Draft No. 2 / 0 November 11, 1971

# AGRICULTURAL CHANGE IN ASIA

by
Dana G. Dalrymple
Agricultural Economist
Foreign Economic Development Service
U.S. Department of Agriculture

Agricultural Change in Asia.

FEA
630.95 Dalrymple, Dana G.
D151 Agricultural Change in Asia. Nov. 1971.
24 p.
Bibliography throughout.
Prepared for the Conference on "Asia in the 70's", Ottawa, Ontario, Nov. 13, 1971.

1.Innovations - Agriculture - FEA.2.Rural development - FEA.3.Agricultural production - FEA.4.Food supply - FEA.I.Title.

Prepared for the Conference on "Asia in the 70's"
Carleton University, Ottawa, Ontario
November 13, 1971

CONTENTS

# I. INTRODUCTION

This is a short paper on a very big subject. No one can realistically hope to begin to talk about change in agriculture in Asia in a few pages.

Rather, what I hope to do is present a few facts and introduce a few points which may set the stage for further discussion, particularly in terms of the Green Revolution in Asia. The result is more a partial outline than fully developed text.

The distinguished members of the panel have infinitely more personal knowledge of Asia than do I. My comparative advantage is perhaps in having more ready access to aggregative statistical data pertaining to Asia.

And though I'll deal initially in numbers, I must be the first to acknowledge their weaknesses. There are innumerable problems with them, but they hopefully will provide a useful starting point. Later in the paper I get into more normative ideas. Some are hardly novel; a few may be a bit new.

In any case, I'm sure Dr. Hopper and Mrs. Nair won't be taken in by any numbers or notions which seem particularly farfetched. And I am sure they will have no shortage of ideas of their own.

## II. PAST TRENDS IN ASIAN FOOD SUPPLY

On our way to considering the 1970's, it might be useful to pause and see what changes took place in Asian food supply during the 1960's. We do not have actual data on consumption so instead we will look at domestic food production and imports.

### A. Trends in Food Production

Two measures of production may be particularly helpful in reviewing the 1960's. One is an index of all food production prepared by the Economic Research Service of the U.S. Department of Agriculture (USDA). The other is data on grain production compiled by the Foreign Agricultural Service of USDA. Both sets of figures exclude Japan.

#### 1. Indexes of Food Production

Trends in food production in non-Communist Asia during the period from 1961 to 1970 are summarized for the three major regions in Table 1.[1/] The results differ considerably, depending on whether total food or per capita production is used.

Total food production in non-Communist Asia expanded sharply during the 1960's. From indexes of about 96.8 in 1961-62, it expanded to indexes averaging about 123.5 in 1969-70. This means an expansion in food output of roughly over 25% - an increase greater than in the developed nations (some of which were attempting to hold output back). The expansion was rather evenly spread over West, South, and East Asia, though a bit higher in East Asia than in the other two regions.

The difficulty, of course, is that population growth was rapid during the same period. In fact it was sufficiently rapid to largely wipe out the gain in production. This, in per capita terms, the increase in out-

Table 1. INDEXES OF FOOD PRODUCTION IN WEST, SOUTH, AND EAST ASIA 1/

| Year | Index of Food Production (1961-65=100) | | | | | |
|---|---|---|---|---|---|---|
| | Total | | | Per Capita | | |
| | West | South | East | West | South | East |
| 1961 | 93 | 99 | 93 | 98 | 104 | 98 |
| 1962 | 98 | 97 | 97 | 101 | 99 | 100 |
| 1963 | 103 | 102 | 98 | 103 | 102 | 98 |
| 1964 | 102 | 104 | 106 | 99 | 102 | 103 |
| 1965 | 104 | 98 | 106 | 98 | 93 | 101 |
| 1966 | 110 | 96 | 112 | 101 | 89 | 103 |
| 1967 | 120 | 106 | 111 | 108 | 96 | 100 |
| 1968 | 123 | 114 | 116 | 107 | 101 | 102 |
| 1969 | 121 | 121 | 123 | 103 | 104 | 105 |
| 1970 | 122 | 127 | 125 | 101 | 107 | 104 |

1/ Excluding Communist Asia and Japan.

Source: Economic Research Service, U.S. Department of Agriculture (March 1971; to be revised in December 1971).

put for non-communist Asia was from 100.5 in 1961-62 to 104.7 in 1969-70, an increase of only about 4%.

