

Issues and strategies for rapid mechanization in western plane zone of Uttar Pradesh

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ABSTRACT : India has shown remarkable progress in agriculture since independence. The food production scenario has greatly improved. In view of the intensive agriculture especially in the food bowl states (Punjab, Haryana and western Uttar Pradesh), short window of time available between harvesting of paddy and sowing of wheat, as well as labour shortage, the farm mechanization can have a crucial role to play. The contribution of western plane zone of Uttar Pradesh to the total food grain production for the state is approximately 34% and to the nation is 6%. Sugarcane is dominant crop of the region, cultivated in 1.27 million ha of total area. For making farming globally competitive and checking impairment to natural resources (soil and water) base, a major shift in farm mechanization is required to realize the goal of eco-friendly sustainable agriculture with cost-effective production of quality produce in western plane zone of Uttar Pradesh. Appropriate and selective mechanization is needed for production agriculture, post-harvest handling, and value addition using a prudent combine of conventional and renewable energy sources. To devise long term strategies for farm mechanization in western plane zone of Uttar Pradesh, it is vital to visualize the needs in view of the prevailing and emerging challenges.

Key Words: Farm mechanization, Indian agriculture, technology.

Total food grain production in the country is estimated at record 291.95 million tonnes which is higher by 6.74 million tonnes than the production of food grain of 285.21 million tonnes achieved during 2018-19 (Anonymous, 2020). The country has attained self sufficiency in food grain production and also has sufficient buffer stock. The country has also made impressive progress in production of food grains, oilseeds, horticultural crops, milk, poultry, etc. Western plane zone of Uttar Pradesh is well known for its intensive agricultural production. The contribution of western plane zone of Uttar Pradesh to the total food grain production for the state is approximately 34% and to the nation is 6%. Sugarcane is dominant crop of the region, cultivated in 1.27 million ha of total area. Average land holding size is 1.12 ha in UP in comparison to 0.93 ha in the country. The holy river Ganga provides natural boundary to the region in the north, separating it from the Hilly and Tarai area of the state. In the west, river Yamuna separates is from the state of Haryana and the union territory of Delhi. Wheat and sugarcane, both cover more than 57% of the cropped area in western plane zone of Uttar Pradesh. Rice and Mustard are the other important crops covering more than 21% of total cultivated area. The growth rate of the total cultivated land has shown nearly 6% increase in the recent years. The area under sugarcane cultivation has registered significant expansion of 2.1% per annum. The average yield of different crops in the region for wheat, sugarcane and rice are 2.9 t/ha, 65.4 t/ha, 2.37 t/ha, respectively.

Among others, the agricultural engineering inputs have played appreciable role in increasing production and productivity through appropriate mechanization inputs for production and post production agriculture enabling timely field operations, conservation and judicious application of water, appropriate post harvest operations to reduce losses, value addition to the produce and by-products for enhanced economic returns and employment generation. The productivity of farms depends greatly on the availability and judicious use of farm-power by the farmers of Western plane zone of Uttar Pradesh. Agricultural implements and machines enable the farmers to employ the power judiciously for production purposes. Agricultural machines increase productivity of land and labour by meeting timeliness of farm operations and increase work out-put per unit time. Besides its paramount contribution to the multiple cropping and diversification of agriculture in western plane zone of Uttar Pradesh, mechanization also enables efficient utilization of inputs such as seeds, fertilizers and irrigation water.

Agriculture is derived from Latin words *Ager* and *Cultura*. *Ager* means land or field and *Cultura* means cultivation. Therefore the term agriculture means cultivation of land. *i.e.*, the science and art of producing crops and livestock for economic purposes. It is also referred as the science of producing crops and livestock from the natural resources of the earth. The primary aim of agriculture is to cause the land to produce more abundantly, and at the same time, to protect it from deterioration and misuse. It is synonymous with farming—the pro-

