hawaiian production and outshipments declined and imports from Japan fell off. California now furnishes practically all of the rice consumed in Hawaii.

relatively scarce. In other regions where work animals are plentiful, their use for plowing is often precluded because the paddies are so small. Thousands of rice fields, in fact, are so tiny that the use of machinery would be impracticable even if it were available. Most of the work in connection with the production of rice and its preparation for consumption must be done by more flexible human beings.

Planting the crop.—The bulk of the world's rice crop is transplanted by hand from carefully prepared seedbeds, or nurseries, to the paddy fields. In some regions, however, especially where labor is scarce, seed is sown broadcast directly on the field, and this is the general practice in most Western rice-growing areas. But transplanting is a practice having a significant bearing upon the yields obtained in the Orient, and is generally the preferred method (pp. 240–44). In the cultural cycle, the seedbeds are the first to be cultivated. As soon as the soil has been softened by the early rains, they are plowed and harrowed several or many times, with or without the assistance of work animals, the amount of time and labor expended upon the preparation of the seedbed being about twice as great as that employed in the preparation of a similar area for transplanting.

When the soil of the seedbed has been worked up to the consistency of a fine, soft mud by hoeing, plowing, trampling, or harrowing, and is free from weeds, it is ready for sowing. Seedbeds are usually small, about 4 per cent of the area to be transplanted, but may extend to about one-tenth of it. In most areas the seed to be planted is first soaked in water and then broadcast by hand on the seedbed from which the water has been drained. Sometimes the seed is allowed to sprout before sowing in order to obtain a better foothold against heavy rains which may fall soon thereafter. The practice in some regions is to cover the seedbed with leaves or grass to afford protection against birds and other pests. After a few days, or immediately after the seeds have germinated, 1 or 2 inches of water are reintroduced and allowed to cover the surface of the nursery. The water level is gradually raised as the seedlings grow, and after 25–40 days they are large enough to be uprooted and transplanted. Uprooted, they are tied together in small bundles and carried to the paddies. In some areas, the seedlings are pulled up and planted again in nurseries before the final transplanting to the paddy field. The plants are usually from 1 to 2 feet high when uprooted, but their tops are commonly cut off before replanting in the paddies.

Once the nursery beds are ready, work begins on the preparation of the paddy fields. The methods used are similar to those employed in preparing the seedbeds except that cultivation is ordinarily not so thorough.[24] Manures or fertilizers, in countries where they are used, are sometimes applied about ten days before the seedlings are transplanted. In other cases fertilizer, or additional fertilizer, is added after planting.[25]

With a few inches of water standing on the field, seedlings are planted by hand (usually by women) in rows 3–8 inches apart or in hills with 2–6 seedlings per hill, simply by pushing them into the soft mud, using the fingers or a simple planting tool.[26] Rows or hills are ordinarily 8–12 inches apart, and planting is usually done with 2–4 inches of water standing on the field. Once the tasks of sowing and transplanting are completed, the crop itself requires little attention until harvest. The paddy field remains flooded with 4–8 inches of water from the time the seedlings are 6–10 inches high until it is ready for draining before the harvest, though in some countries while the crop is maturing it may be drained at intervals for weeding. This is common practice in Japan and Chosen where the paddies may be drained and weeded three or four times; but in the Philippines and in Thailand it is not common

[24] Swampy regions are commonly dug over with hand implements, but in some places (as in parts of Burma) certain low-lying delta areas are not plowed at all.

[25] The use or nonuse of fertilizers is one of the most important cultural practices explaining the differences in yields obtained in various parts of Monsoon Asia, but this subject is more appropriately considered at a later point. See chapter xi, pp. 251–62.

[26] A typical planting tool found in many parts of Malaya consists of an iron rod, about 2 feet long, with a bent wooden handle. At the end of the rod are two short prongs between which two or three seedlings are placed before being thrust into the mud.

to weed after transplanting. As the flowers appear and the ears begin to fill just before harvest, the water is allowed to drain off the fields.

At times flood damage may require a certain amount of repair work, and rats, birds, various insects and diseases may cause the grower real trouble. One of the most important tasks during the growing period is the regulation and maintenance of the water supply on the fields. Water should not be allowed to stagnate, but should be changed at intervals in order to insure sufficient aeration of the soil. This is often impractical, however, for many of the irrigation systems are dependent upon rainfall, and the individual field may not be sufficiently close to a main irrigation canal.