The per capita expansion was greatest in East Asia and least in West Asia. The variations by individual years may be noted in Figure 1. East Asia has shown a relatively steady increase. West and South Asian production has varied more widely; West Asia peaked in 1967 and 1968 and has decreased since. South Asian production dropped sharply in the mid-60's due to drought but has increased sharply since.

2. Production of Major Grains

Much of the world's food supply is composed of grain. The three major food grains are rice, wheat and corn. Within Asia, rice is easily the most important of the three, representing about 70% of production from 1964 to 1970, followed by wheat (18.5%) and corn (11.5%).

Changes in production of each compared with a base period of 1964-68, which unfortunately includes the drought period in South Asia, are reported in Table 2.

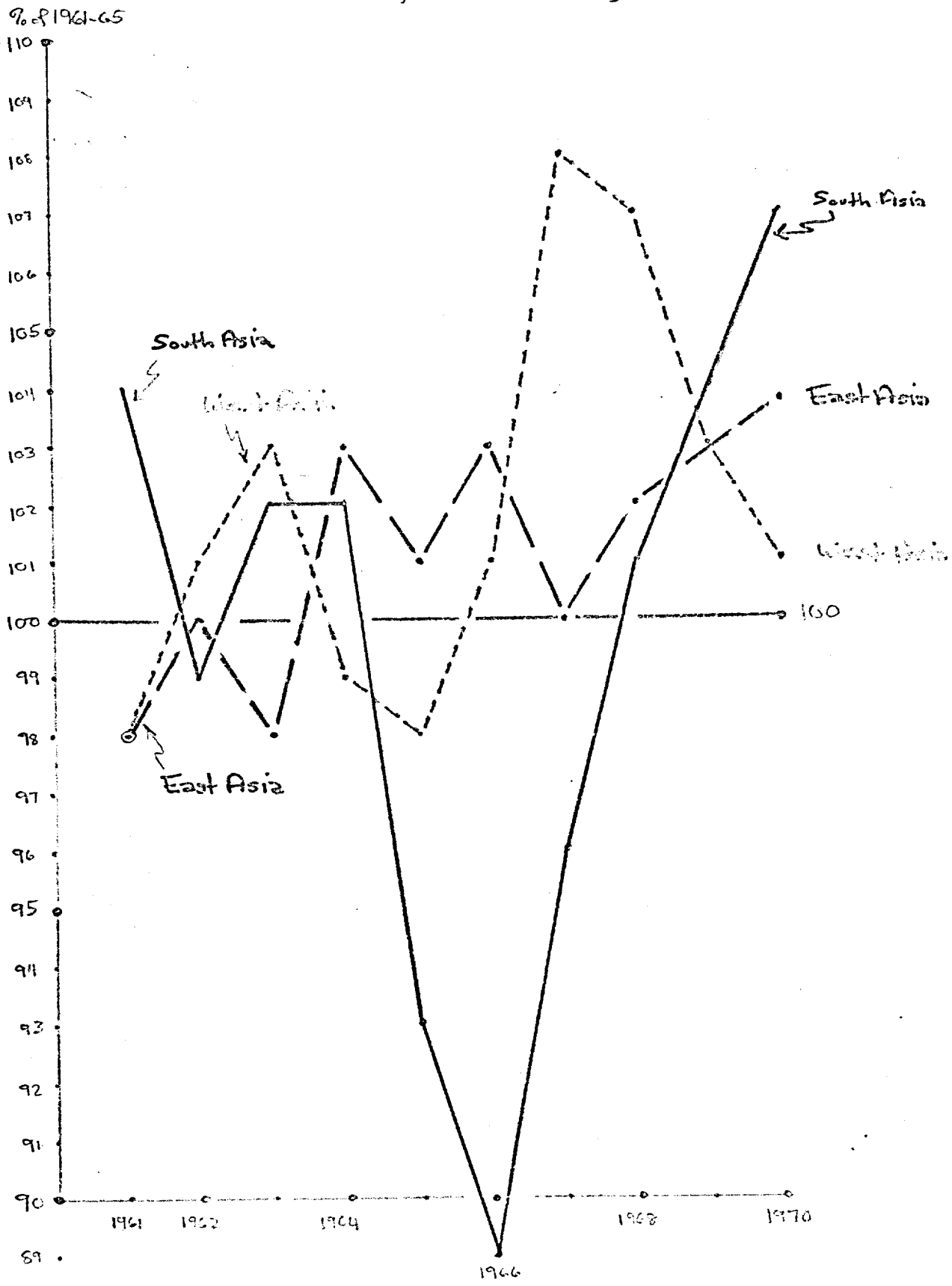
Table 2. GRAIN PRODUCTION IN ASIA*

| Crop | Production 1970 - thousand mt - | Change From 1969 - percent - | Change From 1964-1968 - percent - |
|---|---|---|---|
| Rice | 256,545 | +4.2 | +15.9 |
| Wheat | 71,325 | +8.9 | +28.1 |
| Corn | 40,778 | +4.6 | + 8.8 |
| Total | 368,648 | +5.1 | +17.2 |

* Including Mainland China; excluding Japan.

Source: Foreign Agricultural Service, USDA.

Figure 1. INDEXES OF PER CAPITA FOOD PRODUCTION IN ASIA
(Excluding Communist Asia)




Source: Economic Research Service, U.S. Department of Agriculture

While wheat registered the largest gains, it is only second in importance. The gains in rice, the major crop, were quite respectable.

Because of the base period problem, it may be useful to compare the changes from 1969 to 1970. On this basis, wheat again led with a gain of 8.9%, followed by corn (+4.6%) and rice (+4.2%).

Comparable data are not yet available for the 1971 season except for wheat, which showed a 4.9% increase over 1970.

Thus total grain production in Asia has undergone impressive increases. But if, as previously noted, population growth is taken into account, they are probably negated in large part.

Domestic production, however, is not the only source of grains; a considerable quantity has been imported, principally for use in coastal cities.

B. Imports of Grains

