

Engineering Interventions in Agriculture for Prosperity and Sustainability

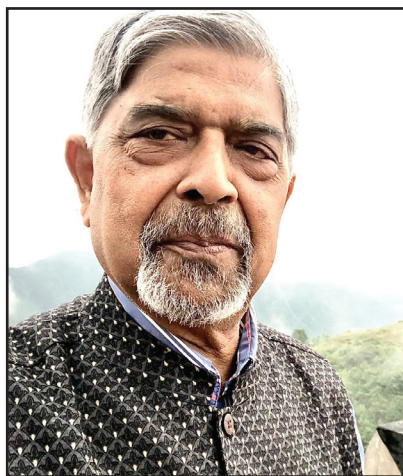
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Indian agriculture, until the onset of green-revolution era, was powered essentially by human and animal power; limited to only 0.30 kW/ha. There was hardly any machinery input in carrying out field and off-field operations. Tools such as spade, axe, plow, and trowel manufactured and serviced by local artisans only were available for use. Tillage and sowing were predominantly animal power-based operations. Weeding, surface irrigation, plant protection, harvesting, threshing, winnowing, and transportation were also carried out using human and animal power. Diesel pump sets began to be available for lift irrigation in the late 1950s.

The absence of mechanization till the onset of green revolution was due to the lack of farm machinery and the associated skills for application in agriculture. The country lacked the capacity to mass produce agricultural machines and mechanically powered prime movers to propel the growth of agriculture. There was only one institution in the country, Allahabad Agriculture Institute, that offered a degree course in Agricultural Engineering. Subsequent establishment of universities and

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IITs brought the discipline in focus by initiating agricultural engineering programmes in collaboration with a few American universities.

The green revolution of the sixties and seventies, therefore, was centred around improvement of genetic make-up of the target crops by way of introducing high-yielding varieties together with the intensified application of inputs, i.e., chemical fertilizers, irrigation, synthetic pesticides and insecticides. The resultant increase in agricultural production made India self-sufficient in the availability of food. However, higher food production coupled with poor transportation and storage facilities created the problem of

plenty. The absence of engineering interventions in terms of appropriate machinery accentuated the problems leading to the second-generation issues of soil health, contamination of water resources, pollution, and intolerable pesticide residue levels in the produce.

Looking back, if agricultural mechanization inputs were available together with the improved genetic material, the synergistic impact of the green revolution would have been multi-fold in terms of productivity, profitability and sustainability. Realising the importance of agricultural machinery, a considerable time was lost in deciding the level of mechanization that should be pursued. It was only some three decades ago that agricultural mechanization in India was realized to be not acceptable as long as cheap human labour was available. Moreover, since majority of land holdings were less than 2 ha, individual ownership of farm machines was considered too expensive and hence not feasible.

Two important developments two decades ago brought the inevitability of agricultural mechanization in sharp focus. The cheap labour syndrome

melted away with the promulgation of Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA). Almost overnight, the migrant labour vanished and the need for machines was found essential. It was around the same time that an alternative to individual ownership of farm machines was found in the form of custom-hiring.

In view of the essentiality of farm mechanization, Ministry of Agriculture and Farmers Welfare, Government of India launched for the first time a Sub Mission on Agricultural Mechanization (SMAM) in the year 2014-15 for nation-wide promotion of farm mechanization with a view to enhance crop productivities, reduce inputs, reduce postharvest losses, and add value to the agricultural produce leading to higher farmers' income.

The most important impact of SMAM has been the saving in time to complete farm operations in a season to use the spare time for increasing the area under cultivation if available. Custom hiring centres have been observed to benefit the client farmers by way of 10-20% saving in inputs, 25-30% reduction in the cost of production, 15-25% increase in production, and 25-40% increase in gross income of farmers. The application of machines has reduced the human drudgery significantly, an important step in attracting youth to agriculture.

It is estimated that the SMAM has impacted about 5 Mha of cultivated area so far. However, the SMAM needs to be strengthened and expanded considerably to the level of a National Mission on Agricultural Mechanization (NMAM) for benefitting the whole of 140 Mha of net cultivated area in the country. Progress in case of Agro-processing centres has been dismal.



Processing and value addition of farm produce needs to be accorded high priority to facilitate reduction in post-harvest losses and better price realization for farmers' produce and increase in their income.

The most commonly known mechanization interventions have been farm-machinery, energy and power management, irrigation pumps, soil and water conservation structures, food storage structures, material handling machinery, value addition to agricultural produce in production catchments, and byproducts utilization. Controlled environment agriculture systems, bio-sensors and digital systems for measurement, monitoring, and control applications, unmanned ground and aerial vehicles, and AI based autonomous machines are recent technological interventions that have the power of transforming the agriculture from a vocation full of drudgery to blue- and white-collar occupations. The decade starting from now must focus on facilitating a quantum jump in our efforts for harnessing the potential of engineering interventions in agriculture in terms of enhancing agricultural productivity, production, profitability, and sustainability.

In 2023, the agricultural machinery

market in India was valued at USD 13 billion and is expected to reach USD 19.5 billion by FY 2029, growing at about 6 % (CAGR) over the 2024 - 2029 period. Interestingly, the annual investment in agricultural machinery in India is close to 25% of the total farm subsidies of USD 50 billion given by the Government. Fertilizer and power absorb 45.6% and 30% of all input subsidies, respectively, while irrigation, credit, and crop insurance get 16.4%, 5.07%, and 2.69%, respectively. The growth is attributed to factors such as education, research, infrastructure development, industrialization of agriculture, advancements in crop science, and rural labour scarcity.

In conclusion, agricultural mechanization presents huge possibilities in reducing the cost of cultivation, increasing the profitability, reducing the human drudgery in agricultural operations, and improving the rural and urban life leading to sustainability.

