

Full Length Research Paper

Farm mechanization status of West Bengal in India

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Accepted 29 December, 2012

Introducing the second Indian Green Revolution to full fill our future food requirements to benefit the small, medium and large size farms needs farm mechanization. The average cropping intensity is 182% in 18 agricultural districts of West Bengal, which is 33.8% higher than the country average. Farm mechanization enhances the production and productivity of different crops due to timeliness of operations, better quality of operations and precision in the application of the inputs. A number of suitable improved tools, implements and machinery were identified, developed and tested by IIT Kharagpur to bridge the existing mechanization gap for major cropping patterns of West Bengal. The popular and effective machinery for paddy and potato cultivation in the State has been in use among the farmers. Front line demonstration and custom hiring services of IIT Kharagpur showed that farmers were more interested in self propelled paddy transplanter, cono weeder, vertical conveyer reaper and flow through paddy thresher in paddy crop and semiautomatic and automatic potato planter and potato digger in potato.

Keywords: Mechanization, paddy-potato cropping pattern, custom hiring, front line demonstration.

INTRODUCTION

West Bengal is the fourth largest economy in the country with the net state domestic production at factor cost of 3080 billion (Source: CSO, March 2012). Agricultural accounts for 27% of the State economy. About 75% of the population in West Bengal resides in rural areas. The farmers cultivate their ancestral lands mainly by family labour. The average cropping intensity is 182% in 18 agricultural districts of West Bengal, which is 33.8% higher than the country average. About 47.6% labours are engaged in agriculture. Distribution of land holdings of the State is shown in Figure 1. The general information available from Directorate of Agriculture, Government of West Bengal indicates that West Bengal is the leading producer of paddy and second largest producer of potato (30% of country's production) in the country. Paddy potato cultivation is one of the major economic activities, and improving the productivity of paddy and potato crop and rational use of inputs may lead to a boost in the economy of the state. With paddy primarily being a wetland crop, not many machines had been used earlier (Bora and Hansen, 2007). However, an in-depth analysis-aiming to boost paddy crop production through prospective mechanization-is a prerequisite for attempt of mechanization. This will require a suitable mechanization program. Mechanization planning requires the

quantitative assessment of a mechanization index, and its impact on agricultural production and economic factors like cost of cultivation, deployment of animate and mechanical power, and economic advantage (Singh 2006). Introduction of suitable machinery in place of manual cultivation practices would definitely increase the production and productivity in the State of West Bengal. The lack of mechanization is one of the causes of such delays in paddy cultivation. Similar reductions were also reported due to inadequate land preparation and irrigation. In another study concerning energy management in paddy cultivation in West Bengal state of India, Chauhan et al. (2006) reported that better use of power tillers and introduction of improved machinery could improve the efficiency of energy use and thereby improve the energy productivity of paddy production system. Thus the objective of the present study was to suggest the complete mechanization solution and future strategies for paddy-potato cropping system in West Bengal.

