P A R T - I

INDIAN AGRICULTURE AND ITS PROBLEMS :

THE STATE-OF-THE-ART FROM THE VIEW POINTS OF ERGONCMICS.

1. INTRODUCTION

From time immemorial, agriculture has played a vital role in the working life of human beings, especially the people of India. Improvement in agriculture is a must, due to the increase in population, so men attempt to adopt newer methods to solve different problems connected with it using fertilizers, high yeilding varieties of seeds, pesticides etc. Now-a-days, efforts from different disciplines are being made to improve the agricultural work, to simplify the working methods, and to minimize time and human labour with the use of modified implements suitable for the workers. These aim at increasing productivity, workers' safety, health, welfare and comfort.

2. INDIAN AGRICULTURAL STATUS

Even today, the economy of India is based on agriculture. India possesses a total area of 329 million hectares approximately, which is only 2.5% of the total land area of the world, whereas 16% of people of the world live in this country. Sixty-three percent of the economically active population of India are engaged in agriculture (1-3) and 46.9% of the total land is used in cultivation. The remainder 53.1% of the land is unsuitable for cultivation as would be seen in Table -1.

2.1 Annual Agricultural Production:-

There are varieties of agricultural produce, e.g. cereals, pulses, jute, herbs and shrubs, horticultural goods, tea, etc. Among them only paddy and tea have been considered in the present investigation.

2.1.1 Paddy Production:-

Inland economy of unorganised agricultural sector of rural India stands on cereals, which is the main crop.

TABLE - 1

Utilisation of Land Property in India (1978-79)

Utilisation of land	Amount of land (10^7 Hectares)	Total land (%)
Geographical area	32.88	-
1. Cultivable land	14.29	46.90
2. Forestry	6.74	22.12
3. Land unfit for cultivation	3.93	12.90
4. Uncultivated land	5.51	18.08
Total land fit for use	30.47	100.00

Unfortunately, the production of major cereals, e.g., rice, wheat, and maize, of 1082, 1437 and 970 Kg. per hectare respectively, is meagre in comparison to the world average of 2750, 1973, and 2988 Kg. per hectare as revealed by the statistics of 1979-80 (1). In 1980-81, the total paddy yield in India was 20% of the total World yield, whereas in China it was 35% (4).

In 1982, although India was the second best in paddy production, and the net yield of paddy per hectare increased to 2049 Kg., this was less than world's average of 2750 Kg. as shown in Table - 2 (4). It is known that, cultivation through the multiple-crop-system is used in India, whereas the single crop system is generally used in several highly productive countries (3).

Net food crop produced in India in 1984 per head per day was only 438 g., as would be evident in Table-3 (2,3), whereas it is expected to increase the level to 500 g. (2, 4). To meet our national demand we need more crop production, ways to be find out.

Of the cereal crops produced in India, rice is the staple food used in Eastern India. In West Bengal, Bihar, Madhyapradesh, Orissa, Utterpradesh and Assam (i.e. the Ganga - Brhamaputra valley area) and the coastal areas of Andhrapradesh, Tamilnadu, Kerala and Maharashtra, it is also the main cultivable crop as shown in Fig. 1, (2, 3). Punjab, Hariyana and Northern Rajasthan also produce paddy due to the recent availability of relatively high irrigation facilities and yield more per hectare of cultivable land.

2.1.2 Tea plantation:-

Among various Indian agricultural commodities, tea is produced by the organised sector. It has a great role

TABLE - 2

Comparative Productivity of Paddy per Hectare in different Countries of the World in Kg. in 1981 - 1982.

