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ABSORPTION OF HUMAN LABOUR IN AGRICULTURE: A Comparative Study of Some Asian Countries

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Introduction

1. The existence of wide differences in the ratio of arable land to agricultural population among various parts of the world has for long been viewed essentially as a measure of differences in intensity of population pressure on agriculture. Recently, however, some authors have noted the significance of these variations as a measure of relative intensity of labour input in agriculture and its relation to differences in agricultural productivity.

2. Boserup[1/] (1965) viewed the land/man ratio variation across countries as the result of historical adaptations of cultivation systems to changes in population pressure. She noted,

> "As long as the population of a given area is very sparse, food can be produced with little input of labour per unit of output and virtually no capital investment, since a very long fallow period helps to preserve soil fertility. As the density of population in the area increases, the fertility of the soil can no longer be preserved by means of long fallow and it becomes necessary to introduce other systems which require a much larger agricultural labour force." (p.117).

The process of intensification, according to her, typically involves a gradual transition from extensive types of cultivation (involving relatively long fallow periods and little or no use of inputs other than labour) to intensive types of farming based on irrigation, multiple cropping and use of fertilisers, animal power and other inputs. The more intensive cultivation systems also involve a higher level of labour input per unit area. Implicit in this formulation is the notion that there exists a positive relation between man land ratio and output per unit of arable land.

3. In a more systematic and empirical study of several Asian countries, Ishikawa (1967)[2/] presents data to show that the average number of working days used in crop production per hectare of cultivated area ranges from around 50 in parts of India to over 500 in Japan. He found a strong positive correlation between output per unit area and the human labour input (measured in man-days) per unit area. He also pointed out that the intensity of human labour input is positively associated with the levels of other current and capital inputs and that an increase in the former by itself cannot increase output per unit area indefinitely: A shift of land productivity from one level to another requires a new set of input combinations which in turn must be preceeded by a significant increase in irrigation and other water control measures in the early stages of development.

4. If intensification of cultivation (based on spread of irrigation, multiple cropping, etc.) can result in additional agricultural employment per unit area on the scale suggested by Ishikawa's analysis, the outlook for providing larger employment opportunities in Indian agriculture would be considerably more promising than is commonly supposed. However, before such a conclusion can be drawn, the analysis has to be carried much further. In the first place, it would be useful to test the strength of the labour input-productivity relation over a larger sample of countries. Secondly, there are doubts whether the data relating to the number of man-days per hectare used in the Ishikawa study are comparable across countries. These arise from three principal sources: (a) the lack of uniformity in the concepts of the 'standard workday' underlying survey data from different countries;[3] (b) differences in the manner in which labour input of males, females and children are aggregated;[4] and (c) the treatment of labour input for tending draught and milch animals.[5] A closer scrutiny of these data to ensure comparability is, therefore, indicated. Thirdly, it is necessary to consider, especially, the extent to which the use of human labour is affected by the availability and use of animal and/or mechanical power. The present study seeks to extend and refine Ishikawa's analysis by taking the above factors more fully, and explicitly, into account.

5. As a first phase of this effort, we present below some preliminary results of analyses based on cross-country aggregate data relating to the number of agricultural workers per unit area, productivity of land, and other related variables. Since the available data for many of the countries included in the sample are quite sketchy, the results must be viewed as highly tentative.

Productivity of Land and Intensity of Employment

6. Table 1 gives some macro data on the number of workers employed and of gross crop production per unit of arable area. The number of workers per hectare of arable land ranges from 492 in Pakistan to nearly 2450 in South Korea. In general, the east Asian countries /namely, China, Japan, Korea and Taiwan/ support a much larger number of workers per unit area than the South-east and South /Asian countries. However, Table 1 does not show any systematic relation between the number of workers per unit area and the gross value of output per unit area.