duction of food, fodder and other industrial materials. As per mechanization is concern it may be viewed as package of technology to (i) ensure timely field operations to increase productivity, reduce crop losses and improve quality of agro-produce (ii) increase land utilization and input use efficiency (iii) increase labour productivity using labour saving and drudgery reducing devices besides, being cost effective and eco-friendly. Appropriate machinery have been adapted by farmers of western plane zone of Uttar Pradesh for ensuring timely field operations and effective application of various crop production inputs utilizing human, animal and mechanical power sources. Diverse farm mechanization scenario prevails in the western plane zone of Uttar Pradesh due to size of farm holdings (average farm holding size 1.6 ha) and socio-economic disparities. Indian agriculture continues to be dependent upon human (agricultural workers population 234.10million in 2000- 01) and draught animal power (27 million pairs). Hand tools and animal drawn implements are extensively used which involve a great amount of drudgery. The availability of farm power or energy per unit area (kW/ha) has been considered as one of the parameters for expressing level of mechanization. Ratio of machine work and sum of manual and machine work has also been considered to estimate the level of mechanization. The unit farm power available from all sources (animate and mechanical power) increased from 0.20 to 0.90 kW/ha (on the basis of net cropped area) from 1950-51 to 1996-97. The ratio of tractive power to total farm power has increased from 0.82 to 32.25 per cent. Adoption of tractors has been on the increase. Sale of tractors during 2005-06 touched 292000 nos.

Issues and strategies for rapid mechanization

Agricultural mechanization technology plays a key role in improving agricultural production in developing counties, and should be considered as an essential input to agriculture (Rasouli *et al.*, 2009). The term 'farm mechanization' is used as an overall description of the application of the variety of tools, implements, equipment, machinery, power and other mechanical inputs. Proper use of mechanized inputs into agriculture has a direct and significant effect on production, productivity and profitability on agriculture farms, along with labour productivity and quality of life of people engaged in agriculture (Bishop, 1997; Clarke, 2000) and it is true for western plane zone of Uttar Pradesh. Empirical evidence confirms that there is a strong correlation between farm mechanization and agricultural productivity. States with a greater availability of farm power show higher productivity as compared to others (Singh *et al.*, 2011).

The cropping intensity in Indian agriculture increased with increase in power availability. It was 120% with power availability of 0.36 kW/ha during 1975-76 and increased to 141% with increase in power availability to 1.84 kW/ha during 2012-13. Net sown area per tractor shows the reverse trend during the same period, which was 487 ha/tractor in 1975-76 and reduced to 30 ha/tractor in 2012-13. The power availability per unit production increased from 0.38 kW/t in 1975-76 to 0.89 kW/t in 2012-13 during last thirty seven years. There may be many reasons including rainfall, crop variety, timely use of tractors, electricity availability etc in increasing the food grain productivity during the period.

The western plane zone of Uttar Pradesh has a great potential of consumption of improved farm machineries and implements. Mostly animals and tractors (35-36 hp) are used as a power sources for completion of various agricultural activities such as. ploughing, sowing inter-cultural operations, threshing etc. Most of the basic farm-implements are locally fabricated: hence they are not of good quality and workability. Both, the animal and power drawn implements like, plough, thresher, sprayer, harrow, cultivators etc. are used only by progressive farmers. Primary tillage is performed on large size holding by harrow and cultivators. The seed is generally sown by broadcasting method. Sugarcane – wheat system is a dominant rotation (more than 57% of the cropped area). However, late planting of sugarcane and late sowing of wheat is common, due to labour scarcity and non availability of cattle, causes delay even in harvesting, thus resulting in reduced grain yield and high cost of production. Surveys of villages revealed that the basic need and problem regarding the mechanization status. Only few farmers use seed drill or seed-cum-fertilizer drill for sowing of wheat in region. Harvesting is done manually and locally made sickle is used for the purpose. Due to non-availability of improved design and standard material, local sickles are in common use. Small farmers don't prefer combine harvester due to complete wastage of the straw. Use of power operated wheat thresher is common. However the multi crop thresher is rare in this region. The popularization of multi thresher the region near to Ganga River has great scope where the paddy (Saket-4) along with other pulse crops has been recently started to cultivate by few farmers even in summer season. the detail of problems identified in the identified in the region with their problem solution has been listed in Table-1.