Countries	Productivity
India	2049
Gabs	7000
Spain	6316
Korea	6000
Egypt	5752
Kenya	5714
Australia	5330
Italy	5140
Japan	5128
Morisus	5000
America	4935
Russia	4217
China	4163
World average	2750

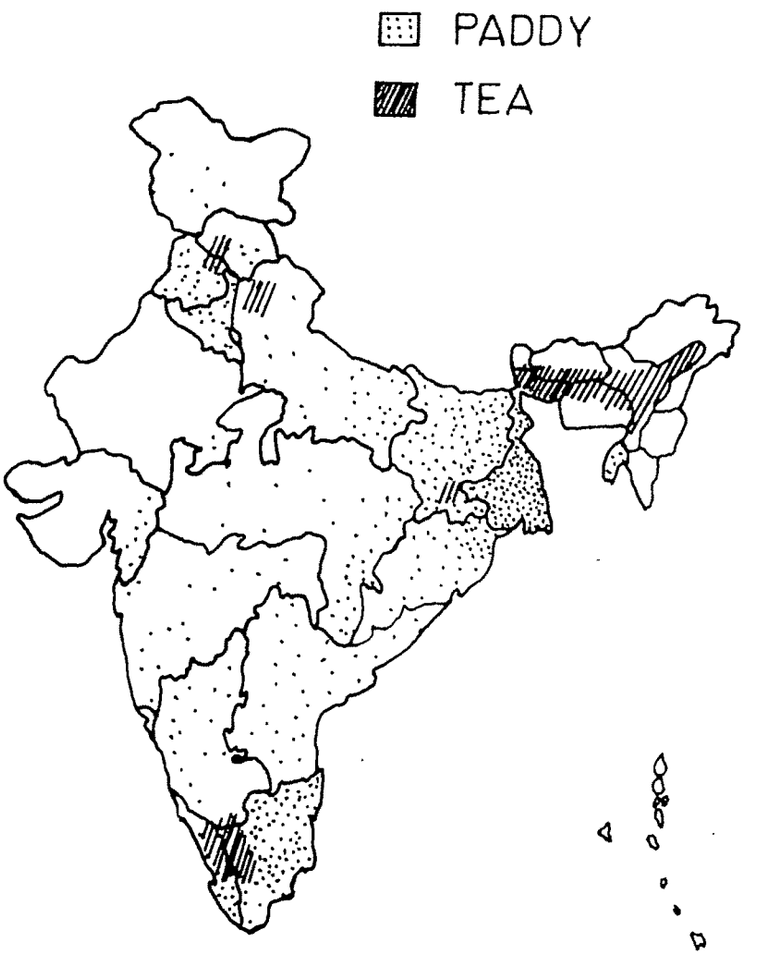

FIG. 1

TEA AND PADDY PRODUCING AREAS IN INDIA

in India's foreign trade. The 145 year-old Indian tea industry, accounting for 30% of global tea exports, produced 1503 Kg. of tea per hectare in 1983-84 (2, 3). Tea production in India as shown in Table 4 is now gradually increasing. Eighty percent of Indian tea of high quality is cultivated mainly in hilly regions of West Bengal and Assam, in the North-East area of India and also in South India, e.g., Nilgiri hill areas of Tamilnadu and Kerala. In recent years, Ranchi, Hazaribag, Purnia of Bihar, Almora of Garwal of Uttarpradesh, Kangra valley of Punjab and Kurg area of Karnataka also became tea producing areas (2), as shown in Fig.1.

2.2. Irrigation and Other Water Resources :-

Rice and tea cultivations in India mainly depend on rain water. The inadequacy of irrigation facilities hampers the cultivation (5, 6). The rain fall in cultivable areas varies from 750 mm to more than 3000 mm in a year, Fig. 2. In the plains, 50% of the land is subjected to floods. Most of the remaining land in the plains and substantial fractions of most of the hilly districts are prone to droughts. There is plenty of ground and surface water in the plains (7) and very little in hilly regions comprising foothills, subplateaus and plateaus. Inequality of irrigation facilities in different parts of India could be observed. The ratio of the irrigated cultivable land area of Eastern and relatively economically advanced Northern India (Punjab) is about 1 : 3 (1, 8).

Ground-water potential and its imbalance use as shown in Fig.-3 creats a maldistribution of irrigation throughout the country.