Asia has for some time been a net importer of grains. Moreover, it has accounted for a very large share of all the grains imported by the LDC's. This is shown in Table 3.

Table 3. NET GRAIN IMPORTS, ASIA*

| Year | Asian Grain Imports - million metric tons - | Proportion of all LDC Grain Imports |
|---|---|---|
| 1960 | 8.6 | 92.8% |
| 1963 | 13.9 | 79.0 |
| 1966 | 20.3 | 96.5 |
| 1969 | 15.2 | 96.7 |

* Includes Communist Asia; excludes Japan.

Source: FAO Trade Yearbooks.

The imports came largely from the developed nations. From 1966 to 1969, there was a significant downturn in the absolute quantity imported. Presum-

ably the quantity of imports will decrease still further in 1970 and 1971, though data will not be available for some time yet.

Clearly, Asian grain imports have been declining as domestic production has increased.

* * *

Production and import data do not, of course, precisely reflect food consumption; food balance sheets would be needed for this, and they probably give a reasonable idea of trends. The statistics for the 1960's have suggested an increase in food production in Asia which is probably largely offset by population growth and a decline in imports.

## III. FACTORS CONTRIBUTING TO INCREASED PRODUCTION

What has been responsible for the substantial increase in food production in Asia during the 1960's? Was it an increase in area planted? Or an increase in yield?

### A. Role of Area and Yield

While increases in both area and yield would be expected, the role of yield might draw special attention. This is because of the recovery from the serious drought of the mid-1960's and the emerging presence of the Green Revolution. What do the data, such as they are, indicate?

#### 1. Past Role

A rough idea of the relative importance of the two factors may be obtained by comparing 1970 production in Asia with that for the 1964-68 period. The approximate proportion of the increase due to area and yield is indicated in Table 4.

Table 4. APPROXIMATE ROLE OF AREA AND YIELD IN GRAIN PRODUCTION EXPANSION ASIA,* 1964-1968 to 1970

| Crop | Proportion "Due" to Area | Yield | Total |
|---|---|---|---|
| Rice | 26% | 74% | 100% |
| Wheat | 47 | 53 | 100 |
| Corn | 64 | 36 | 100 |
| Total | 33% | 67% | 100% |

* Includes Mainland China; excludes North Korea, North Vietnam and Japan.

Source: Computed from data compiled by the Foreign Agricultural Service, USDA.

