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Application of electric drives in agricultural application

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Abstract
Agricultural mechanization involves the use of various power sources and improved farm tools and equipment, with a view to reduce the drudgery of the human beings and draught animals, enhance the cropping intensity, precision and timelines of efficiency of utilization of various crop inputs and reduce the losses at different stages of crop production. It is the miracle of soil of India that it provides food to 1.3 billion population with just an average farm size of less than 1.08 ha. Small and marginal land holdings (< 2.0 ha) contribute to 86% of total operational land holdings and cover 47% of total operated area (Department of Agriculture, Cooperation & Farmers Welfare, 2018). The share of draught animal power is decreasing in the total farm power. There is a linear relationship between availability of farm power and farm yield. Therefore, there is a need to increase the availability of farm power from 2.02 kW per ha (2016-17) to 4.0 kW per ha by the end of 2030 to cope up with increasing demand of food grains. Estimates suggest that by 2050, percentage of agricultural workers of the total work force would drop to 25.7 percent from 58.2 percent in 2001. The need for agricultural equipment caused by increasing world population is more than obvious. Current agricultural equipment has reached its optimization limits in terms of complexity and efficiency with the current technology. Furthermore, improvements in the area of drive technology currently mainly mechanical or hydraulic drives are limited. Therefore, the focus in this area will be on electrical drives in the future. Electrification of implements has the potential for energy savings through more efficient power transfer and savings from the precision agriculture perspective through more efficient and effective application of seed and chemicals. Parallel development of electrified tractors and implements, along with standardization of electric power protocols and hardware, will be key to further development of electrification of mobile agricultural equipment.

Keywords: Electric vehicles in agriculture, battery powered prime mower, tool carrier

Introduction
Vehicles in agricultural applications currently use 14V electricity only for on-board use. Introduced at the 2007 Agritechnica Fair a high voltage system was added to an agricultural vehicle, the John Deere E Premium tractor. This new system provides power to electrically driven engine auxiliaries. In addition to that intelligent control of auxiliary drives helps to reduce the fuel consumption of the vehicle especially under part load conditions, just driving the auxiliaries at the actual required power level. The E Premium tractors represent the first high power electrification approach in series production within agriculture and already represents a catalyst for further electrification in agricultural equipment.
The main drivers for the usage of higher voltage on agricultural machines are:

- Optimized controllability of power flows across agricultural machines and between machines
- Generate sufficient electrical power
- Reduced parasitic loads caused by engine auxiliaries to improve complete machine efficiency
- Increased flexibility in arrangement of components
- Increase productivity and operator comfort.

Electric drives have entered the arena of agricultural machinery. Electrical driven tractor engine auxiliaries have already been introduced to a serial production tractor. Providing just the required power to auxiliary drives independent from the diesel engine speed increases the tractor efficiency or allows being more productive. Intelligent control of auxiliary drives helps to reduce fuel consumption. First concepts and prototypes have been shown that have electrical traction drives on tractors. Other self-propelled machines have comparable needs in terms of drives and will likely follow in the future. The availability of electrical components meeting the design criteria for agricultural equipment is one key for success.

The tractor-implement system electrification represents the next mayor step towards future machine systems. Transfer of technology coming from automation industry and automotive applications is possible in regard of agricultural machines. Agricultural system engineering will apply electric drive technologies to optimize processes and reduce input costs. Obvious system level benefits of electric drives will allow designing new types of machinery. To make all this happen a standardized interface between the tractor and the implement is one key element for success. Mitigation scenarios have to be provided for existing equipment to allow creating critical mass of users. This will create acceptance for this new technology. The ideas for system-level opportunities in combination with automation, navigation and energy storage systems have to be developed.

Lohit & Hasson (2019) [1] evaluated solar operated Paddy Harvester. The steady showed that they designed multipurpose cutting blade which is operated by solar energy. In this steady the only part is operated by solar energy is cutting blade and the operation takes place by holding on hands.

Jain *et al*. (2013) [2] designed and fabricated small-scale harvesting machine, consisted of motor and different mechanisms. The cost of the machine was Rs 30,000. The machine had a capacity to cut 3.75 ton of sugarcane per hour. Compared with manual harvesting 50% of harvesting time and 60% of labors are reduced (in manual crop (sugarcane) harvesting 15-16 labors are required). The cost of harvesting is reduced by 34% compared to manual harvesting.

Boyle *et al*. (2012) [3] evaluated performance of self-propelled cereal reaper. The study showed that the effective field capacity, field efficiency and fuel consumption were 0.21 ha/h 80.76% and 0.45 L/h, respectively at forward speed of 2.15 km/h. The cutting width of the reaper was 1.2 m and total loss of crop was 3%. The labor requirement of mechanical harvesting was 15 manh/ha against for manual harvesting was 240 manh/ha. Mechanical harvesting saved 94% labour requirement of manual harvesting. The reaping cost by reaper was Tk. 626/ha.

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