Harvesting and threshing.—The rice harvest usually begins 3–6 months after transplanting,[27] depending upon whether the varieties planted mature early or late. Except in Japan and China, harvesting is often a group enterprise; neighbors of the village help each other, with men, women, and children participating. Outside labor is imported in some areas especially for the harvest.[28] Helpers commonly receive compensation in the form of a certain portion of each day's harvest, the harvested grain being collected into small bundles, and distributed at the end of the working day—in places like Java, before the afternoon showers begin. In virtually all the rice-growing countries of the East, picturesque ceremonials accompany both harvesting and planting.

Methods of reaping, threshing, and winnowing are usually primitive. Although machinery has been designed and is on the market for mechanizing these preliminary operations, it is not yet widely used. Machine harvesters and threshers are

[27] The total time between germination and maturity of the rice plant varies greatly. Ignoring perennial rice, according to Copeland (*Rice*, p. 12), varieties have been reported that mature in as little as 50 days from germination, others in as much as 221 days, while Cambodian floating rice requires 10 months. The interval between flowering and maturing varies from 11 to 69 days, the average being about 33 days (p. 34).

[28] For example, in Lower Burma, some 200,000–300,000 Indians come for the harvest each year, many remain and work in the mills, and finally return, mostly to the famine areas of southern India.

seldom employed except on large estates or on experimental farms operated by governments.

In most countries harvesting is done with hand sickles, and 1 or 2 feet of straw are usually cut off with the ears. In some parts of southeastern Asia (e.g., the Malay Peninsula, Java, and the southern Philippine Islands) another common method of harvesting involves cutting each ear separately with a special type of knife.[29] In the latter case the straw is not always utilized but is left on the field to be burned off or plowed under.[30] Once cut, the ears and attached stalks may be left on the ground for a few days or as much as a week for drying; but in Japan, where drying is more difficult, they are bundled and hung over small bamboo fence-like arrangements surrounding the paddy fields.

Bundles of harvested ears and attached stalks are carted to the threshing floor, where some further drying occurs before threshing; or they may be placed in bags for "curing" for a period from two weeks to three months. Removal of the straw stalks from the grain is the first stage in the preparation for consumption, and is generally done locally on the many thousand threshing floors scattered through the growing regions.

The threshing floor is often a paddy field scraped smooth and plastered with cattle dung and clay to give it a hard, smooth surface, or it may be a hard earthen or cement floor or a compound surrounding the cultivator's home. In some areas bullocks, carabaos, or oxen tread out the grain; in other places humans perform the same operations. In still other areas the grains are beaten from the ears by flails—

[29] In Malaya this knife is set in "a wooden base which fits into the palm of the hand," and its use is connected with superstition concerning the spirits hovering over the paddy fields. "The setting of the small knife represents a bird," and the natives are said to believe "that the spirits have no prejudice against birds but would resent the brutal use of a large knife" in harvesting (D. H. Grist, *An Outline of Malayan Agriculture*, Straits Settlements and Federated Malay States Dept. Agr., Malayan Planting Manual 2, 1936, p. 125).

[30] This is a practice of southeastern Asia. One seldom observes such stubble in Japan and China, as the straw stalks are fully utilized; usually the roots only are left in the field for improving the soil.

long sticks (usually bamboo) at the end of which are attached stout reeds which swing freely as the operator alternately raises his pole and then brings it down hard on the threshing floor.

The tramped or beaten material is winnowed by allowing it to fall gently from a platform while the wind carries away the chaff, dust, short pieces of straw, and the lighter kernels. Sometimes threshing consists merely of pounding the rice heads on a log. Such crude processes leave a residue of rough grain (paddy) containing more or less foreign matter and dirt. A very large part of the crop, however, is daily converted by these crude methods for immediate use in local consumption.

THE INDO-CHINESE EXPORT AREA

Burma, Thailand, and Indo-China, all part of the Indo-Chinese Peninsula, constitute the great rice-surplus region not only of Monsoon Asia but of the world (Table 2, p. 28). As compared with India to the west and China to the north, they are also relatively new countries, not as densely populated or as fully exploited. The conditions of rice culture in this region, the most important area of *commercial* rice production in the world, merit some additional consideration.

Most of the rice is grown in the river valleys and deltas of the Irrawaddy in Burma, the Menam in Thailand, and the Mekong in Indo-China. A less important rice area lies in northeastern Indo-China, in the delta of the Red River;[31] and there are numerous but small producing areas along the coasts. These regions are shown in Map 5 (p. 56), together with the important seaports of the peninsula—Rangoon, Bangkok, and Saigon, through which passes the bulk of the rice entering into international trade. As the map shows, forests of monsoon type (moderately open rather than dense jungles) lie adjacent to the rice fields especially of the Irrawaddy,

[31] This Tonkinese area is older, more densely populated, and much less of a rice-surplus region than the valleys of the Irrawaddy, Menam, and Mekong.

