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Farm mechanisation in rice cultivation

Present status, bottlenecks and potential

Vijayakumar S[1], Subramanian E[2], Saravanane P[3], Gobinath R[4] and Sanjoy Saha[5]

ICAR-National Rice Research Institute, Cuttack, Odisha 753 006

The production and productivity in Indian agriculture cannot be enhanced by primitive and traditional practices of farming. Stagnating crop productivity and increasing production cost are the two major concern of Indian agriculture. Increasing demand and application of off-farm inputs and higher labour wages are the two important reason for increasing the production cost. Mechanizing the agricultural production will reduce the production cost substantially and improve productivity by reducing the losses during harvesting, threshing and winnowing. Mechanized farm operation such as sowing (seed drill, drum seeder, mechanical transplanter), weeding (cono weeder, power weeder), fertilizer application (root feeding through fertigation, soil injection, foliar spray) improve plant growth thereby yield.

Keywords: Farm mechanisation, Marginal and small farmers, Rice cultivation

As per the agriculture census 2015-16, the number of operational marginal holding (< 1 ha) in total operational holding increased (68.5%) while the share of small (1-2 ha) and large (> 4 ha) holding decreased compared to 2000-01. According to the agriculture census 2015-16, the share of small, medium and large holding in total operational holding is 17.7%, 9.5% and 4.3% respectively. The marginal and small holding together account 86.2% of the total operation holding and remaining 13.8% of the operational holdings are medium and large holding. The share of operational holdings cultivated by women (13.9%, 2015-16 census) is increasing over the year. The average size of operational holding is shrunk from 2.82 ha in 1970-71 to 1.08 ha in 2015-16 and it is expected to follow the same trend in future due to fragmentation of landholding.

Table 1. Current level of farm mechanisation in India

Operation	Mechanisation level (%)
Land preparation	40
Seeding/planting	30
Plant protection	34
Irrigation	34
Harvesting	65
Overall	40

Status of farm mechanization in India

Decline in the use of animal and human power in agriculture is obvious and paved the way for the mechanization of agriculture. Shortage of agricultural labour and the need to enhance farm productivity are among the main reasons for increasing farm mechanization in India. The projected value of the Indian farm mechanization market in the year 2019-20 is ₹ 400 billion. At present, the farm mechanization in India is 40% which is much lower in comparision to U.S. (95%), Brazil (75%) and China (57%). Among the farm operation, harvesting registered the highest mechanization level (65%) followed by land preparation (40%). Seed sowing/planting account lowest level (30%) of mechanization (Table 1). Similarly, crop and operation wise level of farm mechanisation in India is given in Table 2. The farm mechanization in India has largely been tractors and power tillers due to the availability of cheap labour in the past, however, its penetration is not uniform across

Table 2. Crop and operation wise level of farm mechanisation in India

Major crops	Seedbed preparation (%)	Sowing/planting/ transplanting (%)	Weed and pest control (%)	Harvesting (%)
Paddy	85	5	80	70
Wheat	90	80	70	80
Potato	90	80	80	70
Maize	90	80	70	50
Gram	90	50	60	30
Millets	80	30	60	20
Oilseeds	80	30	60	20

Source: Final Report on Monitoring, Evaluation and Impact assessment of SMAM, M&T Division, MoA&FW, May 2018

India. For example, the penetration of tractor in Punjab, Haryana and Uttar Pradesh is much higher than many eastern, southern and northeastern states. Other farm equipment like paddy transplanters and combine harvesters, threshers, rotavator, transplanters, reapers, zero till drills, laser levellers and power weeders are adapted in small scale, and it is expected that in near future the demand and adaption of these machineries will increase due to large migration of rural youth to cities in search of better jobs.

Reason for the low level of farm mechanization in India

- Smaller and scatter landholding
- Hilly topography especially in northeastern states
- Poor socio-economic condition
- High transportation cost
- Diversified cropping system
- Highly fluctuating market price
- High initial investment/cost
- Higher cost of maintenance
- Lack of demand for round the year use (seasonal demand)
- Availability of cheap labour in some region

Determinants of farm mechanization

Small operational holding size and a higher share of marginal and small farmers are the major bottlenecks to the farm mechanization in India. Land size, cropping pattern, market price of crops including Minimum Support Price (MSP), availability and costs of labour, total cost of equipment and subsidy from government are the major factors deciding the growth of agricultural mechanization. Procure appropriate machinery/ equipment as per land holding size and crop.