Table 1: Number of Agricultural Workers, Arable Land and Productivity of Arable Land in Selected Asian Countries

	No. of agr. workers (in thousands)			Arable land (000ha)	No. of workers per 1000 hectare of arable land	Gross value of crop and livestock production per hectare of arable land (in dollars)
	Male	Female	Total			
	(1)	(2)	(3)	(4)	(5)	(6)
South Korea	3332	1765	5147	2100	2451	791
Japan	6120	6610	12730	5893	2160	617
China	na.	n.a.	236907	118940	1992	227
Bangladesh	13479	2596	16075	8919	1802	242
Taiwan	1161	307	1468	890	1649	663
Thailand	5580	5762	11342	8600	1319	124
Philippines	6657	1158	7815	7890	990	126
Sri Lanka	1390	457	1847	1870	988	258
India	88580	48988	137568	161500	852	99
W.Malayasia	843	401	1245	2350	530	248
Pakistan	7892	915	8787	17874	492	80

Notes:

1. Number of workers in agriculture relate to the year 1960 and the data for all countries except Japan and West Malayasia were taken from Production Year Book, 1974 (FAO, Vol.28.1), Taiwanese data is for the year 1956 and was obtained from FAO Production Year Book, (1965). These totals have been broken down by sex on the basis of the proportion of male and female workers in agriculture as reported in the Year Book of Labour Statistics (ILO, 1971 and 1973). Data for W.Malayasia is taken from ILO Year Book and refer to the year 1957.

2. In general the figures cover those engaged in crop husbandry, livestock, fisheries, forestry & hunting (=ISIC Div.0). However, in the case of a few countries, where fisheries are more prominent, the figures exclude estimated employment in fisheries. Agricultural work force in Japan excluding those in the fisheries sector were directly obtained from OECD Labour Force Statistics (Paris, 1973). For South Korea and Taiwan workers in fisheries were estimated from data given in the "Survey of Asian Agriculture" (ADB, 1971) and deducted from total agricultural workers. As for the other countries, the proportion of fishermen were relatively low and hence no adjustments were made.

(Notes 3 & 4 on page 6)

7. It should be noted, however, that Ishikawa's analysis relates to a smaller sample of countries than indicated in Table 1, and focusses attention only on the variations in the man-days of labour input per hectare for crop production alone. The data in Table 1, by contrast, cover more countries representing a wider range of cropping systems and patterns of organisation, and are concerned with variations in the number of agricultural workers per hectare of arable land. There is indeed much diversity in cropping patterns among countries considered by Ishikawa;[6] but, for the most part, the crops in the group of countries covered by his study are annual crops grown under conditions of small scale peasant farming. Our sample, however, includes countries (e.g. Western Malaysia and Sri Lanka) with a high proportion of area under tree crops,[7] whose cultivation involves very different techniques from those used for annual crops. Unlike the latter tree crops require little effort at land preparation and sowing oporations year after year. Also the fact that a relatively high

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Notes of Table 1 (contd.)

3. Arable land includes area under seasonal crops, permanent crops and current fallows. Data for countries other than Japan, China, Pakistan and Bangladesh have been obtained from Indicative World Plan For Agricultural Development to 1975 and 1985, Asia and the Far East (IWP), Vol.II, (FAO, Rome, 1968). The figures correspond to the average of the three years 1961 to 1963. For Japan, China, Pakistan and Bangladesh, they have been collected from Production Year Book, 1975, Vol. 29 (FAO, Rome), and give average for 5 years 1961-65.

4. The value of crop and livestock output used in deriving the averages shown in column 6 are taken from the FAO's IWP, Vol.II, pp.24-32 in respect of the following countries: South Korea, Taiwan, Thailand, Philippines, Sri Lanka, India and West Malayasia. All the figures relate to 1961-1963.

For the remaining four countries, they have been estimated by applying unit values of various crops and livestock products for Asia implied in the IWP estimates to average production figures for 1961-65, taken from the FAO Production Year Book, 1974, Vol.28.1.

proportion of the former are organised in large-scale commercial plantations,[8/] accentuates the differences in terms of labour requirements. In principle, this non-comparability can be mitigated by taking the productivity of land and number of workers per hectare for annual crops alone. This could not be done because the necessary data for the latter are not readily available. However, even if one excluded the countries where plantation crops are important, there is no significant positive relation between output per hectare and number of workers per hectare.