Agricultural Mechanization should contribute to sustainable increase in productivity and cropping intensity so that the planned growth rates in agricultural pro-

Table-1 : Mechanization issues, identified problems and possible solutions.

S. N.	Mechanization issues/Gap	Identified problems	Possible Solutions	Impact on Crop/Soil issues
1.	Timely seed bed preparation for sugarcane planting	<ul style="list-style-type: none"> - Delay in seedbed preparation and planting. - More input of power/ha. - Scarcity of labour. - Traditional method of seedbed preparation is in practice. 	Rotavator	<ul style="list-style-type: none"> - Seedbed preparation for sugar planting and other crops. - Leveled and weed free seedbed. - Less power point
2	Timely sugarcane planting	<ul style="list-style-type: none"> - Traditional method of planting is in practice 	Set cutter Sugarcane planter	<ul style="list-style-type: none"> - Require Sugarcane plant density. - Less weed population.
3	Timely sowing of part millet, wheat, mustard and other crops.	<ul style="list-style-type: none"> - Poor plant population and non-uniform growth in broadcasting. - High weed population. - Imbalance use of fertilizer. 	Tractor mounted Inclined plate planter	<ul style="list-style-type: none"> - Proper crope row specing and plant geometry. —Easy to irrigate. - Decreases plant mortality.
4	Timely harvesting of pearl millet, wheat & mustard	<ul style="list-style-type: none"> - Delay in harvesting. - More input of power/ha. - Scarcity of labour. - Traditional method of harvesting is in practice. 	Self-Propelled vertical Conveyer Reaper/ Tractor Mounted Vertical Conveyer Reaper	<ul style="list-style-type: none"> - Reduces the impact of unfavorable weather conditions. - Appropriate Straw: Grain ratio. - Reduces shattering losses.
5	Timely threshing of pearl millet wheat, mustard and other crops.	<ul style="list-style-type: none"> - Delay threshing. - More input of power/ha. - Traditional meahod of harvesting is in practice. 	Multi-crop thresher	<ul style="list-style-type: none"> - Reduces the impact of unfavorable weather conditions. - Increases the mortality of seed.
6	Proper planting of sapling.	<ul style="list-style-type: none"> - Tractor Operated 	Augur Digger	<ul style="list-style-type: none"> - In time and proper plantation of trees in large area.
7	Plucking of without damage	<ul style="list-style-type: none"> - Heavy damage of fruits result poor quality. - Fruit harvesting is prone to accident 	Mango harvester	<ul style="list-style-type: none"> - Reduction in post harvesting losses. - Quality fruit production. - More safety to the farmers/works.
8	Lack of information among farmers regarding availability of modern pesticide equipments	<ul style="list-style-type: none"> - Poor results of pesticides - Uneven coverage of target. - Not getting the desired output through pesticide to - Indiscriminate use of pesticide 	Orchard Aero-Blast Sprayer	<ul style="list-style-type: none"> - Ease of application of pesticides hormones to orchard. - Uniform distribution and coverage of required dose. - Good quality & less of damage fruits
9	Lack of information among farmers regarding the availability of modern pesticide equipments	<ul style="list-style-type: none"> - High infestation of sucking pest like Aphid, Jessid, and White fly etc in vegetable crops. 	Mist Blower	<ul style="list-style-type: none"> - Uniform distribution and coverage of required dose. - Ease of application of pesticides to vegetable crops. - Ease of management of viral disease propagation.
10	No availability of modern farm implements/equipment for the transplantations of vegetable.	<ul style="list-style-type: none"> Scarcity of labour Poor plant population High inputs of manpower/ha demoralize the farmers for vegetable cultivation 	Tractor Mounted Two-Row vegetable Transplanter	<ul style="list-style-type: none"> - Direct positive impact on vegetable cultivation area. - Proper crop row spacing and plant geometry. - Easy to irrigate. - Increases plant mortality. - Balancing the required dose of fertilizer.

duction are achieved. Mechanization is capital intensive and substantial sums have been invested in our country. In the absence of good planning and direction, investment on mechanization may not yield the expected results. Farmers of western plane zone of Uttar Pradesh should adopt a policy of selective mechanization under diverse conditions, which makes their agricultural mechanization a low challenging task. An appropriate mechanization technology suiting to the cropping pattern and needs of the farmers is required to be adopted.