Mechanization in paddy cultivation

Rice is a labour-intensive crop which requires a work-concentrated harvest. For one hectare area, it need around 850-900 man-hours for cultivation. Mechanisation in rice cultivation is getting momentum due to growing labour scarcity and raising labour wage. The timeliness of operation is adversely affected by labour scarcity during the peak period of the season, thereby reducing the crop yield. Mechanization in rice cultivation in India is increasing due to the use of implements such as tractor, power tiller, paddy transplanter, cono weeder, power sprayer, combine harvester, thresher, etc. Due to the high cost of tractors, paddy transplanters, combine harvesters and threshers, most of the farmers are not able to buy those machineries though loans are available for this purpose, and instead they hire those machineries. Due to heavy hire charges, non-availability of machineries at the right time and labour availability some farmers still hesitate to mechanise their paddy farms. Transplanting (38%), weeding (19%) and harvesting and threshing (32%) operations consume most of the labour requirements in paddy cultivation and hence thrust should be given for mechanising these operations in order to reduce the labour requirement in paddy cultivation.

Present status of mechanization in Paddy cultivation

At present 60% of land preparation, 5% of transplanting, 50% of irrigation, 25% of fertilizer application, 3% of harvesting and 20% of threshing operations are mechanized. More emphasis may be given to promote mechanization in transplanting and harvesting operation to attain the desired level of mechanization.

Reasons for preferring mechanisation in paddy cultivation

Mechanisation saves time in completing different operations, which gives the crop more time to mature, allows the farmer to be more flexible in his farming operations and facilitates multi and relay cropping. The transition from animal power to mechanical power has made agriculture capital intensive. Mechanization of harvesting and threshing save 4-5% losses over the conventional method. It also increases productivity by facilitating timely sowing of rice and efficient control of weeds and reduce human drudgery. In addition, recent moderns days tools like Zero-till seed drill, Laser Leveler, Happy Seeder, Rotavator, etc., helps in conservation of natural resources like water, soil and air.

Farm machineries for paddy cultivation

Power Tiller

A larger portion of the farming population of the country falls into the small and marginal segment and it plays a major role when it comes to affordability of farming equipment. Utility wise, power tillers can perform a lot of functions just like tractors in the fields and highly suitable for smaller fields where tractors may not be much efficient. The marginal and small farmers can afford it as it is cheaper compare to the tractor, and the government is providing subsidy range from ₹ 40,000-90,000. The penetration of power tillers in India is higher in southern and eastern India as compared to the other parts of the country on account of the small size of land holdings per farmer in these respective regions. It is a 12 hp self-propelled machine specifically useful for paddy fields and orchards as it can take short turns. It comes with a package of implements like rotavator for puddling, cultivator for land preparation and it is also used for operations like pumping, threshing and farm transport. It takes about 5h to puddle one hectare. Its cost is approximately ₹ 1 to 1.5 lakh.

Tractor

India is the world largest manufacturer of tractors with 50% of the world's output in 2016; it is also the world largest tractor market. Tractors are available in two power ranges. Small power range tractor is meant for paddy cultivation. It is a lightweight tractor with four-wheel drive with rotavator used for puddling. It has a small turning radius. Trafficability problem can be avoided with this tractor due to its lightweight. It can puddle one hectare in 2.5-3h.

Drum seeder

A row seeder (also known as drum seeder) sows the pre-germinated paddy seeds in the rows at a spacing

of 20 cm or 25 cm in puddle soil. There is saving in the cost of cultivation to the tune of 35% by using this device.

Paddy Transplanter

It is a self-propelled machine driven by diesel engine and achieves uniform spacing and plant density. Proper pla•nt spacing makes uniform growth of plants and makes weeding (mechanical weeding), spraying, and fertilizer application operations are more efficient and easier. It facilitates uniform depth of transplanting and fast recovery of seedling, vigorous growth. This machine reduces about 40% of the labour requirement. It requires mat type nursery through which it reduces the seed rate and cost of nursery raising. It also helps in large scale adaption/promotion of system of rice intensification (SRI).