The figures suggest that about 2/3 of the overall increase in grain

production may have been related to increases in yield while about 1/3 may have been related to an expansion in area. Yield increases were most pronounced for rice and least pronounced for corn.

There are many limitations to these estimates. Perhaps the first is the crude method of calculation.[2/] The second is that the base period includes two years of drought in South Asia, which may inflate the role of yield. Thirdly, the figures do not take into account possible expansion in multiple cropping which may be viewed either as an increase in area or yield, or a combination of both.

Still, they suggest a rough order of magnitude and indicate that yield increases have been substantial. And they suggest that the yield increases for rice may have been greater than might have been expected.

2. Projected Role

How might these relationships hold in the future? FAO has recently made some agricultural commodity projections through 1980 which provide some guidelines.[3/] The approximate role of area and yield, using 1970 as a base, is indicated in Table 5.

Table 5. PROJECTED ROLE OF AREA AND YIELD IN GRAIN PRODUCTION EXPANSION SOUTH AND EAST ASIA, 1970 TO 1980

| | Proportion "Due" to | | |
|---|---|---|---|
| Crop | Area | Yield | Total |
| Rice | 41% | 59% | 100% |
| Wheat | 51 | 49 | 100 |
| Coarse grains | 24 | 76 | 100 |
| Total | 37% | 63% | 100% |

Source: Agricultural Commodity Projections, 1970-1980, FAO, Vol. I, 1971, p. 17.

Overall, and for wheat, the changes are projected to be little different from those cited in the previous table. The role of yield is expected to be less important in the case of rice but much greater for coarse grains than was true in the past for corn.

The FAO figures seem conservative for rice and wheat, but the spurt in the role played by coarse grain yields is more than I might have expected. Just what factors are expected to give a particular boost to coarse grain yields are not entirely clear to me.

B. Role of High-Yielding Varieties

The introduction of new semi-dwarf, fertilizer responsive varieties of rice and wheat has of course played a vital role in increasing yields in Asia during the 1960's. This process is popularly known as the Green Revolution. Many of the rice varieties were developed at the International Rice Research Institute in the Philippines while many of the wheats were originally developed in Mexico. But more than just new varieties is involved; they must be accompanied by a package of inputs including water control and adequate fertilization to be of maximum benefit.

1. Area Planted

The expansion of area planted to high-yielding varieties (HYV's) in Asia since the mid 1960's has been truly remarkable. I have been keeping a record of the area for several years now; the data I have collected - which are for the most part based on official statistics - are summarized in Table 6.

Table 6. ESTIMATED AREA PLANTED TO HIGH-YIELDING VARIETIES OF RICE AND WHEAT NON-COMMUNIST ASIA

| Crop Year | Rice | Wheat | Total |
|---|---|---|---|
| | | - acres - | |
| 1965/66 | 17,650 | 22,900 | 40,550 |
| 1966/67 | 2,505,200 | 1,542,200 | 4,047,400 |
| 1967/68 | 6,487,100 | 10,170,700 | 16,657,800 |
| 1968/69 | 11,620,300 | 19,654,300 | 31,274,600 |
| 1969/70 | 19,104,300 | 21,672,000 | 40,776,300 |

Source: Foreign Economic Development Service, USDA.

The 1970/71 data are not complete yet, but it appears that there will be a further expansion of at least 8.3 million acres, bringing the total rice area nearly up to that of wheat. In 1969/70, the HYV's accounted for about 9% of Asian rice land and about 21% of wheat area (excluding non-communist Asia). In addition, we know that the IRRI rices are being widely planted in North Vietnam, and that China may well have some sort of equivalent.

Much of the total area planted in the non-Communist nations is found in India. In 1969/70, India accounted for about 56% of the Asian HYV area in rice and wheat. Other countries with over 1 million acres included: rice - Philippines, Indonesia, and West Pakistan; wheat - West Pakistan and Turkey. During 1970/71, East Pakistan and South Vietnam joined the group in rice.

2. Yields

But if the expansion in area of HYV's can be reasonably well documented, the effect on yield is less easy to chart. A number of rather wild statements have been bandied around. Relatively few people have even taken a close look at the results of experimental work.[5/] And

even fewer have considered just what happens in actual practice on individual farms where water control may be less than perfect and only a portion of the recommended amounts of fertilizer is applied.