To sustain growing population of the country, the agricultural production has to be increased by 85% and the productivity by 100% from present level. This will require intensification of agriculture. The contribution of western plane zone of Uttar Pradesh will be significant in this context. With weather conditions becoming more erratic, to perform the farm operations timely, the energy input to agriculture will increase from present level of 1.3 kW/ha to 3.9 kW/ha to achieve the desired level of food grain production and horticulture production. About 65% of this power will have to come through tractors and self propelled machines. More than 60% of cultivable land is under rain-fed and dry land areas. Development and popularization of agricultural machinery under varied conditions are required and adoptions of precision farming techniques on large scale for higher input use efficiency are our main goal in western plane zone of Uttar Pradesh. This will require regular training of scientists and farmers on modern technologies. Identification and use of alternate materials in manufacturing of agricultural equipment is the need of the hour to bring down the cost without loss of efficiency. Conservation agriculture technologies such as zero till drill, till plant machine, roto-till-drill, strip till drill, raised bed farming system with straw management will have to be adopted on large area. Farm mechanization related data need to be collected and periodically updated to formulate good farm mechanization policy. The farm operations of horticultural crops are highly labour intensive. These need to be appropriately mechanized for drudgery reduction, productivity enhancement. With power operated farm equipment becoming more popular, the accident rates are also on increase. The male to female ratio among the agricultural workers is expected to change from present of 60:40 to 45:55 by 2025, which indicates the increase in dependency on female work force. This will necessitate development of gender specific tools and equipment and imparting training to female farm workers on operation and maintenance of farm tools and equipment. With fossil fuel becoming scarce, alternate renewable fuels like bio-diesel for tractors, IC engines and automobiles will have to be developed and used on

mass scale. Many oil bearing non-edible and edible seeds besides jatropha can be used to prepare bio-diesel of good quality at competitive price. Production of hydrogen (for use as fuel) from renewable sources will also be an option to be encouraged. Production of bio-fuel or bio crude from biomass through pyrolysis has an inherent advantage of having the potential of decentralized fuel generation and decentralized power generation. For optimum utilization of scarce natural resources, efficient irrigation systems such as drip and sprinklers with high precision and on farm water management practices will have to be developed / adopted. Improving efficiency of irrigation systems and pumping systems is essential to save energy and water. Involvement of State Departments of Agriculture and Agricultural Engineering in transfer of technology activities needs to be formalized and strengthened. The demand for better equipment and technology for promotion of agri-business and commercial agriculture has thus increased. The R&D in the field of agricultural engineering, therefore, required orientation to support not only technological demand of general purpose farm machinery and processing equipment but also for specialized-equipment.

Strategy for Mechanization of Indian Agriculture

The widely fragmented and scattered land holdings in many parts of the western plane zone of Uttar Pradesh need to be consolidated (virtual or real) to give access for their owners to the benefits of agricultural mechanization. However, consolidation of the lands have been done in most of the districts (Chandel *at al.*, year????). There is a need to have more interaction among the farmers, research KVK and development workers, departments of agriculture and industry to make farm machinery research and development base stronger. The quality of operations like seedbed preparation, sowing, application of fertilizer, chemicals and irrigation water, weeding will have to be improved by using precision and efficient equipments particularly for sugarcane to achieve higher production levels. The rice transplanting operation can be mechanised by introduction of self-propelled walking type rice transplanters on small and medium land holdings. The riding type rice transplanter may be introduced on large size land holdings on custom hiring basis (Mehta and Pajnoo, 2013). The benefits of agricultural mechanization should be extended to all categories of farmers including small and marginal farmers, to all cropping systems by custom hiring including horticultural crops and to all regions of the country especially the rainfed areas. Therefore, there is a need to innovate custom service or a rental model for high cost farm machinery such as combine harvester, sugarcane harvester, potato com-