Farm mechanization

Farm mechanization may be viewed as package of

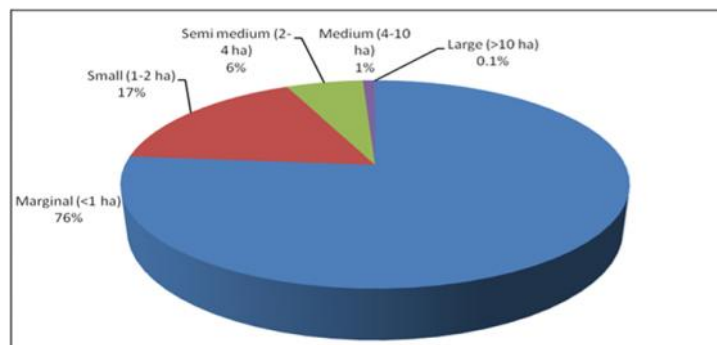


Figure1. Status of land holdings in West Bengal

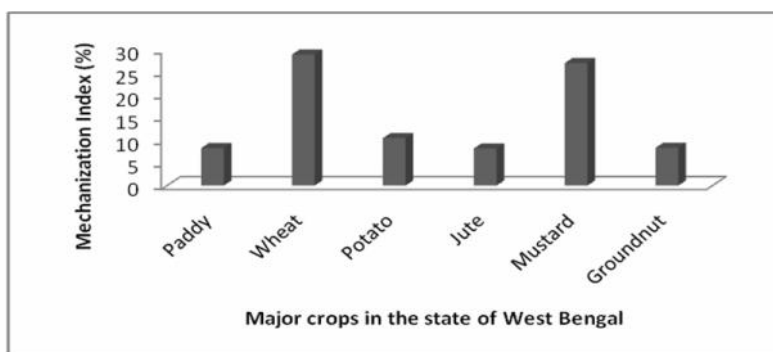


Figure 2. Mechanization index of major crops in West Bengal

technology to ensure timely field operations, increased productivity, reduced crop losses and improved quality of grain or product. Farm machines have not only increased the mechanical advantage, but also helped to reduce drudgery while performing the different agricultural operations. The contributions of agricultural mechanization in various stage of crop production could be viewed as saving in seeds (15-20%), saving in fertilizers (15-20%), saving in time (20-30%), reduction in labour (20-30%), increasing in cropping intensity (5-20%) and higher productivity (10-15%). The general information available from Directorate of Agriculture, Government of West Bengal indicates that West Bengal state is the leading producer of paddy and second largest producer of potato (30% of country's production) in the country. Farm power availability in West Bengal is 1.25 kW/ha, which is less than average farm power available on Indian farms (1.35 kW/ha). Mechanization index of major crops is given in Figure 2.

METHODOLOGY

Selection of study area and type of crops

The state of West Bengal, which is considered for the study, is a poor farm mechanized region of the country.

The state is in eastern part of India and is divided into four agro-climatic zones. The availability of human resources and cultivable areas of different productivity groups of paddy potato cropping systems in villages of each of the agroclimatic zones are considered for the study. Therefore, the technology, machinery and strategies selection of the present investigation is based on important crops grown in West Bengal. Use of appropriate machinery is very essential for the betterment of cropping pattern and attracting the newer generation to farming sector.

Present Status of Important Crops and Available Farm Machinery

Among all food and cash crops in West Bengal, paddy, potato, jute and oilseed crops play a dominant role. West Bengal has gross cropped acreage of more than 9.52 million hectare out of which net cropped acreage 5.37 million hectare is under paddy, jute, potato and other major food crops. The paddy production was 10.134 million tons in 2006-2007. Other major cereal crops include wheat, which accounted for 0.0144 million tons. Potato ranks second under cultivation in West Bengal after paddy. The major oil producing crops include sesame, groundnut, and mustard in the State. The



Figure 3. Effective machinery for paddy cultivation

individual status of different crops is described below.

Paddy

The State of West Bengal ranks first in area and production in country for paddy cultivation. About 78% of total area under rice in the state is concentrated under high and medium productivity groups, which accounts for nearly 84% of total production of paddy in state. Paddy is grown in three cropping seasons namely Aus (April-mid July), Aman (July- November) and Boro (December-March). Average productivity of paddy in state is 2259 kg/ha against 1947 kg/ha average productivity of country. The mechanization index for paddy crop is about 8.27 and the average cost of production is 13084/ha. Use of paddy transplanters has been on an increasing trend in the State due to shortage of labour. In and around IIT, the farmers have come forward for adoption of transplanting with self-propelled paddy transplanter. Vertical conveyor reaper is another such machine which has been taken up on a wider scale by the farming community. Other equipment like, paddy weeder and paddy thresher also being used by the farmers. The human labour cost is 4503/ha (34.4%), largest component in the cost of production. Animal and machinery costs '929 (7%) and 490 (3.7%) per hectare respectively. Popular and effective machinery for increased production in paddy cultivation for West Bengal farmers are presented in Figure 3. Farmers responded that, awareness creation and machine availability can increase the demand of machinery in crop cultivation especially in case of paddy crop.

Wheat

The contribution of West Bengal in wheat production is

minimal. Percent share of normal area under wheat is about 1.45 and production is 1.24% when compared with national level. With regard to productivity, State ranks fifth (2321 kg/ha). Energy consumption for wheat production is about 13139 MJ/ha to achieve average yield. The mechanization index based on cost of use of machinery for wheat crop is maximum (29.0) and average cost of production is '12523/ha. Harvesting and threshing of wheat crop is done effortlessly by vertical conveyor reaper (tractor/power tiller mounted, self propelled), reaper binder, combine harvester and different types of wheat threshers. Important machines for wheat cultivation, optimum for West Bengal conditions are shown in Figure 4.

