

Impact of Agricultural Engineering Research on Indian Agriculture and Beyond

Dr. S. N. Jha
President, ISAE &
DDG (Agricultural Engineering), ICAR

Agricultural Engineering is providing the speed and scale to the Indian Agriculture as the luxury of putting more area under cultivation is drying up. Increasing the per unit land and labour productivity in the realm of over 69% of marginal farmers with less than one-hectare land and continuously declining land holdings pushed more than 86% farmers to small and marginal farmers' categories. According to a third party report submitted to Department of Agriculture and Farmers' Welfare, Government of India, mechanization saves 15% – 20% seeds, fertilizers and 20%-30% time, increases germination by about 25 %, reduces weeds and labour by about 20%-40% and enhances cropping intensity by 5%-10% and yield by 13% -23%. This means mechanization is a sure shot way to mitigate the challenges being faced by the Indian Agriculture. Recognizing these facts and essentiality, **the 58th Parliament Standing Committee on Agriculture, Animal Husbandry, and Food Processing** has given target of increasing the average mechanization level of the Indian Agriculture from current 47% to 75% by 2047 and recommended to



open Directorate/Department of Agricultural Engineering in each state employing Agricultural Engineers in district, block and Panchayat levels in sufficient numbers.

Agricultural Engineering technologies have played a pivotal role in Indian Agriculture. Imagine if a wheat thresher and proper irrigation pump would not have been available during the green revolution period and combine harvester during COVID-19 period for harvesting of wheat. Irrigation without pump, harvesting

without combine harvester when all labour forces were off the farm, and threshing of wheat without threshers could have been impacted badly in production and post-production operations of Indian Agriculture. India is now the highest producer of quality tractors and net exporters of farm machinery (Fig. 1) including tractors and ginning machinery to the tune of about Rs 12000 and Rs. 300 crores, respectively, per year. Impact study of only a few machineries, tools and gadgets indicates economic gains of about Rs. 7210 crores annually besides social intangible gains like easing of operations, improving comfort, health benefits, and allied income of stakeholders.

To minimize the wastage of water in agriculture sector, the scientific methods of water application systems such as micro-irrigation is the game changer for better on-farm water management practices. Standardized irrigation and fertigation schedules using drip irrigation have showed promising outcomes with 9-80% higher yield, 11%-71% irrigation water saving, 18%-25% fertilizer

saving and 10-200% higher income from various crops grown under varying soil textural classes across the country. The average penetration rate of micro-irrigation in India is about 19%. As of 2023, the area under micro-irrigation in India is approximately 83.46 lakh hectares, covered under the Per Drop More Crop (PDMC) scheme. During the last five years, about 70,000 ha waterlogged saline soils have been reclaimed in different states of India through subsurface drainage technology. This has resulted in 25%-100% improvement in cropping intensity and significant enhancement in crop yields (upto 45% in paddy, 111% in wheat and 215% in cotton). Recent development of check dams using rubber and fibre reinforced plastic (FRP) are in deploying stage and may change the scenario of water conservation and land degradation in plains and hilly regions, respectively. ICAR flexible check dam (rubber dam), an inflatable structure build across a stream, has the ability for better water conservation, flood control and regulating flow of water in the stream and has been successful in watersheds in different parts of the country. Participatory integrated watershed management approaches covering biophysical and socio-economic interventions have shown rich dividends for ensuring resilience to climate change. A well-managed watershed supports human wellbeing by providing direct economic benefits (e.g., provisioning services such as food and fruits), as well as a host of indirect benefits, including regulatory, cultural, and supporting services. To have production of high value crops in harsh conditions, agricultural engineering research has contributed in the field of greenhouse/protected cultivation and it has covered 1,27,000 hectares till 2018 and has given several