8. This finding should, however, be interpreted with caution. For the number of agricultural workers, shown in Table 1, includes not only those engaged in crop production and animal husbandry, but also in such activities as fisheries and forestry. The proportion of total employment in the primary sector devoted to activities other than crop production and animal husbandry varies from country to country. While we have excluded the number of workers engaged in fishing in a few countries (Japan, Korea and Taiwan) where they are particularly prominent, the adjustments are neither complete nor can they claim to be accurate. However, given the overwhelming importance of agriculture and animal husbandry in the primary sector of most countries, the above deficiency is unlikely to vitiate the comparison. On the other hand, the average intensity of employment (i.e., the number of man-days for which a worker is employed in a year) and/or the proportion of labour days spent by workers primarily dependent on agriculture, in non-agricultural activities could also vary from country to country.

To this extent the relative position of countries in terms of man-days of human labour for crop production per hectare may not correspond with that in terms of number of agricultural workers per hectare.

9. Hence a firm conclusion of the relation between human labour input and productivity per unit land must be deferred till a proper analysis of labour input in agriculture per se, after making due allowance for differences in cropping systems. Such an analysis requires detailed farm survey data which are not readily accessible to us at present. Nevertheless, it seems possible to get some insights on the relation between differences in the intensity of land use and cultivation practices (as measured by cropping intensities, extent of irrigation and degree of fertilization) and the differences in the number of workers employed per unit of arable land. In what follows we shall concentrate on the differences between East and South Asia which represent two extreme situations in terms of the number of workers employed per unit land.

Cropping Intensity

10. An important reason for the relatively large number of agricultural workers per hectare of arable land in East Asian countries compared to India is that arable land is utilised more intensively in the former. The ratio of gross cropped area to arable area, which is a rough index of the intensity of land use,[2] is around 1.3 in China and reaches a high of 1.8 in Taiwan compared to 1 in India. Most of the differences in number of workers per hectare of arable land between India and Taiwan, and over half the differences between India on the one hand and China and South Korea on the other, could be attributed to the differences in the intensity of cropping.

11. Prima facie, the more intensive use of arable land in East Asia would seem to be explainable by the relatively high proportion of irrigated to cultivated land in this region. Thus about a third of China's cultivated land, and upward of half in Japan, Korea and Taiwan, are served by irrigation facilities compared to around one-fifth in India. However, a closer examination suggests that the explanation might be more complex. For the extent to which irrigation increases cropping intensity depends on how far it increases the assurance of water supply and modifies the seasonal availability of water for crops from natural rainfall. The latter, in turn, depend on the nature of the project as well as the seasonal distribution of the rainfall in relation to crop requirements as determined by evapo-transpiration.

12. The relevant climatological data are presented in Table 2. Many of the principal agricultural tracts of East Asia (including the southern parts of mainland China) have relatively high average annual precipitation, a more even distribution of precipitation and lower mean temperatures. The average annual rainfall in Japan, South Korea and Taiwan, for instance exceed 1200mm. while two-thirds of the cultivated area in India is located in regions with an average annual rainfall below 1150 mm. Again while nearly three-fourths of the annual precipitation in India is concentrated in 4 months (June-September),[10/] in Japan and Taiwan the four rainiest months (which in general fall between May and September) account for half or less of the total rainfall. The comparable proportion in Korea (70 per cent) though rather high, is still below the Indian

average. The mean temperature in the hottest summer months in those East Asian countries is 4 to 10°F less than in India.

Table 2: Rainfall Characteristics, Irrigation and Cropping Intensity in Selected Asian Countries