On a national basis, a few estimates are available which provide yield ratios (that is yields of HYV's as a multiple of native varieties). The basic problem with the ratios is that they involve the comparison of not only the improved variety, but also of an associated package of inputs with traditional varieties. Also, the improved varieties tended to be raised on the best land.

- Wheat. Tsu has calculated relative yields for HYV's and traditional varieties in 1969 for three countries. The multiples were: India 3.5, Pakistan 2.2 and Turkey 3.0.[6/] They are higher than I would expect. Moreover, it should be recognized that the improved wheats were often raised on irrigated land while native varieties were more often raised under rainfed conditions. Official data from Turkey, for example, suggest that for the 1969/70 crop year, the yield of Mexican varieties was 1.8 times that of native varieties; but the Mexican varieties were grown in the irrigated coastal areas.

- Rice. Most of the rice raised in developing nations is raised in paddies. Therefore irrigation of a sort is usually available for both improved and native varieties - though the quality may well differ sharply. National crop statistics show that in the Philippines yields of HYV's were 25% higher than traditional varieties in 1970 and 20% higher in 1971, while in Indonesia they averaged about 25% higher in both 1969 and 1970. These increments would seem reasonable for rice.

While actual relative yield multiples for wheat and rice are unclear,

one might expect the initial increase to be greater for wheat than for rice. The early wheat varieties had wide adaptability and, as suggested, were generally grown under irrigation. Water control for rice is more difficult for rice and further breeding efforts were often needed to adapt varieties to local conditions. The matter could well be studied further, however.

In any case, as the area planted to HYV's expands to less and less suitable land, the yields may be expected to decrease.[7/] Partially offsetting this will be the continued effort to develop new varieties - varieties that are even higher in yield, more disease-resistant, and more acceptable to the consumer. The original HYV rices introduced in the 1960's are now obsolete in some areas and have already been replaced by varieties better adapted to local conditions. Varietal improvement is a never-ending challenge.

* * *

What kind of broader challenges can Asian agriculture expect in the 1970's? We now turn from a retrospective view of the 1960's to the decade ahead. What can we say about it?

## IV. AGRICULTURAL PROBLEMS OF THE 1970's

The challenges for Asian agriculture in the 1970's will be of two main types: physical/biological and social. The continuing expansion in the rate of population growth will mean that Asian agriculture will have to - as it did in the 1960's - do well to increase output even slightly on a per capita basis. Moreover, as attempts to expand output succeed, numerous social problems will emerge. We shall look at each separately.

### A. Production and Marketing Challenges

During the 1970's the population of south and east Asia is expected to increase at an annual rate of 2.6%. West Asia is expected to grow even more rapidly, 2.9% per year. Asian centrally planned economies, however, are expected to grow at a lower rate, 2.0% per year.[8/] This expansion in population alone provides a challenge to Asian agriculture. It means the feeding of an additional 360 million people in non-communist Asia and 196 million in communist Asia by 1980.

In some individual nations the task will be particularly great. Several countries are expected to have annual growth rates of 3% or more. These include Iran (3.2%), Iraq (3.7%), Jordan (3.4%), Syria (3.1%), Sabah and Sarawak, Malaysia (3.75%), the Philippines (3.5%), and Thailand (3.0%). The Philippines were claimed to have achieved self-sufficiency in rice in the late 1960's. They are the home of the leading high-yielding varieties of rices and they have been widely planted. How did they do in 1971? Not too well. Rice production, despite an expansion in HYV area, expanded only 2.1% from 1970, well below the population growth rate.[9/] The crop suffered from hurricane damage, but next year's crop may fare no better

because the Tungro virus is expected to cause severe damage to IR-5, IR-8, and IR-20 in central Luzon.[10/] No, the battle is not yet won in the Philippines. And certainly not in densely-populated, strife-ridden East Pakistan.

For South and East Asia, FAO recently projected that overall food output will expand from an index of 100 in 1970 to an index of 139 in 1980. The comparable increase in Communist Asia is placed at 128. Per capita indexes of food production would be 107 in south and east Asia and 105 in Communist Asia.[11/] These indexes assume continued efforts to expand production. The list of actual and potential barriers could be a very long one; not the least of the items will be the need for improved water control.