Recently progressive farmers have been using the ground water by means of shallow or deep tube-well with

TABLE - 3

Increase of Population and Food Crops Production in India

Year	Population (10^6)	Yearly Increment Rate of Population (%)	Food Crops Production 10^9kg	Yearly Food Crops Production Increment Rate (%)
1950-51	361	1.33	55.0	2.8
1960-61	439	2.16	82.0	4.9
1970-71	548	2.48	105.0	3.0
1980-81	685	2.23	129.6	2.2
1983-84	700	-	151.0	5.5

TABLE - 4

Production of Tea in India

Year	Land (10^5) Hectare	Total Production (10^8kg)	Production per Hectare (Kg.)
1950-51	3.14	2.75	875
1970-71	3.54	4.19	1182
1979-80	3.74	5.52	1476
1980-81	3.78	5.75	1521
1983-84	3.93	5.91	1503

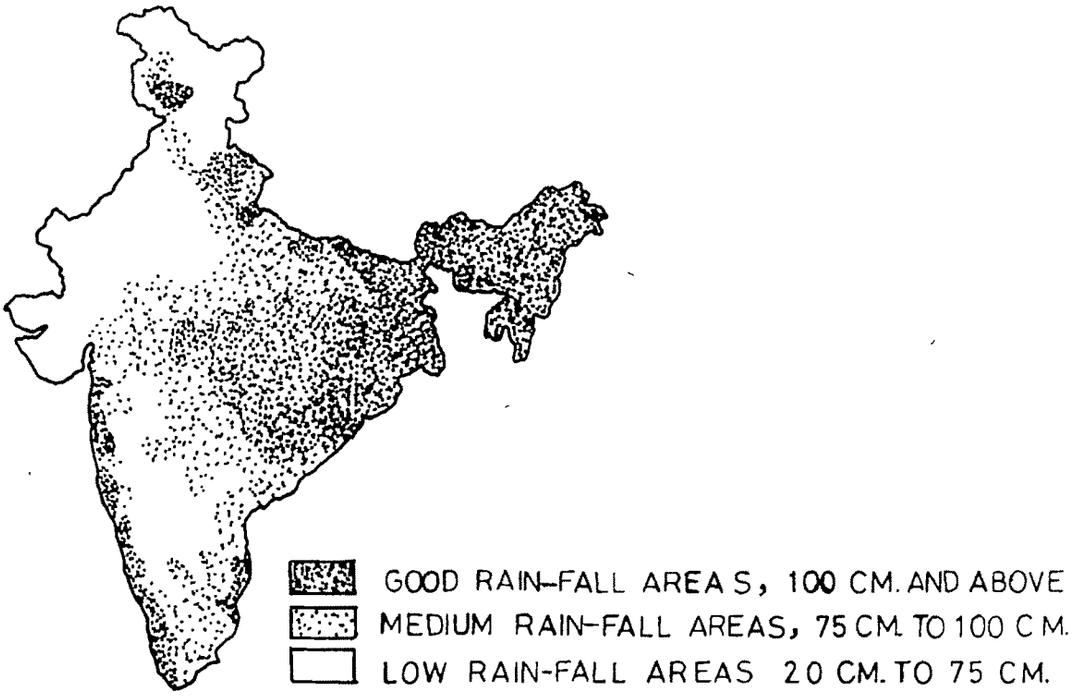

FIG. 2. YEARLY RAIN FALL DISTRIBUTION IN INDIA.

