Journal of Agricultural Engineering, Vol. 41(1): January-March, 2004

Status and prospects of farm mechanization in Madhya Pradesh

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ABSTRACT

This paper aims to study the status of mechanized farming practices adopted by the farmers for different farm operations of major cropping systems in the state of Madhya Pradesh with the purpose of identifying the existing mechanization gaps for different farm operations and to suggest the possible remedies to bridge those gaps. A total of 360 farmers were selected for collecting information by adopting multiple stratified random sampling technique. It was found that certain operations like weeding and plant protection were carried out by manually operated, low capacity equipment resulting into yield loss due to delay in conducting these farm operations. All of the farm operations except tillage were not completed within the available critical time. This was either due to inadequate use of mechanical power sources and high capacity implements, such as in the case of tillage, sowing, harvesting and threshing operations or due to not using mechanical power such as in the case of weeding and plant protection operations. Improvement of certain existing machines such as bullock or tractor drawn planters, bullock drawn seed cum fertilizer drill for small seeds, rice transplanters and bullock operated potato digger already developed in various research organizations, and development of new machines like self propelled power weeder, spraying attachment to power weeder and small combine harvesters are required to meet the mechanization requirement as expressed by the farmers.

Mechanization in agriculture has enhanced production and productivity of agricultural commodities through timeliness of operation, better management of inputs and reduction of post harvest losses in India. But the level of adoption of mechanized agricultural practices varies widely across different regions in the country. One of the reasons may be attributed to the variation in farm power availability for agricultural operations among different states of India which was found as high as 2.58 kW per hectare in Punjab during 1991-92, expected to reach to a level of 4.03 kW per hectare during 2001-02 as compared to only 0.46 kW per hectare during 1991-92 in Madhya Pradesh, expected to increase to a level of 0.75 kW per hectare during 2001-02 (De *et al.* 2000). The level of adoption of mechanized agricultural practices varies with the cropping pattern followed, agro-climatic and soil conditions and socio-economic status of the users. The state of Madhya Pradesh, located in central part of India, is generally considered as a low mechanized region as compared to North and North Western part of the country. This region, having medium to deep black fertile soil and moderate rainfall (800-1200 mm), occupies total area of cultivable land of 22.11 million hectare out of which 19.87 million hectare area is under cultivation with an average land holding size of 2.63 hectare per farm (Statistical overview of M.P. 1998). The main crops grown in this region are soybean, pigeon pea, pearl millet and rice during rainy season (June-October) and wheat, chickpea, potato and mustard during winter season (November-March). The crops are mainly grown under rain-fed conditions in most of the parts though irrigation facilities from canals, rivers and deep tube wells are also available in some areas.

The available density of farm power sources and agricultural implements is shown in Table 1 and the availability of farm power per hectare of cultivated land is shown in Fig. 1. Most of the farm power for conducting agricultural operations comes from the

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Table 1. Availability of farm power sources and agricultural implements per thousand hectare of net sown area in Madhya Pradesh.

Sl. No.	Name of the power sources and implements	Density (per ,000 ha of net cropped area)
1	Agricultural tractors	8.75
2	Power tillers	0.08
3	Draught animals	575.44
4	Human labourers	1086.58
5	Tractor drawn mould board plough	2.35
6	Cultivators	11.95
7	Bullock drawn wooden plough	223.40
8	Blade harrow	14.95
9	Bullock drawn seed drill	64.32
10	Tractor drawn seed drill	3.61
11	Manually operated hand hoe	54.90
12	Bullock drawn blade hoe	29.55
13	Diesel engine operated pumps	10.08
14	Electric motor pumps	52.34
15	Sprayers	18.45
16	Dusters	4.10
17	Combine harvesters	0.26
18	Threshers	7.90