	Mean temperature in the hottest month (°C)	Average annual rainfall (mm)	Proportion of total rainfall in four rainest months (Percentage)	Proportion of cropped area under irrigation	Cropping intensity
	1	2	3	4	5
South Korea (Seoul)	25.4	1259	71	26	152
Japan (Hokkaido & Tokyo)	17.5-26.4	994-2337	46-56	46	116
China:				51	128
Spring wheat and winter wheat/ millets region	26.4	343-508	66-85	15	114
Winter wheat/ kaoliang region	25	633	80-85	28	154
Subtropical region	27.2	803-1105	54-75	48	
Yangtse rice/ wheat region	28.3	1148-1593	49-56	56	171
South West rice region	23.6	1044-1176	57-71	28	n.a.
Double crop rice region	28.6	1436-1615	51-59	52	187
Bangladesh	29.3	1880	66	5	119
Taiwan (Taipei)	28.4	2100	51-59	51	181
Thailand (Bangkok)	30.2	1252	61	22	96
Philippines (Manila)	28.1	2121	70	9	102
Sri Lanka (Colombo)	28.0	2397	40	22	95
India:				21	99
North	34.3	310-1214	78-91	28	111
East	31.1	1214-2380	65-85	23	106
West	33.5	686-3335	52-94	8	96
South	32.7	660-2722	27-81	30	95
West Malaysia (Penang)	28.1	2647	51	13	102
Pakistan (Karachi)	30.4	204	82	72	87

Notes: (See page 11)

13. Comparisons involving India and mainland China are complicated by their vast size and diversity. The average annual precipitation in China is lower than in India. It would seem that barely 40 per cent of China's cultivated area is located in tracts with an average rainfall of 750 mm. or more, the comparable proportion in India being around 65 per cent. In fact, about a third of India's cultivated area has more than 1150 mm. of rainfall, while hardly any part of China receives so much precipitation. Despite higher precipitation,

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Notes of Table 2 (contd. from page 10)

Temperature and Rainfall data relating to most of the centres (unless otherwise specified) are taken from World Climatic Table in H.H.Lamb, "Climate, Present, Past and Future", Vol.I (Methuen and Co.1972), pp.533-540.
Rainfall data for Bangladesh (Dacca), Thailand (Bangkok) and W. Malayasia (Kula Lumpur) are from R.R.Rawson, The Monsoon Lands of Asia, Table 1 (Hutchinson Educational 1963). Temperature data for Bangladesh (Dacca), W.Malayasia (Kuala Lumpur), Thailand (Bangkok), N.India (Delhi), E.India (Calcutta), W.India (Ahmedabad), and S.India (Madras), are taken from Victor Showers "The World in Figures" (John Wiley and Sons, 1973), pp.329 and 348.

The figures relating to cropping intensity (=gross cropped area by arable land) and the percentage of area irrigated for S.Korea, Taiwan, Thailand, Philippines and W.Malayasia, have been taken from FAO, IWP - Vol. I. The figures for Japan are computed from the data published in the FAO Production Year Book, 1975. However, this is much lower than Ishikawa's figure (1.33) based on the Farm Accounts Survey data. The discrepancy needs to be explained.
For China, the irrigation ratio refers to the percentage of cultivated area under irrigation and has been obtained from Kang Chao, Agricultural Production in Communist China, (Wisconsin University Press, 1970), pp.289-295. The cropping intensity figures for various regions of China are taken from S. Ishikawa, "Changes in the Structure of Agricultural Production in Mainland China" in W.A.Douglas Jackson (ed.), Agrarian Policies and Problems in Communist and non-Communist Countries (Washington University Press, Seattle, Wash.1971). The regions in Ishikawas' classification are not strictly comparable to those included in the Table). The irrigation ratio and cropping intensities for different parts of India have been computed from data for 1964-65 published in GOI, Ministry of Agriculture, Indian Agriculture in Brief-Eleventh Edition (1971). The cropping intensity has been estimated by dividing gross cropped area by the arable land which includes net sown area and also the fallow lands.
For , , Bangladesh and Pakistan the figures correspond to the average for 1961-65 and are from Production Year Book, Vol.28.1. (FAO, 1971).

the cropping intensities in India's wet regions are rather low because of the very high seasonal concentration. And precipitation in the main rainy season is so high and intense that it results in flooding. And in the absence of proper drainage facilities intensive cultivation is hampered even in the main crop season. In the relatively low rainfall tracts of Northern and North-Eastern China, the seasonal distribution of precipitation is as skewed as in most parts of India. And, as in the dry regions of India, irrigation is relatively less developed in these tracts - and cropping intensity is low. However, in the Central and Southern parts of the country, though total rainfall is lower than in the wet regions of India, the seasonal distribution is markedly more even. Mean summer temperatures are also much lower than in India. It is precisely in these tracts that irrigation is more developed and cropping intensities are high.