Potato

In India, more than 80% of potato crop is raised in the winter season under assured irrigation during short winter days from October to March. West Bengal ranks number two in terms of potato production after Uttar Pradesh. 6% percent of potato produced in West Bengal is grown in two adjacent districts viz., Bardhaman and Hoogly. Total land in the State under potato cultivation is 0.352 million hectare and total production 7.076 million tonnes with average production of 22.23 tonnes/ha. The mechanization index for potato crop is 9.23 and average cost of production is '24535/ha in the state. Recently, tractor drawn automatic potato planter, tractor drawn potato digger cum elevator etc. have been introduced in the State. The best possible machinery for better cultivation of this crop is shown in Figure 5.

Mustard

Mustard and rapeseed have been traditionally important



Figure 4. Effective machinery for wheat cultivation



Figure 5. Effective machinery for potato cultivation



Figure 6. Machine for mustard cultivation

oil seed crops in the state. The production is found to fluctuate in the range of 0.25Mt. The mechanization index for Mustard crop is 17.02 and average cost of production is '9019 /ha in West Bengal. The human labour cost is '2226/ha (24.7%), largest component in the cost of production. Animal and machinery costs are '344 (3.8%) and '954 (10.5%) per hectare respectively. For sowing of mustard seed, use of pneumatic planter and inclined plate planter in place of broadcasting is beneficial. Reaper cum binder and improved sickle increases field capacity at the time of harvesting. Following two machines could be well utilized for the increased production of mustard in the farming conditions of West Bengal. Figure 6.

Groundnut

Groundnut is the largest oilseed crop in India in terms of

production. Groundnut accounted for 34.66% of the production of oilseeds in the country. The area in West Bengal under groundnut cultivation is about 0.06 million hectares and production is about 0.05 million tonnes, which is 1.15% of total production. Average productivity of groundnut in state is 870 kg/ha that is higher than the national average of 733 kg/ha. Groundnut planters are helpful for easy sowing in place of manual planting of seeds. Introduction of groundnut digger cum elevator, groundnut digger shaker, and pod stripper in the state is an important step towards mechanization. The mechanization index for groundnut crop is 8.37 and average cost of production is '13977 /ha in West Bengal. The human labour cost is '4099/ha (29.3%), largest component in the cost of production. Animal and machinery costs are '1009 (7.2%) and 466 (3.2%)/ha respectively.

Some important implements for groundnut cultivation are shown in Figure 7.



Figure 7. Implements for groundnut cultivation

Table 1. Crop area under cultivation and productivity in different districts of West Bengal

Productivity group	Districts	Area (000 ha)	Area (%)	Productivity (kg/ha)	Production (000 tons)
Paddy					
Higher productivity	Birbhum, Burdwan, Hoogli, Nadia	1612.2	27	2733	4667.1
Medium productivity	Bankura, DakshinDinajpur, Howrah, Malda, Midnapore East, Midnapore West, Murshidabad, North24-parganas, Uttar Dinajpur	2930.1	50.9	2264	7740.1
Medium low productivity	Cooch Behar, Purulia, South24-parganas	1231.3	17.1	1751	1924.4
Low productivity	Darjeeling, Jalpaiguri	285.1	5	1372	453.2
Higher productivity	Howrah, Hoogli, Nadia	98.4	30.7	26810	535.5
Medium productivity	Bankura, North24-parganas	31.6	10.4	2399.6	777.5
Medium low productivity	Burdwan, Birbhum, DakshinDinajpur, Midnapore West, Uttar Dinajpur	128.2	37.2	21714	2950.1
Low productivity	Cooch Behar, Darjeeling, Jalpaiguri, Malda, Midnapore East, Murshidabad, Purulia, South24-parganas	62.1	21.7	18910	1023.5

Crops and Mechanization Status of West Bengal Farms

Based on socio-economic parameters, it is observed that 41% cultivators fall under low income class; 52% cultivators fall under low middle class, about 7% cultivators fall under high middle class. The current status of major crops like paddy, potato of the state in different districts along with their area, production and productivity is mentioned in the Table 1. The implements used by the cultivators for performing various agricultural operations

are *Desi* Plough, Bose Plough, Leveller, Long Handle spade, Row marker and *Khurpi*. Low income, less land holding, lack of proper infrastructure and inadequate facilities of repair and maintenance for different types of machinery/implements has forced a poor mechanization status to the State. Details of different farm machinery and equipment widely used in West Bengal along with their field capacity, man-hour/ha, and unit cost of operation (₹/ha) are given in Table 2 and also suggested package of implements and machinery for the various crops of the State is shown in Table 3.