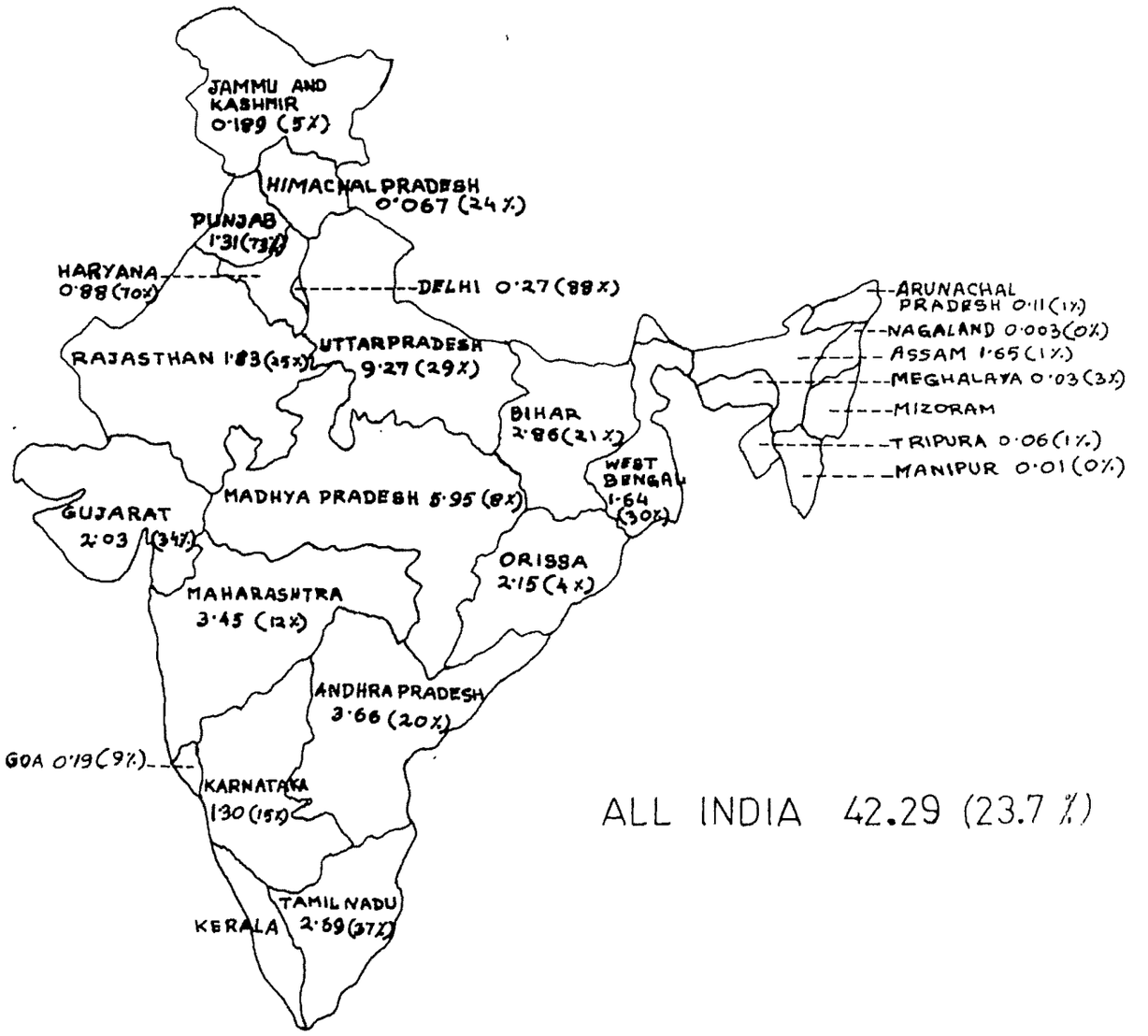

FIG. 3. GROUNDWATER POTENTIAL AND ITS USE
STATE WISE USABLE POTENTIAL IN 10^6 HECTARE-METRE AND WITHIN PARENTHESES ITS PERCENTAGE OF USE.

the financial assistance from the Government (9-12). It was observed that due to unplanned water use, wastage of irrigated water and gradual lowering of the ground water level produce even scarcity of drinking water in summer seasons. This is a great problem in rural Eastern India.

Improvement of planned irrigation facilities (13,14) in Eastern India as well as distribution of wells throughout the country will increase our national productivity. Rain dependant single crop (15) yielding areas thus could be transferred into multiple crop areas.

2.3 Comsumption of Plant Nutrients :-

The consumption of plant nutrients (Nitrogen + Phosphorus + Potassium), is very low in Eastern India. It is 18.1 Kg. per hectare of gross croped area as compared to 74.8 Kg. per hectare in Northern India and 44.3 Kg. per hectare in Southern India (1).

2.4 Tools and Implements Used :-

The use of indigenously made different varieties of nearly primitive type of tools and implements (16) and the use of animals are the main basic facilities in Indian agriculture. The suitability of accepting capital-intensive machines in the field is now not preferred and the cause is discussed in Part - II of this thesis. A general survey of implements being used at present in rural Indian agriculture is presented in Part - IV of this thesis.