But even assuming output can be expanded as FAO expects, there will be a substantial problem in improving marketing. Efficient, low-cost distribution is essential if the twin problems of maintaining incentive prices to farmers yet keeping consumer prices as low as possible are to be dealt with. Moreover many groups lie outside the market economy; a different approach may be needed for them.

As production and marketing changes are made, what other problems can be expected to appear?

B. Emerging Social Issues

The Green Revolution, like any significant technological advance, brings with it a mixed bag of blessings. Is it, on balance, as Clifton Wharton neatly asked a few years ago, a cornucopia or a Pandora's Box?[12/] I will not attempt to discuss all of these issues here today; extensive writings are available on the subject.[13/] And many points have been

discussed by other speakers at this conference.

Rather, I will briefly turn to several questions which I think are, or should be, occupying center stage. They are cogently summarized for Asia in a recent study by Walters and Willett:

> The faster the rate of adoption of the Green Revolution technology, the greater the benefits in reduced costs of food and in resources released from agriculture.
>
> - If productive uses are found for this land and labor and methods are devised for cushioning the accelerated degree of dislocation entailed, a rapid rate of adoption will provide for further advances in agricultural productivity, a more diversified food supply, and a more rapid rate of economic growth.
>
> - If productive uses are not found for the released resources and policies are not adopted to ameliorate the dislocation effects a rapid rate of adoption of the new technology will accentuate the problems of unemployment and disadvantaged farmers. 14/

Current development attention is particularly focused on the problems of income distribution and employment.

1. Income Distribution

One of the prominent reasons for social unrest is often considered to be the wide social and economic disparities between various groups in society. Often an initial effect of technological change, or of economic development, will be to widen these disparities. The rich get richer and the poor may be little better off. Even if the poor are better off in absolute terms, others may benefit more, so that relative disparities are widened. 15/

Where technological change is a key factor in development, the poor often do not benefit as much as the more affluent because of indivisibilities or economies of scale in using the technologies. This is not true of the seeds themselves - for an input could hardly be more divisible - but of the associated necessary technologies such as irrigation. Also, credit is not so readily available. Reaching small farmers with effective programs will be one of the most difficult tasks in the years ahead.

2. Unemployment

Unemployment is also a chronic problem in the less developed nations, and the Green Revolution holds little direct potential for reducing it. The new technologies require more labor per unit of land, but the greater resulting yields means that labor per unit of product is not increased; in fact it is likely to be reduced. The problem is, of course, severely aggravated where indiscriminate mechanization is allowed (some nations, pressured by large influential farmers, have in effect enccuraged mechanization by favorable import duties). Indirectly, however, the Green Revolution may lay the base for added employment through the foundation it lays for diversification and multiple cropping. We shall say more of this later.

3. Nutrition

Another matter which should be of greater social concern is nutrition. We need to improve not only the quantity but also the quality of diet in the developing nations. This will be difficult because those that most need improved nutrition are least able to pay for it. Moreover the production of relatively inexpensive yet highly nutritious foods such

as pulses has declined in some countries.

Concern has been expressed that this decline may have been due to substitution of less nutritious crops such as wheat. And there has been concern that the HYV's may be lower in nutritional value than regular varieties. Although the evidence is thin, these may not be major problems. Pulse availability has declined in India and East Pakistan, but most of this occurred before the Green Revolution.[16/] And the few estimates we have suggest that the nutritional qualities of HYV wheat are about the same as traditional varieties.[17/]

Still, the nutritional problem remains and its solution will require a complex blend of programs to influence demand and supply. Demand programs involving the improvement of income and the reduction of costs are apt to be long-term in nature. Supply programs may involve improving the nutrient levels of existing products (through increasing natural nutrient levels, processing, and fortification) providing new processed foods, and mass feeding efforts. Combined supply and demand programs could involve expanded food-for-work programs and possibly even price discrimination. We are a long way from reaching the optimum blend of combinations in most countries.

## V. POSSIBLE AGRICULTURAL APPROACHES FOR ASIA

Asia faces the twin problems of expanding food output while at the same time ameliorating emerging social problems. How is all of this to be accomplished in light of the relatively low levels of income in these countries and rather uncertain levels of foreign aid? There is no easy answer. Obviously a broad range of efforts will be needed. Let me just suggest two agricultural approaches, which while related to the Green Revolution, may have been relatively overlooked. They are the interconnected matters of diversification and multiple cropping. Both offer unique opportunities for Asia.