Table 2. Implements and tools used for crop production in West Bengal

Tool/Implements	Field capacity (ha/h)	Man hours per hectares	Unit cost of operation (₹/ha)
Bose plough	0.35 - 0.40	25 - 30	820
Khurpi	0.004	250 - 300	2900 - 3245
Row marker	0.06 - 0.19	17 - 20	260
Spade	0.05	128 - 160	1488 - 1860
Sickle	0.03	210 - 240	2325 - 2790
Tractor intensity in West Bengal			4.61 per 1000 ha
Power tiller intensity in West Bengal			5.12 per 1000 ha

Table 3. Suggested package of implements and machinery for the various crops of the State

Tillage machinery	Implement and		Sowing and	Plant protection equipment		Harvesting and
	Seed preparation	Bed		Weeding	Spraying	
Paddy						
M B Plough, Disk plough, Cultivator	IIT Puddler, Hydrotiller, Power tiller, Rotavator, Tractor drawn puddler		Self-propelled paddy transplanter, Drum seeder	Conoweeder, Hand hoe, Wet land weeder	Knapsack sprayer, Foot sprayer, Power sprayer	Vertical conveyor reaper, Reaper binder, Combine harvester, Axial flow paddy thresher
Potato						
M B Plough, Disk plough, Cultivator	Cultivator, Harrow, Rotavator, Power tiller,		Automatic potato planter Bullock drawn Semi automatic potato planter	Hand hoe, Wheel hoe, Hoe cum rack, Power weeder	Knapsack sprayer, Foot sprayer, Power sprayer	Potato digger, Potato digger elevator

(Source: Directorate of Agriculture, Government of West Bengal, Department of Agriculture and Cooperation)

RESULTS AND DISCUSSIONS

Mechanization status of West Bengal farms

Based on the survey conducted on socio-economic parameters and mechanization status of the West Bengal by IIT Kharagpur, it is observed that 41% cultivators fall under low income class; 52% cultivators fall under low middle class; about 7% cultivators fall under high middle class. The implements used by the cultivators for performing various agricultural operations are *Desi* plough, *Bose plough*, wooden leveller, long handle spade, row marker and *Khurpi*. Low income, less land holding, lack of proper infrastructure and inadequate facilities of repair and maintenance for different types of machinery/implements has forced a poor mechanization status to the State. Details of different farm machinery and equipment widely used in traditional practices and improved machinery for West Bengal, their field capacity, man-hour/ha, and unit cost of operation (Rs/ha) are given in the Table 4.

Agricultural Mechanization Strategy (AMS)

An AMS deals with manual, draft animal, and mechanical

power, the utilization of tools, implements, machinery, their supply and maintenance. The strategy may cover importing and domestic manufacture of tools, equipment and machinery, their repair and maintenance, relevant training and extension programs through SHG and NGOs, custom hiring services and promotion of financing systems for the purchase of draft animals and machinery and power source. In present scenario, the dominating philosophy for the development of mechanization is that governments should provide the basic conditions which would encourage private individuals and organizations to take appropriate initiatives and make sound investments to contribute to national development objectives with minimal government interventions.

Role of custom hiring services

In West Bengal, more than 93% of operational land holdings are either marginal (<1 ha) or small (1-2 ha) in size. Investment capacity of majority of the farmers in these categories of land holding is poor. These farmers cannot spend on expensive farm power and machinery. However, they are making use of modern technology like combine harvester, tillage, sowing and planting

Table 4. Improved implement and machinery with field capacity and unit cost of operation

Operation	With Improved Machinery				With Traditional Practices			
	Name of Machinery	Field capacity (ha/h)	Man hours per hectare	Unit cost of operation (Rs/ha)	Name of Machinery	Field capacity (ha/h)	Man hours per hectare	Unit cost of operation (Rs/ha)
Paddy production								
Pudding	IIT Puddler	0.10 - 0.13	20 - 28	785	Bose plough	0.048	54	2412
Sowing	Hydro tiller	0.15 - 0.2	5 - 6	570	Broadcasting	0.25	40	1683
	Drum seeder	0.125	16	325				
Transplanting	Self-Propelled paddy transplanter	0.15 - 0.18	27 - 35	1000	Manual transplanting	0.026	308	5775
Weeding	Cono weeder	0.025	30 - 35	675	Manual weeding	0.04	144	2700
Harvesting	Vertical conveyor reaper	0.20	5 - 6	410	Sickle	0.035	210 - 240	2790
Harvesting and binding	Reaper cum binder	0.25 - 0.30	4	860	Manual binding	0.084	95	1781
Threshing	Axial flow paddy Thresher	0.1 - 0.2	43	1410	Hold on paddy thresher	0.056	142	2678
Potato production								
Sowing	TD automatic potato planter	0.25	12	1845	Row marker	-	730	13687
Weeding	Power weeder	0.076	15	594	Manual	0.004	250 - 300	2900 - 3245
Spraying	Knapsack sprayer	0.11	9	200		0.11	9	200
Harvesting	BD potato digger	0.048	205	4850	Manual	-	1120	12350
	TD potato digger	0.23	34	1310				