Source: Livestock Census Report of Madhya Pradesh, 1997 De et al. (2002)

animate sources like drought animals and human labourers but use of tractors for conducting some selected agricultural operations like tillage and sowing is also common among the farmers. Improved farm implements like mould board plough and cultivators for tillage operations, seed drill and seed cum fertilizer drills for sowing, diesel engine and electric motor operated pumps for irrigation and power operated threshers for threshing of crops have been widely adopted by the farmers in this region. Though these mechanized farming practices are being followed by the farmers at different places in the State, the adoption rate of mechanized farm operations is still far from satisfactory and a huge mechanization gap exists resulting into delaying in critical farm operations under acute scarcity of natural and man made resources and subsequent yield losses. Therefore, it is necessary to assess the level of mechanization for different agricultural practices in different agro-climatic regions and identify the existing mechanization gap so that new technologies and implements can be identified for development to bridge this gap. Keeping these factors in view, the present mechanization status for different farm operations in Madhya Pradesh was examined to identify gaps in farm mechanization of different agricultural operations, and to suggest the development of new equipment.

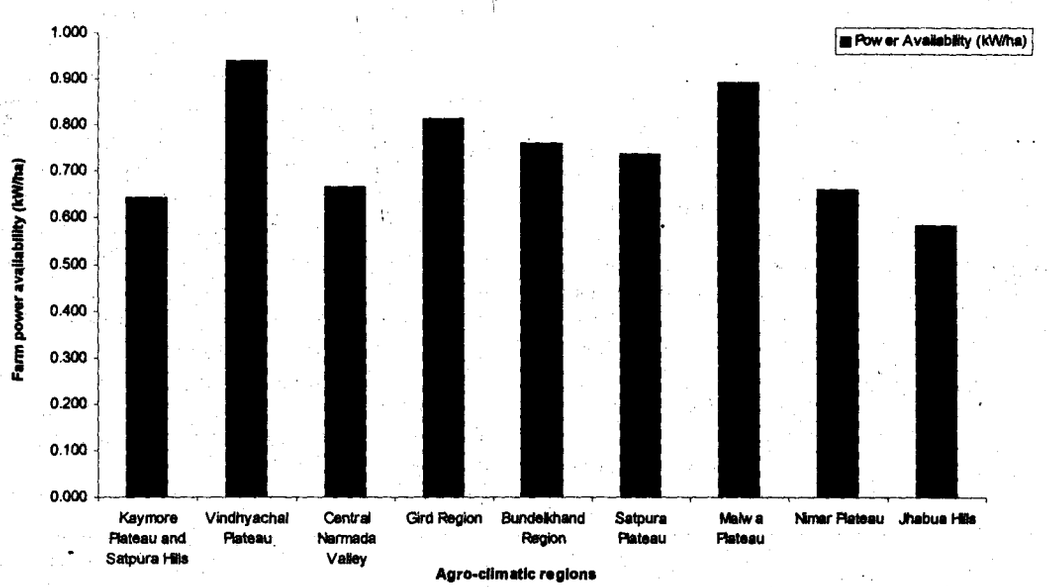

Fig. 1 Availability of farm power in different regions of Madhya Pradesh (KW/ha)

MATERIAL AND METHODS

A survey was conducted during 2000-2001 covering 360 sample farmers' households in nine distinct agro-climatic regions in the state of Madhya Pradesh namely, Kaymore Plateau and Satpura Hills, Vindhyachal Plateau, Central Narmada Valley, Gird Region, Bundelkhand Region, Satpura Plateau, Malwa Plateau, Nimar Plateau and Jhabua Hills as shown in Fig. 2. Multi-stage stratified random sampling technique was used for the selection of sample districts, villages and farmers for the study. At the first stage, one representative district was randomly selected from each region. In the second stage of sampling, two villages were randomly selected from each selected district keeping in view that one of them would be located within ten kilometers and the other would be located beyond ten kilometers from the district headquarter. At the final stage of sampling, 10 % of the farmers' households were selected from each village for the interview. A suitable pre-tested interview schedule was used for collecting the primary data from the sample farmers on different aspects of agricultural operations and farm machinery used through personal interview method with the help of trained field investigators. The secondary data required for this study was collected from different published sources of Directorate of Agriculture, Government of Madhya Pradesh. The collected data were then analyzed for identification of cropping pattern, mechanization practices followed, existing mechanization gaps for different farm operations and new technologies and implements required to bridge the gaps for the State.