### A. Diversification

By diversification I mean simply the shifting of production from a monoculture to a broader variety of crops. In an Asian setting, this means moving from grains (principally rice) to other items such as fruits and vegetables or livestock. As the Green Revolution increases yields to the point where market demands for basic grains are met, it may be possible to divert some of the land to the production of other items.

Many fruits and vegetables offer good prospects. They require much more labor than grains per unit of land. They can be raised by small farmers. Moreover they provide a broader range of nutrients which may better balance society's needs. Less certain is the question of how profitable they will be, for the market for such products may be rather thin in the poorer countries. Moreover, the potential customer will not benefit from their nutritional qualities if they are very expensive. Still,

there is a potential here well worth investigating. An Asian Vegetable Research Center is being established on Taiwan which could play a major role in guiding future diversification efforts.* Also AID and ERS are well along the road toward establishing a study of diversification in cooperation with the Philippine Government.

Animals such as swine and poultry offer another route for diversification which may be appropriate for small farms in Asia. But the role of larger animals may be more open to question.

Diversification in either of its forms may be increasingly possible as multiple cropping expands.

B. Multiple Cropping

Multiple cropping is basically the growing of more than one crop per year on the same piece of land. When two sequential crops are grown, the process is usually known as double cropping; three crops, triple cropping etc. In this way, the output per unit of land per year may be greatly expanded.

Although multiple cropping is hardly a new practice in Asia - it has been practiced thousands of years in some locations - it is being given a new stimulus by the Green Revolution. The high-yielding varieties mature over a shorter period of time than traditional varieties, thus providing more time for the cultivation of a second or third crop. Moreover many of the inputs required for the HYV - particularly irrigation - greatly enhance the possibilities of multiple cropping.

Many of the advantages of diversification also apply to multiple cropping. Traditionally, and perhaps surprisingly, multiple cropping has been carried out to a greater degree on small rather than on large farms

---

* An International Potato Research Center is also being established in Peru which could provide an important complementary input.

in Asia. The presence of an additional crop each year naturally expands the potential for employment and family income. Usually the additional crop is not the same as the basic crop (often because of cultural reasons), meaning that diversification of output is encouraged - with its concomitant potential beneficial effects on nutrition.

Research on multiple cropping has been relatively limited over time, but the last few years have seen an upsurge in work in India and Thailand and to a lesser extent in some other Asian nations. Dr. Richard Bradfield initiated studies in this area at the International Rice Research Institute several years ago.

* * *

Thus diversification and multiple cropping offer promise of contributing to the amelioration of some of the major problems which may face Asia in the future. Neither is a panacea.** Neither is easily accomplished. The difficulties are many and these I have discussed in detail in two bulletins (one of which, on multiple cropping, will be released in a week or so).[18/] But both hold so much potential merit that they deserve serious attention in further development programs.

---

** Neither, moreover, gets around the problem of regional disparities related to the availability of irrigation.

## VI. CONCLUDING REMARKS

Where do we come out? The 1960's were clearly a period of sharp change for Asian agriculture. The 1970's promise to be likewise.

Because of the high man land ratio in Asia, future developments may be expected to be more in the direction of intensive rather than extensive agriculture. This notion is not novel, but the components may be somewhat different than in the past.

During the 1960's a more intensive agriculture consisted largely of increasing yield per crop. This process was facilitated by the introduction of high-yielding varieties of grains, particularly wheat and rice and a package of improved practices such as fertilization and irrigation.

During the 1970's, I expect the emphasis to move to increasing the quantity and variety of output per acre per year. This will be brought about by an increase in diversification and multiple cropping. Both factors were made increasingly possible by the Green Revolution of the 1960's, and by the conditions which brought it about.

Such an approach to intensive agriculture, given adequate credit, water control, and other inputs, could do much to improve the quantity and quality of food production in Asia. It could also contribute to important emerging social problems of income distribution, unemployment, and malnutrition.

None of this, however, will be easily accomplished. It will require much concerted effort and outside resources. The developing nations will continue to be in great need of capital and technical assistance during the 1970's.

## VII. FOOTNOTES AND REFERENCES

1/ I say nothing about prices or exports, and do not mention other factors which should be brought into a fully comprehensive review.