14. With a more even seasonal distribution of rainfall and lower temperatures, the requirements of supplemental irrigation to sustain crop growth, even during the relatively dry periods, in much of East Asia is smaller than in India. Lower temperature during the growing period means lower evaporation and hence lower plant water requirements.[11/] A more even distribution of precipitation reduces the extent of moisture deficit to be met by irrigation during the drier period. Moreover, to the extent a more even seasonal distribution of rainfall results in a more even seasonal distribution of river flows, it may be possible to supplement natural rainfall by relatively simple diversion type works,

tanks, lift irrigation and other small scale projects instead of relying on massive storage-based irrigation systems. It is perhaps no accident, then, that small irrigation projects figure much more prominently in the irrigation systems of East Asia than in South Asia.

15. Thus about 90 per cent of the irrigated area in China is served by relatively small scale works (Table 3).

> "Traditionally, Chinese peasants and local governments were so keenly concerned about the scarcity of agricultural land that irrigation systems usually had been built with a minimum use of land. In South China, farm ponds were common. They served to conserve water as well as soil. In the terraced area, soil was washed away from higher land and deposited in the ponds; during winter, farmers dredged out the pond mud and put it back onto the fields. Some ponds were isolated, whereas others were connected by a few short leading channels. Farmers used water-wheels or other instruments to convey water from ponds or channels into fields. Cases of exclusive reliance on the force of gravity to distribute water were not common because this type of irrigation used too much land... There was a strong aversion to reservoirs. The new irrigation system built in 1947-56 did not depart too much from the traditional pattern." 12/

In sharp contrast, around 37 per cent of the irrigated area in India is served by canals fed for the most part from medium and large storage works. And this category of works accounted for a little under half the addition to irrigated area since 1950. 13/

Table 3: China — Area Covered by Different types of Irrigation Systems

(10^6 mou)

Type of Irrigation	1949	1952	1956	1964
Gravity - large canals	23.5	31.9	43.2	278.0
-do- small & Aequaducts	261.6	289.2	182.0	
Farm ponds and weirs			216.5	82.0
Pumping with mechanical and electrical power	4.2	5.0	11.9	86.0
Wells and other subterranean water	14.6	24.5	86.4	34.0
Total	303.9	350.6	540.0	480.0

Source: King Chao, Agricultural Production in Communist China, 1949-1964, (University of Wisconsin Press, Madison, Wisc. 1970,) p.124.

The Level of Fertilisation

16. The relatively high proportion of irrigated area and the higher intensity of cropping in East Asia would also seem to be a prima-facie explanation for the higher level of fertiliser and manures per hectare characteristic of this region. The level of fertilisation is clearly much higher in East Asia than in South Asia. Japan, S.Korea and Taiwan use more than 100 kg. of plant nutrients per hectare in the form of artificial fertilisers, compared to less than 4 kg. per hectare in India and Pakistan. The consumption of artificial fertilisers in China is relatively low (10 kg. per hectare), but if allowance were made for the farm yard manure, the quantum of nutrients comes to more than 100 kg.

per hectare. The comparable levels in Japan, Korea and Taiwan would be much higher. T In general the East Asian countries use more nutrients, a good part of it in the form of organic manures. Though the available data are neither complete nor reliable, the fact that China, Korea and Taiwan use 6 to 10 times the farm yard manure per hectare as India (Table 4) is sufficiently indicative of the vast differences between South and East Asia in this respect. This could have a significant impact on labour requirements: Unlike commercial fertilisers, which usually have rather high concentration of nutrients, the nutrient content of organic (or farm yard) manure is very low so that, for any given level of nutrient application, the latter involve handling much larger volumes of material. Moreover, farm yard manures, by their nature, involve much labour in collection and composting of farm (and human) wastes.