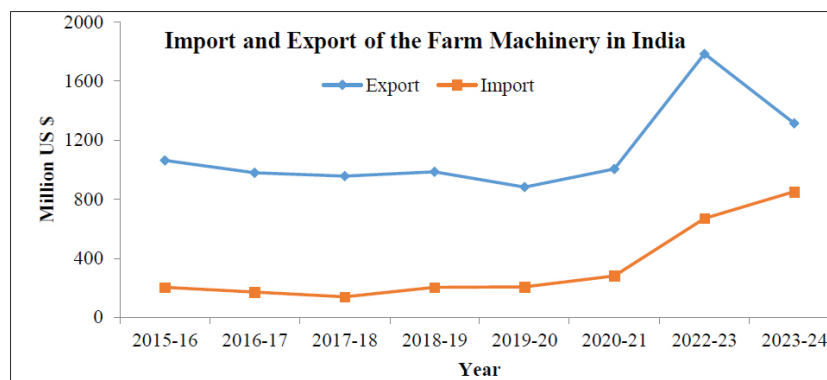


Fig. 1. Overall approximate import/export of farm machinery (including tractors) of India

standardised design of structure for all parts of the country.

On renewable and bio-energy front, contributions of Agricultural Engineers are visible at national level and Government of India therefore has made target to fulfil around 33% and 75% of India's and rural areas' energy needs respectively through solar, wind, geo-thermal and bio-mass energy. According to the Central Electricity Authority of India, about 50% of the country's power supply will be generated by renewable energy sources by 2030. Wider adaptation of biogas technologies has made biomass-based electricity generation systems

and bio-CNG plants operational in the country. Thermo-chemical and biochemical conversion based electrical power routes are available and there is a need to promote these with better incentives.

Agricultural Engineers pioneered the concept of Agro-Processing Centers (APC) since 1980 in production catchments by providing technical guidance and monitoring. These APCs have an impact in terms of reduction of storage and processing losses, higher recovery, cost saving, energy saving, timeliness of operation, premium price for better quality, maintaining hygienic conditions and improved comforts



and social and economic wellbeing of different stakeholders. More than 300 such APCs have been established through explicit intervention of ICAR, each of which generates direct employment to 4-6 persons and average annual profit of about Rs. 5.0 lakh. Successes of these APCs have played a key role in formulating several Government schemes.

India is only country after USA to have its own calibration cotton as standard of cotton fibre and several value added products and machinery for other natural fibres and those are testament contributions of Agricultural Engineering research in India. Quantity of Post-harvest losses of foods have decreased from about 74.11 million tonne in 2012 to 66.48 million tonnes in 2021 (accounting for 54 commodities) and thereby saving 7.63 million tonnes of food due to adoption of post-harvest technological interventions and infrastructural development. PH loss study of 2012-13 reported monetary loss of ₹92,651 crores (about 11300 million USD) (for 65.4 million tonnes of 45 commodities only). With the premise that if the extent of losses recorded in 2012-13 would have continued, the value loss estimated would have been ₹1,66,593.72 crores (about 2030 million USD) in 2021-22. However, study by NABCON in 2021-22 estimated the monetary loss of ₹1,46,153.15 crores (about 17,820 million USD) for 45 crops covered under 2012-13 study. The difference of monetary losses of 45 commodities resulted in savings of ₹20,440.58 crores (about 2,493 USD). In addition, adoption of ICAR recommendations for uniform norms for loss calculation in FCI and CWC godowns (One nation one norms) about Rs. 540 crores (about 660 million USD) is being saved annually to FCI



Fig. 2. Laser land leveller



and CWC combined.

The contributions of Agricultural Engineering on on-farm and off-farm mechanization have been unparalleled and have added value in food, feed, fodder, fibre, natural resins and gums. Some important contributions which have impacted indelibly include a mass scale adoption of rotavator, laser guided land levellers (Fig. 2), zero till drill, paddy drum-seeder, seed-cum-fertilizer drills, inclined plate planters, micro-irrigation systems, combine harvesters, threshers, mini dal mill, maize sheller, makhana popping machine, accelerated jute retting system, diversified jute products,

cotton ginning technology, small and medium lac processing plants, non-destructive diagnostic tools and methods for fruits and vegetables etc. In fact, use of sensors, big data analysis, infrared spectroscopy, artificial intelligence, remote sensing, establishment of food testing laboratories with modern technologies etc. are the pioneering contributions of Agricultural Engineers in the Indian Agriculture, which now are the words of mouth of every researcher. Agricultural Engineering Research have improved socio-economic status of populations many folds as compared to other fields of research and is driving force of Indian Agriculture and Agriculture based startups. Agricultural Engineering education, research and extension need primary focus for giving further speed and scale to Indian Agriculture.