2/ Basically the percentage increases in area and yield were calculated, then added together, and recalculated as a proportion of the total. This procedure seems reasonable if area and yield are assumed to have equal roles in production. It is recognized that a more detailed production function approach might be desirable to give a more precise evaluation.

3/ Agricultural Commodity Projections, 1970-1980, FAO, Vol. I, 1971, p. 17. The FAO proportions seem to be calculated in approximately the same way as those I have computed (at least the figures are the same or differ only by a few percentage ponts). West Asia is included in the Near East in FAO's classification and is therefore not included here. Communist Asia is excluded from the FAO figures; Japan is included.

4/ Revision of data contained in Dana G. Dalrymple, Imports and Plantings of High-Yielding Varieties of Wheat and Rice in the Less Developed Nations, U.S. Department of Agriculture, Foreign Economic Development Service, January 1971. These data should be considered approximate or as rough orders of magnitude. In addition there are complex problems of definition which are discussed on pp. 1-2.

5/ One of the first to do so for both wheat and rice was Joseph W. Willett in The Impact of New Grain Varieties in Asia, U.S. Department of Agriculture, Economic Research Service, ERS-Foreign 275, pp. 12-15.

6/ Sheldon K. Tsu, High-Yielding Varieties of Wheat in Developing Countries, U.S. Department of Agriculture, Economic Research Service, ERS-Foreign 322, September 1971, pp. 13, 17, 21.

7/ Tsu demonstrates this in the case of India, Pakistan, and Turkey (op. cit., pp. 14, 18, 22).

8/ Agricultural Commodity Projections..., op. cit., Vol II, pp. 6,7. The data in the following two paragraphs also come from this source.

9/ Based on official estimates of the Bureau of Agricultural Economics, Department of Agricultural Economics.

10/ "Rice Virus Outbreak in the Philippines," The IRRI Reporter, 1971, No. 2, p. 3.

11/ Agricultural Commodity Projections..., Vol. I, p. 16.

12/ Clifton Wharton, "The Green Revolution: Cornucopia or Pandora's Box," Foreign Affairs, April 1969, pp. 472-473.

13/ For background on the general influence of technological change, see Dana G. Dalrymple, Technological Change in Agriculture; Effects and Implications for the Developing Nations, Foreign Economic Development Service, U.S. Department of Agriculture, April 1969. Greater detail on the problems raised by the Green Revolution may be obtained from: Walter C. Falcon, "The Green Revolution: Generations of Problems," American Journal of Agricultural Economics, December 1970, pp. 698-710; and Francine R. Frankel, India's Green Revolution: Economic Gains and Political Costs, Princeton University Press, 1971, 232 pp.

14/ Harry E. Walters and Joseph W. Willett, "The Green Revolution in Southeast Asia in the 1970's," in Southeast Asia's Economy in the 1970's (ed. by Hla Myint), published for the Asian Development Bank by Longman's, 1971, para 208.

15/ Irma Adelman and C.T. Morris, "The Anatomy of Income Distribution Patterns in Developing Nations," Development Digest, October 1971, p. 32.

16/ For instance, data compiled by Byron Berntson of the Foreign Economic Development Service indicate that per capita pulse availability as a proportion of total cereal availability in India was as follows:

| | |
|---|---|
| 1959/60 - 1961/62 | 16.8% |
| 1964/65 - 1966/67 | 13.2 |
| 1969/70 - 1971/72 | 12.5 |

The Green Revolution in India really did not get underway until 1967/68. Similarly, when I did a study in East Pakistan in 1967 I noted a long-term decline in pulse production; planting of HYV rice varieties just began to gain momentum there in the late 1960's.

17/ Dana G. Dalrymple, Economic Aspects of Nutrition Improvement in Tunisia, U.S. Department of Agriculture, Foreign Economic Development Service, July 1970, pp. 27-29; A. Austin, et al., "Protein Survey of Improved Indian Wheat Varieties" Indian Journal of Agricultural Sciences, April 1970, pp. 302-308.

18/ Dana G. Dalrymple: The Diversification of Agricultural Production in Less Developed Nations, U.S. Department of Agriculture, Foreign Economic Development Service, August 1968, 56 pp.; Survey of Multiple Cropping in Less Developed Nations, U.S. Department of Agriculture, Foreign Economic Development Service, July 1971, 108 pp.