Cono Weeder

Cono weeder found most suitable implement for weeding in rice. Mechanical weeding alone increased the plant height and enhanced the grain yield by 10.9% as compared to manual weeding. The weeder is moved front and back between every two rows both vertically and horizontally. Besides increasing the aeration and root trimming, it also facilitate in-situ incorporation of weed as green manure. The manual cono weeding in rice is a tedious job that require more energy. This problem was solved with the development of power operated weeder. Cono weeder can be used extensively in SRI.

Power Sprayer

A sprayer is a device used to spray a liquid. In paddy field, power sprayer is used to spray herbicides, pesticides, and fertilisers to paddy crops.

Combine Harvester

This is a self propelled machine which cuts, conveys, threshes, cleans and bags the produce from the field. It can harvest even a lodged crop. Wheel and chain combines are available. The chain combine is having more manoeuvrability by having lesser turning radius. It has a working width of about 4.2m. It can harvest 0.8-1.2 ha/h of paddy. Use of combined harvest will ensure the timely harvest of rice. During the peak time of harvest, availability of labour is a major problem. Delay harvesting causes shattering of grain in the field.

Thresher

The traditional method of paddy threshing involves treading by bullocks or trampling by tractors. This method causes more yield loss due to more number of unthreshed paddy and it also needs more time and human labour. Thus, replacing this traditional method with power operated threshers either diesel or electrical power minimize the yield loss, besides saving labour, cost and time.

How to improve farm mechanization in India

- Custom Hiring: Machinery and equipment which is of high cost can be used by custom hiring.
- Efficient scheme implementation and delivery mechanism.
- Procure appropriate machinery/ equipment as per land holding size and crop.
- Information transfer: In every State, agricultural mechineries/ instruments are issued to farmers in subsidied rate under different government schemes (Table 3 & 4). Due to the lack of knowledge about various schemes, most of the farmers do not avail the benefits of government schemes. More initiative from governmet organization like, State Agricultural Universities, KVK, and State Agricultural Departments should transfer information about the various government schemes.
- Region and crop-wise promotion of farm mechanization: For example, for paddy more importance should be given in West Bengal, Uttar Pradesh, Andhra Pradesh, Punjab; for cotton in Gujarat, Maharashtra, Telangana, Punjab; for Maize in Karnataka, Madhya Pradesh; Bihar for Potato in Uttar Pradesh, West Bengal, Bihar, Gujarat; for Sugarcane in Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu; for Soybean in Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, etc.
- Farm Mechanization skill upgrade through the promotion of skill development centres (SDCs).
- Forging Public–private partnership models.
- Ensuring improved access to finance.

SUMMARY

The huge diversity in climate, topography, ecosystem, culture, food habits, social custom, and socio-economic status of farmers makes Indian agriculture unique. Despite this diversity, Indian agriculture

Table 3. Government Schemes Support Mechanization

Scheme	Support for farm mechanisation	Funding/financing pattern
NFSM (National Food Security Mission)	Assistance (up to 50% the cost of machinery) is given to machinery such as pump sets, tractor mounted sprayers, seed drills, zero till seed drills	60% assistance from the Centre and 40% from the State
RKVY (Rashtriya Krishi Vikas Yojana)	Assistance for large equipment (tractors, combine harvesters, sugarcane harvesters, cotton pickers, etc.) is available for establishing custom hiring centres (CHCs)	60% assistance from the Centre and 40% from the State
MIDH (Mission for Integrated Development of Horticulture)	Key interventions - horticulture mec-hanisationAssistance for grower associations, farmer groups, SHGs, women farmer groups (with more than 10 members), etc., are engaged in cultivation of horticulture crops for procurement of power-operated machines and tools, besides for import of new machines.	60% assistance from the Centre and 40% from the State

Table 4. Financial Assistance for Procurement of Agricultural Machinery and Equipments