2.5 Energy and Power :-

Most of the motive power used in agriculture in India comes from animal power, e.g., bullocks and buffalos (17), and manpower by the use of muscles. 80 million Indian

work animals (of which 70 million bullocks and 8 million buffaloes) produce 40,000 Hp or about 30,000 mw, approximately equal to the installed capacity of electric power generation in India. Investment for this power generation capacity is Rs.30,000 crore where as total investment in work animals with the associated infrastructure is Rs.10,000 crore (18). Electrification and the use of machines are found mostly in urban areas, and very little in rural areas. The uses of atomic energy (19, 20) and solar energy (21) in agriculture are now being experimented upon.

2.6 Poverty Amongst Agricultural Workers :-

It is highly unfortunate that the agricultural workers those who are growing food for all are themselves starving. They are living in dire poverty (22, 23), with an average yearly income of Rs. 8.41 (about U.S.$ 0.75) per day per agricultural worker, working on a daily wage basis. Daily wage rate in term of Kg. rice in the year 1977 - 78 in India was 1.81 (1.44 - 2.68) Kg. and till now it is not much increased. In relation to the typically large family size, this is not sufficient to provide full meals to every member. Population per square kilometer of cultivable land in East and South-east Asia, e.g., in Indonesia in 1977 was 731 and in Phillippines it was 563, which are higher than that in India, i.e., 367. Yet the wage rate observed is higher than that of Indians (23). A survey on Indians' present status is discussed in detail in Part - II, 5.2 and 5.4 sections of this thesis.

2.7 Future Improvements and Mechanisation :-

A great deal of Indian agricultural activities in the near future will depend on the development of Eastern India as such (1). The improvement through mechanisation

in agriculture as employed in advanced and developed countries, is unlikely to change throughly. More productivity in agriculture through mechanisation is attained in North-West India. In Eastern India, however cultivable land is not so suitable for fully mechanised agriculture for several reasons. The cultivable land of Eastern India is possessed by a large number of poor farmers, share croppers and feudal land owners (1). The deplorable socio-economic conditions of the people living on widely divergent soil and water resources, high frequencies of natural calamities, etc. in Eastern India as well as in whole India. Attempts to use newer technologies to solve various problems in different ways are being made. Uses of high-yielding varieties of seeds (24-26) and modern fertilizers (27, 28), electrical and diesels pumps, manual pumps for irrigation, pesticides, multiplication (18) and rationalisation of inputs, improvements in storage and marketing, and modern transport systems are gradually being introduced in the recent years.

2.8 Man-Machine-Environment Relationship :-

However, it is very unfortunate that, 'Man' one of the most important component in the man-machine-environment system in agriculture is being neglected in developing countries like India (29-31).

3. PRINCIPLES IN ERGONOMICS IN RELATION TO THE DEVELOPMENT OF INDIAN AGRICULTURE :-

There are some Ergonomic principles which can promote Indian agriculture considering man as an important component of the system.

3.1 Ergonomic Principles :-

"Ergonomics is a multidisciplinary subject dealing with Science, Technology and Art of Man-at-Work" (29, 31). It

takes recourse to optimization of "Man-Machine-Environment System". The aim is to enable man to work with optimal physical and mental comfort, to use one's senses most effectively in order to get the best productivity and improve the quality of working life, prosperity of economy, and extension of life span.

The subject deals with the reduction of physiological cost of work, betterment of work methods, working conditions, minimization of occupational hazards, improvement of design of implements and machines for users, betterment of quality and quantity of production, improvement of workers' safety, health and welfare (29 - 37).

3.2 Scope of Ergonomics in Indian Agriculture :-

Indian agriculture mainly depends on man, animal and conventional work methods and implements. Due to the huge population of India, ergonomics has great potentialities in the proper utilisation of human resources. Ergonomics principles are concerned with promoting efficiency in work methods, the design of implements and machines, to improve workers' performance, to suggest the optimal working conditions, etc. There is immense scope for improvement in Indian agriculture through the application of ergonomics principles. If a small improvement could be made in the field of agriculture there would be a great deal of total benefit when we consider the huge population of India.