Thus incorporation of above listed machinery would help in enhancing the production status of different crops. Knowing the machinery and using it in the proper way is very essential for efficient usage of machinery.

machinery through custom hiring, through private entrepreneurs, SHG, NGO, or co-operatives. This will help to increase annual use of these equipment, thereby making farming economical. Thus, custom hiring of specialized farm equipment for replacement crops can greatly facilitate diversification of production of agriculture as well as to generate jobs for the unemployed youth in the villages.

Role of SHG and NGOs

The mechanization is a costly affair for the farmers of West Bengal as the number of marginal and small farmers is large. The mechanization in the West Bengal can be implemented through the self-help groups through SHG and NGOs. They can be helpful in educating farmers about the new innovations in farm machines. They can also help in transferring the low cost technologies to farmers through their own system of financial funding. A well articulated self help group can reduce the resistance being put by the farm labours and

educate them about the new job opportunities that will come with the implementation of mechanization.

Role of banks and other financial organizations

The farmers were approaching moneylenders to meet their credit demands and paying exorbitant rate of interest. The nationalized banks come as a stimulant for adoption of farm mechanization and establishment of agro service centre through their provision of liberal credit loans. Loans are made available for the purchase of tractors, power tillers, diesel engine, reaper, new improved agricultural machinery and implement package depending on need. They also contribute to the network of custom hiring, sales and services through Agro Service Centers. Other state organizations like Land and Seed Development Corporation, West Bengal Marketing Federations, etc. also have come up with providing valuable technical and financial help to promote the mechanization activity. NABARD provided loans for repairs/renovation of tractors were made available even

during the currency of the earlier loan, irrespective of availment of loan for purchase of tractors. Further, the banks were allowed to extend loan towards the cost of repairs on account of damages caused to the tractors due to accidents. The margin money requirement was reduced for purchase of new tractors and second hand tractors to 5 and 10 per cent, respectively, of the investment cost. Refinance facility for financing purchase of second hand tractors was extended to all states and was made available even in the case of second resale of tractors.

Role of government and private organizations

Government, as a donor organization increases funding for agricultural research and for supporting institutions relevant for small-scale farmers. They implement policy reforms that encourage private and public sector participation in economic activities in accordance with their comparative advantages. Government is focusing on addressing market failures, ensuring competitiveness and quality of support services, protecting the environment and common property resources and promoting balanced regional development. Private organizations are also adopting recommendations to develop micro credit programmes, extension services, education and marketing support for small scale farmers, especially women, the less skilled and the disadvantaged. A cumulative effort of the State government and private organizations in implementing need based strategies in developing the farming sector through effective mechanization of farms of West Bengal would be a convivial signal in achieving the projected production of different crops. This will prosper the farmer and thereby the State to become a significant contributor to the national economy.

CONCLUSIONS

A suitable cropping pattern of crops like paddy, potato helps to increase the productivity of the crop yield in the State. It is to be noted that introduction of implements and machinery would definitely increase the present status of crops for the State. Human resources are inadequate in most of the regions in State to complete transplanting

and harvesting operations in paddy and sowing and digging in potato crop. This indicates the needs of transplanter and harvester machineries for these operations in paddy and automatic potato planter and potato digger in potato crop. Major cost contributions come from initial machinery and prime moves cost in the mechanization options. Technological advancement of tractor and allied machinery manufacturing, policy incentives to encourage manufacturing of quality machinery and some social changes of farm machinery operation through custom hiring and off field works (to increase annual use) would reduce the operational cost. Banks provide term finance to farmers for development purposes and short term loans for production purposes. There is also a need to finance farmers for purchasing machinery, implements to expand new activities like custom hiring service, agro-service center and make existing small and marginal units economically viable. This would enable farmers to diversify their present activities and take up allied activities.

ACKNOWLEDGEMENTS

The authors are grateful to DDG (Engg), and ADG (Engg), ICAR New Delhi, and Project Coordinator of All India Coordinated Research Project on Farm Implements and Machinery for, granting financial assistant and for their valuable guidance during the course of the investigation.

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