(Table 4)

Availability of Alternative Source of Power

17. More intensive cropping also involves additional work in the application of water and other material inputs, in weeding and perhaps harvesting. The high level of irrigation and intensive farming which goes with it clearly increases the volume of work to be done per unit area. But, since this work can be done by human labour, animals and mechanical equipment in varying combinations, its effects on the quantum of human labour input per se will depend on the extent of animal and mechanical power in use. In the early 1960's, to which most of our data relate, mechanical power was relatively unimportant in most Asian countries, except

Table 4: Intensity of Fertilizer Use in Selected Asian Countries

	Synthetic fertilisers 1/	Organic manures 2/
South Korea	105	6,447
Japan	263	n.a.
China	10	10,627
Bangladesh	3	n.a.
Taiwan	106	10,800
Thailand	3	n.a.
Philippines	11	n.a.
Sri Lanka	40	n.a.
India	4	1,164
W. Malaysia	20	n.a.
Pakistan	5	n.a.

Notes:

1/ Synthetic fertilizers in kgs. of nutrients per hectare of cultivated area.

2/ Natural manures in quantity of total material applied (kgs) per hectare of cultivated area.

Data on the consumption of synthetic fertilisers in each country relate to the average for the years 1961-65 and have been collected from Production Year Book, Vol.28-#, (FAO, ROME.)

Figures regarding farm yard manure for Taiwan and Korea refer to the year 1939 and 1940 respectively and have been obtained from Shigeru Ishikawa 'Economic Development in Asian Perspective, (op. cit.)

Figures of farms for China relate to the year 1965, and has been taken from S.Ishikawa, 'Changes in the structure of Agricultural Production in Mainland China, (op.cit).

Figures for India relate to the year 1955-56 and are estimated from GOI National Sample Survey, 11th round, Report No.140.

Japan. Animal power was, as it still is, a significant source of power in South Asia, while in East Asian countries they seem to play a relatively minor role.[14] One important reason for the relatively high input of human labour in East Asia could well be the minimal use of animal power for agricultural operations in this region. This may have something to do with the better seasonal distribution of moisture and lower temperatures both of which would seem to make it possible to prepare land with human labour. In South Asia, however, the hot dry summer hardens the soil to a degree which makes the use of animals necessary to break the ground and prepare the soil for sowing after the monsoon sets in. While this ecological factor may be the compelling factor for use of animals in South Asia, once they are there, animals are apt to be used for operations which may not, strictly speaking, require animals.

(Table 5)

18. The case of Japan and Bangladesh[15] cannot be fully explained in terms of the above reasoning. For despite a relatively high level of mechanisation in Japan, the number of workers per hectare of cropped area remains very high — in fact the highest next to South Korea. Whether this conceals a relatively high degree of dependence on non-agricultural work in rural Japan is a matter to be investigated. In Bangladesh, on the other hand, despite relatively low levels of fertilisation, and a high density of draught animals, the number of human workers, per hectare is extraordinarily high. The reason for this can only be understood by a more detailed study of the use pattern of labour and other inputs in this region.

Table 5: Number of Agricultural Workers, Draught Animals and Mechanical Power per 1000 Hectares of Cropped Area in Selected Asian Countries

	Number of agrl. worker per 1000 hectare of cropped area	Number of draught animals per 1000 hectare of cropped area	Tractor horse power per 1000 hectare of harvested area
South Korea	1616	56	1.12
Japan	1861	n.a	1388.00
China	1554	n.a	14.83
Bangladesh	1515	581	2.83
Taiwan	910	93	9.07
Thailand	1372	n.a	9.07
Philippines	970	272	17.86
Sri Lanka	1044	164	106.16
India	865	500	7.47
W. Malaysia	521	n.a	19.25
Pakistan	565	280	12.50

Notes: Draught animals include only cattle and buffaloes used for traction purposes. In the cases of countries Taiwan, Japan, Philippines, Sri Lanka and India data relate to 1960, and are taken from the Report on the 1960 World Census of Agriculture, Ch.3 (FAO, Rome, 1971). In the case of Japan it is stated that the figure quoted is of beef cattle, and hence cannot be used for comparison purposes. For Pakistan and Bangladesh, the figures have been estimated from adult stock of male cattle and buffaloes, and the data refer to the period 1955 for Pakistan and 1948 for Bangladesh.