To our knowledge, such studies on Indian agriculture are very few. The majority of the farmers are not able to purchase costly, heavy and sophisticated machinery which needs a large capital. Small land holdings and small divided plots of land are not suitable for mechanisation (1 - 4, 18). The above, tends to improve the existing methods of work, implements etc., through

the application of ergonomics, so that it can minimize the overall demands of the tasks within allowable limits and to increase the overall output.

4. OUTLINES OF RESEARCH WORK IN ERGONOMICS IN INDIAN AGRICULTURE :

Some research work on work physiology and ergonomics on Indian agriculture had been reported. In 1965 Rao and Saha (38) worked on some general problems for a few Indian agricultural workers. Ramanamurthy and Belavedy in 1966 (39) worked on energy expenditure of a limited number of agricultural workers. These works have been sporadic and scanty. They observed eight agricultural tasks and found the puddling and bund trimming were the heaviest agricultural work. In 1976 Sen, et al. (40) undertook first ergonomics study on tea plantation but it was restricted to males only. Latter studies on female tea-pluckers are presented in this thesis. Venkatakrishnan (41) studied work measurement on tea leaf plucking operation, for management purposes in the year 1977. Sen, et al in 1978 (42) determined some work load on a few agricultural workers engaged in different agricultural tasks. In 1977 Sen, et al. (43) worked on biotechnological aspects of manual water lifting arrangement. Nag, et al. in 1978 (44) estimated O_2 uptake in relation of age and sex of some agricultural workers. Sen and Pradhan in 1978 (45) did an ergonomic evaluation and design on different types of spades ('Kodali') used in agriculture as well as in other fields. Sen and Ghosh in 1977 (46), Sen and Mazumder in 1979 (47) had modified designs of an agricultural hat for personal protection of the workers against solar radiation. Nag and Dutta in 1980 (48) took an ergonomical approach to improve Indian agriculture by measuring cardio-respiratory efficiency on a few workers of Western India engaged in

some specific agricultural tasks. In 1984 De (49) submitted the thesis work on some Indian agricultural workers of Eastern India regarding different problems on occupational health hazards, as well as postural consideration in some selective tasks, e.g., ploughing (50), sheafing (51) transplantation etc. in paddy cultivation. National Institute of Occupational Health in 1976 - 77 (52, 53) had investigated occupational workload in relation to working climate and human factors in Indian agriculture in Western India. Nag et al. in 1980 (54) determined occupational workload on some selective agricultural tasks, covering the whole paddy cultivation cycle in western part. In this study of 25 agricultural tasks, land levelling, fertilising and cutting crops, etc. were the lightest jobs and ploughing, waterlifting, bund trimming (wetland and dryland), threshing of paddy pennacles using a pedal threasher, etc. were the heaviest jobs in agricultural work. Sen, et al. in 1982 (55) carried out an ergonomic study of different tasks performed by Indian paddy cultivation workers for improvement of productivity. An investigation based on Physiology was carried out on human performance of the workers applicable to agriculture by Alvi in 1971 (56). Nag and Chatterjee in 1981 (57) worked on females who were engaged in agriculture. In 1980 an assessment of work load on some agricultural tasks was carried out by Tonlinson (58). Yadav in 1985 (59) mentioned the role of ergonomics in crop production for national development.

5. CONCLUSIONS :-

From the above discussions it may be concluded that a great deal of the future of Indian agriculture depends on the development of Eastern India also. Extensive surveys, critical observations and attempts for betterment by the application of Ergonomics principles may be made

considering the present agricultural and economical state of Eastern India as well as that of the whole of India.

6. SUMMARY

The present day Indian agriculture in relation to other developing countries is not modernised. Within the country there are imbalances of agricultural intensity at different places, e.g., North-Western part is more progressive than Eastern part. As a whole, India in relation to her total area is thickly populated. Till now she uses mainly rain as water resources, primitive types of tools and animals' and human muscular power as energy resources. The main operator in Indian agriculture - "Man", is still remaining neglected. To increase worker's efficiency, productivity, safety as well as welfare the application of Ergonomics principles may fulfil the long cherished overall goal of the people of India.