The following mathematical formula was used for working out the shortage of time for each agricultural operation.

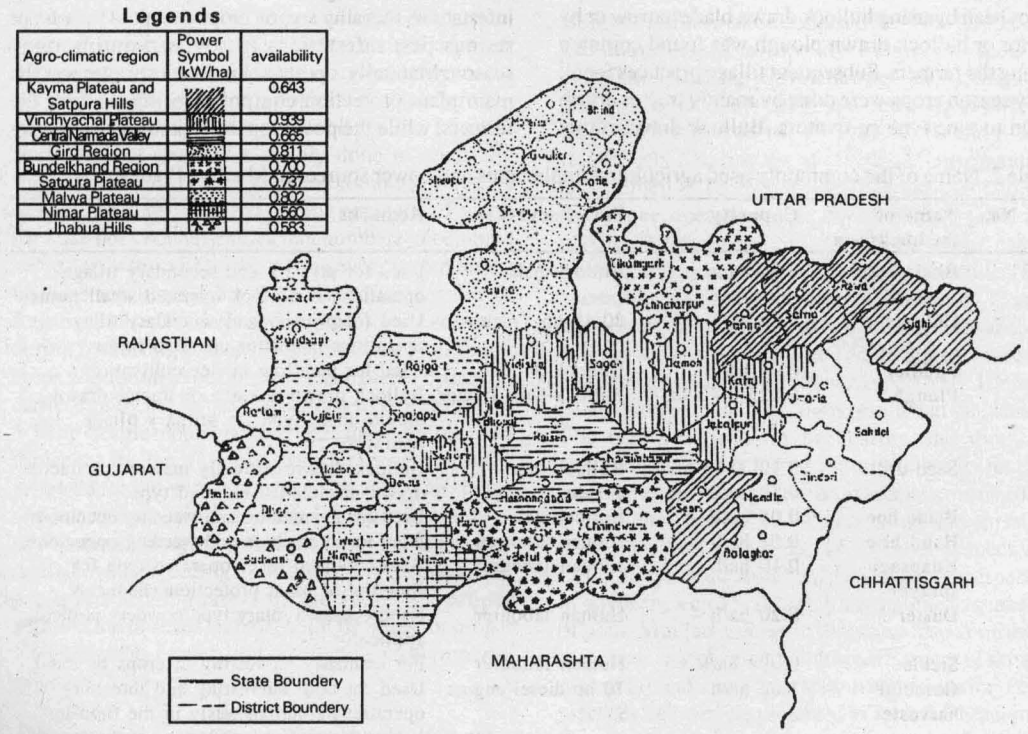

Fig. 2 Agro-Climatic Zones of Madhya Pradesh

$S_j = D_j - S A_{ij}F_{ij}$ (i = 1,2,3.....n) ...(1)

Where,

S_j = Shortage of time for j-th operation

D_j = Maximum time available for conducting j-th operation, days.

A_{ij} = Availability of i-th implement for conducting j-th operation per thousand hectare of net cropped area.

F_{ij} = Field capacity of i-th implement used for j-th operation, ha/h.