(Source: Handbook of Agricultural Statistics, Government of Pakistan, Planning Commission, June 1964, Table 73).

Data on the number of tractors and garden tractors (average for years 1961-65) in each country have been taken from Table 125, Fao Production Year Book, Vol.29. Total horse power has been estimated at the rate of 30 H.P. for a power tractor, 5 H.P. for a garden tractor. The figures do not include irrigation pumps and other mechanical equipments.

Conclusion

19. The facts and arguments presented in this note are evidently not adequate to provide a satisfactory explanation for the vast differences in labour intensity of agriculture among Asian countries. While they suggest that, besides the extent of irrigation development, climatic factors and the immense variations in the use of animal power might be important factors, no definitive conclusions are possible at this stage. Even at the level of macro comparisons, it is essential to consider the extent to which the prevalence of tree crops affect the relative position of different countries in terms of number of agricultural workers per hectare. And we have to explain such apparent oddities as Japan and Bangladesh. This cannot be done without more data on the levels and pattern of use of different inputs, their inter-relations inter-se as well as with overall productivity of land. Such comparisons could be especially illuminating if they related to regions with broadly similar climate, irrigation development and crop pattern. Comparative studies of the intensity of labour and other inputs for particular crops across countries and regions within a country will be useful. These are the directions in which we intend to pursue the study in its subsequent phases.

NOTES

1/ Ester Boserup, The Conditions of Agricultural Growth, (George Allen and Unwin, London, 1965), Chapters 3, 4, and 5

2/ [illegible], Economic Development in Asian Perspective (Kinokuniya Book Store Co., Tokyo, 1967).

3/ Ishikawa notes (see footnote on p.218) that wide differences in the "definition of the working day", but gives no clear indication whether the figures of labour days used in his analysis adjust for these differences.

4/ The basis for computation of man-days of work done by males, females and children in different countries are not indicated by Ishikawa. He only refers to Taiwan data where female work is converted to adult male work in the ratio of 0.8 to 1 (ibid.)

5/ A scrutiny of data in Table 3-2 (pp.226-227) of Ishikawa's book shows that in the case of India, the labour input figure relate only to crop production. The inclusion of labour used in animal husbandry makes a substantial difference: as against 115 working days for Madras, the figure of total labour input in all crops used in 1964 the comparable figures for West Bengal are 193 vs. 137 working days respectively.

6/ Among the countries studied by Ishikawa, differences in crop patterns are reflected in part by the proportion of area under paddy. The latter varies from around 20-25 per cent in India and China to around 45 per cent in Taiwan. Another important difference would seem to be in the proportion of area allocated to tuber crops - the latter being considerably more important in East Asia.

7/ In Sri Lanka in 1959 [illegible] of the arable land under perennial crops (Source: FAO, IMF, op.cit., Sri Lanka in 1959 and 61 per cent of the total area under plantation crops. Source K.D. Snodgrass, "Ceylon: An Export Economy in Transition" (R.D. Irwin Inc., Illinois, 1966) p.49.

8/ In Sri Lanka, more than 70 per cent of the production of rubber [illegible] Ten crops from the Plantations sector. In Malaysia, plantations account for more than 50 per cent of the production of rubber. Source: Asian Development Bank, Asian Agricultural Survey (1969), p.392.

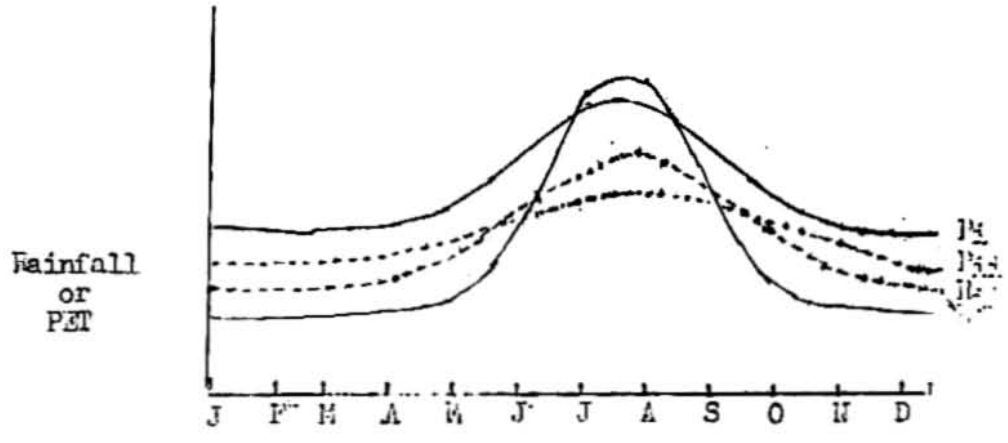
9/ Since different crops occupy the land for varying periods [illegible], a more refined measure would be in terms of [illegible] area of arable land,