MAP 5.—RICE LANDS AND FOREST AREAS OF THE INDO-CHINESE PENINSULA*

* After Van Valkenburg, *Economic Geography*, January 1933, IX, 10.

Menam, and upper Mekong; much of this forest is teak and provides the basis for a substantial lumbering industry. The rest of the territory is practically all dense tropical forest, largely mountainous.

Each of the three countries is something of a replica of the others in climate, topography, and land utilization, a similarity of conditions with important economic implications. Rice crops mature and are harvested at about the same time; hence rice shipments into export channels are highly concentrated. This nearly simultaneous movement is commonly supposed to result in intensified competition and consequent pressure on prices, with adverse effects upon returns to growers and government revenues.[32] Such importance in the world economy as rice enjoys from the standpoint of trade and shipping is derived largely from the surpluses produced on the Indo-Chinese Peninsula. Rice exports are so important a source of revenue that fluctuations of prices or yields are of paramount concern to some 50 million inhabitants.

The whole Indo-Chinese Peninsula is, of course, climatically dominated by the Asiatic monsoons. Various densely forested mountain ranges extend to the south and southeast from the high plateau of southern China and Tibet (Map 1, facing p. 24); upon their windward faces over 80 inches of rain falls annually. On the opposite sides of these mountain ranges the rainfall is less, but is generally sufficient for the rice crops grown on the great river plains. Over the years in all three countries, the important rivers have been slowly enlarging the land area by depositing rich silt washed down from the highlands.

The rivers overflow at least once a year, and either supplement the rains so that little irrigation is necessary for the summer crop, or destroy a portion of the crop by failure to flood enough or by flooding too much. As the floods slowly and gently subside, alluvial deposits of silt are left which enrich the soil and permit rice to be grown continuously year after year with little fertilization and no rotation of crops. Flooding of the Red River in northeastern Indo-China, however, is more violent and constitutes a major hazard with which the Tonkinese rice growers have to contend.

Over long periods of time wide estuaries have been created. The Menam River system of Thailand, for example, has deposited enough alluvial clay to leave a flat delta plain about 100 miles wide near Bangkok. The Mekong, which rises near the headwaters of the Yangtze in the distant mountains of Tibet, is similarly responsible for the actual formation

[32] See chapter vii, pp. 162-64, for further consideration of typical postharvest depression of rice prices and alleged effects upon producers.

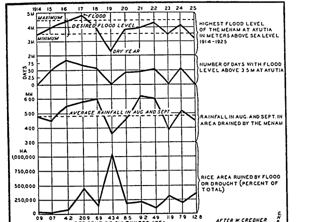
of Cochin China and a large part of Cambodia in southern Indo-China. Here the rainfall is more than 78 inches annually, comes mostly in the summer, and is therefore sufficient for the summer rice crop without irrigation. In Burma the annual rainfall over the Irrawaddy-Sittang delta is generally about 80 inches and is more reliable than that in Thailand or Indo-China.

Though not as thickly populated as, for example, the rice region of northeastern India in the delta of the Ganges and Brahmaputra, the great Burmese river valley is just as productive. But relative sparseness of population makes it necessary to import considerable labor from India to care for the crops, particularly for transplanting and harvesting. The relatively new character of the rice-growing region along the Irrawaddy is suggested by the fact that the political center of Burma, and its densest concentration of population, still lie in the drier section of central Burma north of the delta.

In Thailand the political center, capital, and rice center are found together around Bangkok. Central Thailand embraces the lower and middle parts of the Menam valley known as the Great Central Plain where there is less rain and more frequent drought than in Burma, since much of the monsoon moisture is lost by precipitation on the western mountains. Although the average annual rainfall on the central plain is about 60 inches, only about 40 inches fall during the summer. The need for supplementary irrigation of the summer rice crop is great enough to have led the government to construct a system of canals and controls for the purpose of impounding water supplies. When the Menam overflows its banks, there is a great inland extension of the Gulf of Bangkok and, although this flooding produces rich silt and more adequate water, it may nevertheless be either excessive or inadequate from the point of view of the rice growers.