RESULTS AND DISCUSSION

Cropping systems and cultural practices

Soybean was the main crop grown along with paddy, sorghum, maize and cotton during rainy season and wheat, chickpea, potato and mustard were the main winter season crops grown in the study area. Among major cultural practices, one or two summer ploughing of the field before or at onset of monsoon for cultivation of soybean by using bullock drawn blade harrow or by tractor or bullock drawn plough was found common among the farmers. Subsequent tillage practices for all rainy season crops were done by mainly tractor-drawn seven to nine tyne cultivators. Bullock drawn rotary type puddlers were used for puddling operation before transplanting of paddy in paddy growing regions of the State. Sowing of seeds was mainly carried out by using bullock drawn manually metered seed sowing devices, commonly known as diphan and triphan, by small farmers and tractor drawn mechanically metered seed drill by medium and large farmers (Table 2). Custom hiring of tractor drawn implements for completing the critical farm operations like tillage and seeding within the limited time available were also common among small farmers in highly mechanized regions. Transplanting of paddy seedlings in puddled seed bed was mainly done by human labourers. The intercultural operations like weeding in rainy season crops were carried out by human labourers using small hand tools but lack of adequate availability of farm labourers during that period resulted into reduction in yield due to higher crop-weed competition for soil moisture and nutrients. Proper plant protection measures were rarely taken up by the farmers against insect pests and disease infestations for rainy season crops except in the case of serious pest infestations in soybean during rainy season. Manually operated knapsack sprayer was the main plant protection equipment being used by the farmers, while the power operated knapsack sprayers

Table 2. Name of the commonly used agricultural implements and power sources in Madhya Pradesh

Sl. No.	Name of the implement	Capacity	Power source	Remarks
1	Blade harrow	0.04 ha/h	Bullock-pair	Used for primary and secondary tillage operations in bullock operated small farms
2	Cultivator	0.50 ha/h	20-45 hp Tractor	Used for primary and secondary tillage operations in tractor operated farms
3	Puddler	0.05 ha/h	Bullock-pair	Used for puddling in rice cultivation
4	Plough	0.025-0.40 ha/h	Bullock-pair/ tractor	Bullock drawn wooden or tractor drawn mould board type for primary tillage operation
5	Seed drill	0.10- 0.15 ha/h 0.50 ha/h	Bullock-pair Tractor	Bullock drawn manually metered or tractor drawn mechanical metered type
6	Blade hoe	0.05 ha/h	Bullock-pair	Used for interculture and weeding operations.
7	Hand hoe	0.01 ha/h	Human labourer	Used for interculture and weeding operations.
8	Knapsack sprayer	0.10 ha/h	Human labourer	Back mounted lever operated type for spraying of plant protection chemicals
9	Duster	0.20 ha/h	Human labourer	Hand operated rotary type powdery pesticide applicator
10	Sickle	0.004 ha/h	Human labourer	For manually harvesting of crops by hand
11	Combine harvester	1.00 ha/h	70 hp diesel engine	Used for both harvesting and threshing operations simultaneously in the field by custom hiring from other parts of the country
12	Thresher	2.5-5.0 q/h 15-20 q/h	5-10 hp motor 35 hp tractor	Electric motor operated low capacity or tractor operated high capacity multi-crop thresher

Table 3. Availability of time for critical farm operations and mechanization gaps

Sl. No	Operations	Maximum time available (days)	Implements used	Availability (per ,000 ha NCA)	Days required (per ,000 ha)	Shortage of time (Days)
1	Tillage	14	Wooden plough	223.40	9.54	Nil
			Blade harrow	14.95		
			Mould board plough	2.35		
			Cultivator	11.95		
2	Sowing	10	Bullock drawn seed drill	64.32	15.18	5.18
			Tractor drawn seed drill	3.61		
3	Weeding	12	Hand hoe	54.90	61.68	49.68
			Blade hoe	29.55		
4	Plant protection	7	Knapsack sprayer	18.45	46.90	39.90
			Duster	4.10		
5	Harvesting	10	Sickle	1086.58	27.14	17.14
			Combine harvester	0.26		
6	Threshing	8	Power operated thresher	7.90	16.07	8.07

Note: NCA = Net cropped area
Assumption : Eight working hours per day.