Type of Agricultural Machinery	For SC, ST, Small & Marginal farmers, Women and NE States beneficiary		For other beneficiary	
	Maximum Permissible subsidy per Machine/Equipment per beneficiary (₹ in lakh)	Pattern of Assistance (%)	Maximum Permissible subsidy per Machine/Equipment per beneficiary (₹ in lakh)	Pattern of Assistance (%)
Marker for SRI	0.10	50	0.08	40
Drum Seeder (Below 4 Row)	0.03	50	0.025	40
Drum Seeder (Above 4 Row)	0.04	50	0.030	40
Power Tiller (below 8 BHP)	0.65	50	0.50	40
Power Tiller (8 BHP & above)	0.85	50	0.70	40
Conoweeder	0.012	50	0.010	40
Self Propelled Rice Transplanter				
4 rows	1.50	50	1.20	40
4-8 rows	5.00	50	4.00	40
8-16 rows	8.00	50	6.50	40
Reaper cum Binder (3 wheel)	1.75	50	1.40	40
Reaper cum Binder (4 wheel)	2.50	50	2.00	40
Paddy Thresher	1.00	50	0.80	40
Combine Harvester (self propelled, upto 14 feet cutter bar)	8.00	50	6.40	40
Combine Harvester (track, 6-8 feet cutter bar)	11.00	50	8.80	40
Tillage and seed bed preparation equipments				
MB Plow, Disc Plow, Cultivator, Harrow, Leveler Blade, Cage wheel, Furrow opener, Ridger, Weed slasher	0.20	50	0.16	40
Furrow opener, Bund former, Crust breaker, Rotopuddler, Rotocultivator, Power Harrow	0.40	50	0.32	40
Rice straw Chopper, Zero–till multi crop planter	0.30	50	0.24	40
Paddy Thresher, Multi crop Threshers, Winnowing fan	0.30	50	0.25	40
Chisel Plough	0.10	50	0.08	40
Seed cum fertilizer drill/Zero till Seed cum fertilizer drill				
9 tines	0.213	50	0.170	40
11 tines	0.241	50	0.193	40
13 tines	0.269	50	0.215	40
15 tines	0.280	50	0.224	40
Happy/Turbo Seeder (9 tines)	0.728	50	0.582	40
Happy/Turbo Seeder (10 tines)	0.756	50	0.605	40
Happy/Turbo Seeder (11 tines)	0.784	50	0.627	40
Automatic rice nursery sowing machinery	1.75	50	1.40	40
Mini Rice Mill	2.40	60	2.00	50
Manual sprayer: Knapsack/foot operated sprayer	0.0075	50	0.006	40
Powered Knapsack sprayer (capacity 8-12 lts)	0.031	50	0.025	40
Powered Knapsack sprayer (capacity above 12-16 lts)	0.038	50	0.03	40

Source: A Farmer Friendly Handbook Schemes & Programmes 2018-19. Department of Agriculture, Cooperation and Farmers Welfare. Ministery of Agriculture and Farmers Welfare Government of India

continues to stands backbone of the country economy for many decades. However, in recent years, percent population depends on agriculture and the contribution of agriculture to total GDP is decreasing. Yield stagnation and increasing production cost further threaten the country food and livelihood security. Farm mechanization has a scope to increase productivity besides cutting production cost significantly. The diversified cropping system, small land holding, poor economic status of farmers, high cost of machineries are the major bottleneck to the farm mechanization. India has the highest scope for farm mechanization market in the world. The surge in demand for machineries like, combine harvester, reaper, thresher, transplanted, weeder, and seed drills are witnessed in recent years. This trend is expected to continue in near future too. However, the development of low-cost machineries which suits marginal and small farmers are highly important. Adequate awareness creation about the government subsidy to various farm implements and machineries is highly needed. This will not only increase mechanization percentage in India, but also helps in attracting and retaining youth in agriculture.

[1,5]Scientist, ICAR-National Rice Research Institute, Cuttack, Odisha 753 006, [2]Assistant Professor, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu 641 003. [3]Associate Professor, Pandit Jawaharlal Nehru College of Agriculture & Research Institute, Karaikal, Puducherry 609 603, [4]Scientist, ICAR-Indian Institute of Rice Research, Hyderabad, Telangana 500 030, Corresponding email: "Vijayakumar S" <vijitnau@gmail.com>