The hazards of drought and flood in the Menam valley of Thailand are perhaps greater, but more or less similar to those in the Irrawaddy and Mekong districts, and are well illustrated by Chart 2. Here plowing of the paddies begins early in June, after the first monsoon rains of May have softened soil that lay parched and cracked throughout the dry winter. Rice is transplanted from the seedbeds to the paddies in July. The rains usually keep the fields flooded

CHART 2.—RELATION BETWEEN FLOODS AND RICE HARVESTS IN THE MENAM VALLEY OF THAILAND*



* Reproduced from *Economic Geography*, January 1933, IX, 8.

during this month and August–September (their seasonal peak). Then, on account of the preceding accumulation of rainfall, the river begins to flood; more commonly than not, as Chart 2 shows, it remains at the "desired" level for more than 50 days. In some years (1919, 1923, 1925) the rainfall in August–September may be exceptionally low, and the flood may not reach the desired level; under such circumstances of drought much of the rice acreage may be ruined.

In other years, of which 1917 seems the best example, the flood level may considerably exceed the level desired, and again the acreage destroyed may be large, presumably by drowning the plants. Exceptionally long duration of the flood level above the desired minimum, as in 1916, does not seem to be a major crop hazard unless accompanied by exceptional depth of water, though over-long duration might reasonably be expected to interfere with the harvest. Damage from drought appears to be a greater hazard in the Menam delta than damage from excessive water, since the water supply was excessive in only nine years out of ninety-nine, whereas river levels were distinctly poor in thirty of these years.[33]

Some parts of the great river deltas of Indo-China necessarily lie so low that the flood waters are too deep to permit rice culture and such land remains uncultivated.[34] So does much of the higher land out of reach of the flood waters and receiving too little rainfall to mature rice; but this land may be used to some extent for production of upland crops, and might be used for rice if adequate irrigation and better control over malaria were provided. On the whole, however, very little of the principal rice region receives too little water for at least one rice crop a year, and in Indo-China floods probably do more damage than drought.

LEVELS OF YIELD PER HECTARE

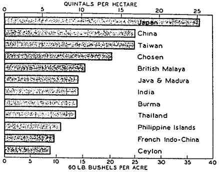
The outcome of the growers' efforts is indicated by the yields obtained per unit of land cultivated. Chart 3 gives average data for all 12 countries of Monsoon Asia including China. The contrasts are striking. Yields in Japan are much the highest, those in China and Taiwan are about two-thirds as high, and those of Chosen a little over half. In India, Burma, Thailand, and Java and Madura, yields average under 40 per cent of the Japanese. Yields in British Malaya are a

[33] Siam Ministry of Commerce and Communications, *Siam, Nature and Industry*, p. 190.

[34] However, in places, recourse may be had to the growing of so-called floating rice; see pp. 20–21 n.

CHART 3.—COMPARATIVE LEVELS OF RICE YIELDS IN COUNTRIES OF MONSOON ASIA, AVERAGE 1930–31 TO 1934–35*

(*In terms of cleaned rice*)



* Data from Appendix Table III; for China, from China Ministry of Economic Affairs, National Agricultural Research Bureau, *Crop Reports.*

little better, and those in Indo-China considerably lower, than in the neighboring countries. Yields are poor also in the Philippines, and lowest of all in Ceylon—less than a fourth of those in Japan.

Yields differ also from region to region within countries. In India, among the principal rice-producing provinces, the yield is nearly 80 per cent higher in Madras than in the United Provinces; in southern China the yield in Hunan province exceeds that in Kiangsu by nearly 50 per cent; and in Indo-China the yield in Tonkin exceeds that in Cambodia by about 45 per cent.

The influences responsible for regional differences in unit yields of any crop are always numerous, complex, and interrelated. At this point there is little occasion to press beyond the more obvious reasons for the larger contrasts in levels of rice yields indicated by the chart.[85] In general, it can be

[85] For further discussion of factors influencing yields, see chapter xi, pp. 229–65.

said that natural conditions favor higher yields in the Sino-Japanese part of the rice belt than in the southern part, for flood and drought in particular are greater hazards in the south. In addition, the paddy area of the northern region is more largely irrigated by artificial means and the use of fertilizers is more common, presumably with beneficial effects upon the level of yield despite a wider prevalence of double cropping with rice. Moreover, cultivators of the northern regions, especially in the Japanese Empire, use superior varieties and seemingly employ better methods of cultivation in such details as transplanting or weeding. It is not entirely clear why average yields should be lower in the Philippines, Indo-China, and Ceylon than in other countries of the southern part of the rice belt. The explanation seems to be a matter partly of less favorable natural conditions (Ceylon), and partly also of less intensive cultivation or absence of any crop rotation, poorer seed, greater damage from diseases and pests, generally poorer cultural methods, and possibly also of misleading statistics.