were used by few farmers. In case of delayed monsoon, erratic distribution of rainfall and prolonged dry spell during rainy season, application of irrigation by means of electric motor operated pump sets at critical growth stages of the crops was practiced by the farmers. Harvesting of crops was mainly done manually by sickles but the use of self-propelled combine harvesters on custom hiring was found gaining popularity. Though the State does not have sufficient numbers of combine harvesters within its territory, however custom hiring of these machines from the neighbouring states of Rajsthan, Uttar Pradesh and Gujrat is very common during harvesting seasons. The threshing of different crops was found to be the most mechanized operation carried out by the farmers. All crops were threshed by 5-10 hp electric motor operated or 35 hp tractor operated threshers by the farmers. Similar practices were followed for the winter season crops also. The choice of winter season crops depended on the availability of soil moisture, irrigation facilities and the amount of rainfall in the preceding rainy season. Wheat was most preferred if adequate soil moisture for proper germination of seeds and irrigation facilities for proper establishment, growth and development of crop was available, followed by chick-pea.

Timeliness of operations and mechanization gaps

Due to rainfed nature of the cultivation processes of different crops, the availability of soil moisture becomes the most crucial factor for determining the availability of time for most of the critical farm operation. On the basis of the information collected from the farmers, the maximum available time for tillage and seed bed preparation, seeding, interculture operations, irrigation, plant protection, harvesting and threshing of different crops were found as 14, 10 12, 5, 7, 10 and 8 days, respectively. The timeliness of critical farm operations is presented in Table 3. It was observed that none but the tillage operation was completed in time. The maximum timeliness gap was found in the case of weeding and plant protection among all the critical farm operations. As against the time availability of 12 and 7 days, the actual time required considering the availability of implements were 61.68 and 46.90 days for weeding and plant protection operations, respectively. Untimely completion of these operations resulted in yield losses. The time required for harvesting and threshing operations was more than the time availability for these two operations. As against the available time of 10 and 8 days, the time taken for harvesting and threshing operations was 27.14 and 16.07 days, respectively. Delay in harvesting increased the yield losses, especially in soybean, which was highly susceptible to shattering of pods. Similarly, delay in threshing also contributed to increase in yield losses. The consequences of shortage of time in conducting critical farm operations for present practices followed are presented in Table 4. The untimely completion of farm operations may be one of the reasons for the low yield of crops in Madhya Pradesh. The yields of major crops are lower by 40.15, 29.42, 11.21, 8.10 and 6.43 % than the national average in the case of paddy, wheat, maize, sorghum and soybean, respectively (Fertiliser Statistics 2000-2001).

Table 4. Farm mechanization gap for different agricultural operations.

Sl. No.	Name of operation	Shortage of time (days)	Problem faced	Present practices followed
1	Tillage	Nil	Nil	Primary and secondary tillage operations by animal operated country plough, bullock operated blade harrow, tractor operated cultivator and animal operated puddler
2	Seeding	5.18	Lower plant population and low yield	Sowing in furrow behind country plough and sowing by bullock operated manually metered sowing devices, tractor operated seed drills and manual transplanting of paddy
3	Weeding	49.68	Higher crop-weed competition and low yield	Manual weeding by small hand tools and weeding by bullock drawn blade hoe
4	Plant protection	39.90	Higher yield loss due to pest infestation	Spraying and dusting by manually operated and power operated knapsack sprayers/ dusters
5	Harvesting	17.14	High yield losses due to delayed harvesting	Manual harvesting by sickle and mechanical harvesting by combine harvesters on custom hiring
6	Threshing	8.07	Higher storage and post harvest losses	Threshing by 5-10 hp electric motor operated threshers and 25-35 hp tractor operated threshers