$$\sum_{i=1}^{n} \frac{\text{area under crop } i \times \text{number of months for which it occupies the land}}{\text{arable land}}$$

[illegible] would be important when the proportion of [illegible] to perennial crops (e.g. sugarcane) is [illegible].

10/ This figure, representing the average distribution for the country as a whole, is taken from GOI, Ministry of Agriculture, Indian Agriculture in Brief, (11th Edition) 1971, p.17.

11/ The basis for the argument can be explained in terms of the following diagram.



The R curves represent the seasonal distribution of rainfall and the P curves relate to evaporation in different parts of the year. The rainfall region R_1 is marked by a high degree of seasonal concentration while R_2 represents a more evenly distributed seasonal pattern of rainfall. While the shape of both P_1 and P_2 are similar P_1 is consistently higher and is meant to capture the effect of differences in mean temperatures. While the curves are not drawn to scale based on actual magnitudes of precipitation, temperature etc., the two sets of curves (namely R_1 P_1 and R_2 P_2) can be taken as stylised approximation of the pattern typical of India and South East Asia respectively.

Since PET sets the upper limit for plant water requirements, the difference between P and R at each point of time gives a measure of the moisture deficits which have to be met by irrigation if healthy crop growth is to be sustained. Typically, in both situations the moisture deficits are relatively low in the winter months and rise to a peak in the summer; during the rainy season, natural rainfall is more than adequate to meet plant water need, but deficits emerge again once the rains are over. The important thing however is that the deficits in situation 1 (corresponding to India's) is persistently higher than in situation 2 (East Asia). It can be easily seen that this is due to the fact that in situation 2, the precipitation in summer months is appreciably higher even as the PET is lower than in situation 2.

...22/-

Clearly the amount of water to be provided by irrigation to sustain healthy crops in situation 1 is much higher than in situation 2. This would mean to imply that the productivity of irrigation in the former situation (or contrariwise, the penalty by way of loss of output due to a shortage of water) during the drier months is also larger. If this is a correct reading, it seems likely that the conflict between individual and collective interest in the optimal use of limited irrigation supplies will be much more severe in the Indian situation compared to East Asia.

12/ Wang Chao, Agricultural Production in Communist China: 1949, op.cit., p.124.

13/ In 1968-69 out of a total net irrigated area of 29 million hectares the area under government canals was 10.9 million hectares; and of the 8.1 million hectares addition to irrigated area between 1950-51 and 1968-69, 3.7 was from the latter category of works; Government of India, Ministry of Finance, India: Pocket Book of Economic Information, 1972.

14/ Data regarding the stock of draught animals are not readily available for some of the countries, especially for Japan and China. However, some recent farm surveys show that the level of animal labour input per hectare related to human labour is very small in East Asia. The ratio of animal labour days to human labour days was 1:23 in Taiwan and Korea (See Department of Agriculture and Forestry, Provincial Govt. of Taiwan, Report of Farm Record Keeping Families in Taiwan, October 19[illegible] and Republic of Korea, Ministry of Agriculture and Forestry, Report on the Results of Farm Household's Economic Survey and Production Cost Survey of Agricultural Products (1971). The pattern is apparently typical of both China and Japan.

15/ The Chinese case also needs explaining because despite the high levels of cropping intensity, fertilization and labour use, product per hectare is nowhere as high as in Korea, Japan or Taiwan. It should be noted, however, that, we cannot be as confident of the data relating to China as in other countries.