bine, paddy transplanter, laser guided land leveller, rotavator etc. and can be adopted by private players or State or Central Organizations in major production hubs. Medium and large scale farmers may be provided with Govt. subsidies to encourage them to buy and to apply advanced medium and high size machinery such as cotton picker, rice transplanter, sugarcane harvester and combine harvester on their fields (Mehta and Pajnoo, 2013). The farm machinery bank may be established for machines to users/farmers on custom hiring mode. There is a need for strengthening training programmes by KVK at various levels and for different categories of people on operation, repair and maintenance of agricultural machinery, tractors, power tillers, etc. and for transfer of technology.

Testing and quality control

The adoption of agricultural machinery is greatly influenced by testing/standardization, quality control and after sales services available to the farmers. Since most of farm machinery is manufactured in India in small-scale industries, the quality is affected by the manufacturing technology adopted by them. Testing and evaluation helps in up-gradation and quality production of machinery. In addition to the four major farm machinery training and testing institutes located in Madhya Pradesh, Haryana, Andhra Pradesh and Assam states, recently 29 new centres including Agricultural Universities and Institutes under Indian Council of Agricultural Research have been approved by Government of India to conduct quality certification evaluation for manufacturers.

Farm equipment are used in farming operations including immediate post-harvest activities with a view to increase productivity of land and labour through timeliness of operations, for efficient use of inputs, improvement in quality of produce and safety and comfort of farmers, and reduction in loss of produce and drudgery of farmer. Tractor mounted implements such as mouldboard ploughs, disc ploughs, cultivators and other crop-specific equipment are widely being used for seed bed preparation in western plane zone of Uttar Pradesh. Seed drills and planters, both tractor mounted,

have become popular. Long handle tools and power weeders for weeding and inter-culture and manual and power operated sprayers and dusters for application of chemicals have been commercialized. Cereal crop harvesters including various designs of vertical conveyor reaper windrowers and combine harvesters are being used.. Spike-tooth and rasp-bar type threshers for cereal crops and crop specific threshers for major crops such as wheat and paddy have been developed and commercialized. Future requirement for farm equipment and technologies include rota-tiller for seed bed preparation, till planter, strip till drill, pneumatic precision planter, sugarcane sett cutter planter, vegetable transplanter and check-row planter, for sowing and planting. Power-weeders and equipment for chemico-mechanical weed management, electro-static spraying and tall tree spraying are required. Harvesting equipment for sugarcane is required to be developed

References

- Anonymous, 2020. India's 2019-20 foodgrain production to hit a record high of 291.95 million tonnes .*economictimes.indiatimes*
- Bishop, C., 1997. A Guide to Preparing an Agricultural Mechanization Strategy, AGSE. FAO, Rome, Italy.
- Chandel, N.S.; Senthilkumar T. and Mehta C.R. 2014. Agricultural Mechanization in Asia, Africa, and Latin America : **45**.
- Clarke, L.J., 2000. Strategies for Agricultural Mechanization Development: The Roles of the Private Sector and the Government. Agricultural Support Systems Division, FAO Publication, Rome, Italy.
- Mehta, C.R. and Pajnoo, R.K., 2013. Role of Japan in promotion of agricultural mechanization in India. *Agricultural Mechanisation in Asia, America and Latin America*, 44(4): 15-17.
- Rasouli, F.; Sadighi, H. and Minaei, S., 2009. Factors affecting agricultural mechanization: A case study on sunflower seed farms in Iran. *J. Agric. Sci. Technol.*, **11** : 39-48.
- Singh, S.P.; Singh, R.S. and Singh, S., 2011. Sale trend of tractors and farm power availability in India. *Agricultural Engineering Today*, **35**(2): 25-35.