Strategies and technologies needed to reduce the mechanization gaps

Extensive and adequate planning and carefully drawn mechanization strategies are needed to bridge the existing farm mechanization gaps in the state of Madhya Pradesh not only for augmenting the agricultural production and raising the farm income but also to increase the productivity of scarce natural and man-made resources by ensuring their judicious use. It was observed that even the small scale bullock operated farms in this region are becoming more interested in custom hiring of high capacity power operated farm implements rather than owning low capacity bullock drawn implements. Therefore, the introduction of improved and cost-effective technologies and implements is the need of the time to ensure the timeliness of operations, increase in economic efficiency of operation and efficient use of scarce inputs. The existing implements required to be improved and new machines to be developed for reducing the mechanization gaps as suggested by the farmers are presented in Table 5.

Almost half of the farmers interviewed (47.83%) expressed the requirement for improved seeding implements for sowing of cotton, mustard, wheat and chickpea. This requirement can be met by increased adoption of tractor operated seed drills already in use by the farmers and by improvement of bullock and tractor operated planters and bullock drawn seed cum fertilizer drill for small seeds already developed in different research organizations. Similarly, encouraging the adoption of improved paddy transplanter can ensure the timeliness in transplanting operation of paddy. Timeliness in weeding operation can be improved by increasing the adoption of manually operated wheel hoes and power weeders. In case of plant protection operation, the timeliness gap can be met by developing the spraying attachment to diesel engine operated power weeder. In the case of combine harvesters, the height of cut is 15-20 cm above the ground, which results in the reduction of straw yield. It was noticed that when the use of combine harvester increased, there was a shortage of straw as a source of animal feed. On the other hand, relying purely on manual harvesting delays harvest resulting in shattering loss especially for soybean crop. To solve the problem, development of small combine harvesters with straw remover is required. These low cost combines can also be affordable by the local farmers on ownership basis. Similarly few farmers of potato growing regions of the State expressed the requirement of low cost potato digging equipment. The present mechanization gap existed in threshing operation was satisfactorily met by the use of high capacity tractor operated threshers available on custom hiring from neighbouring states as per the opinion of the farmers.

Table 5. New implements and improvement of existing machines required for reducing the mechanization gaps as expressed by the farmers

Sl. No.	Crops and operations	Implements to be developed	Implements to be modified	Price range (Rs.)
1	Sowing for cotton, mustard, wheat and chickpea (47.83)	None	(1) Bullock/ tractor drawn planter (2) Bullock drawn seed cum fertilizer drill for mustard	6500 1000 3500
2	Rice transplanting (17.39)	None	Manually operated rice transplanter	5700
3	Intercultural operations in all crops (30.44)	2-3 rows, 6-10 hp diesel engine operated power weeder	None	35000
4	Spraying for cotton and pulse crops (28.35)	Spraying attachment to 6-10 hp diesel engine operated power weeder	None	35000
5	Harvesting of soybean, rice, wheat and chickpea (21.74)	Small combine (1 m width) with 50 hp diesel engine	None	300000
6	Digging of potato (4.35)	None	Bullock drawn potato digger	2500 3000

Figure in the parentheses are percentage of farmers expressing the requirement.

CONCLUSIONS

(1) Soybean was the main crop grown along with paddy, sorghum, maize and cotton during rainy season and wheat, chickpea, potato and mustard were the main winter season crops grown in Madhya Pradesh.

(2) Mechanical power sources and matching implements were in use for seed bed preparation, sowing, harvesting and threshing operations although the extent of use varied depending on region, size of holding etc. Threshing was the most mechanized operation where almost all farmers used mechanical threshers (individually owned or on custom hire basis). Traditional methods were used in weeding and use of plant protection equipment was very low.

(3) Among the critical farm operations, only the tillage and seedbed preparation was found to be completed in time. The maximum timeliness gap was observed in the case of weeding followed by plant protection operation among all the critical farm operations.

(4) Increased adoption of mechanical power sources and improved farm implements already in use in case of most of the farm operations as well as introduction of new high capacity machines and implements can ensure timeliness of farm operations.

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