

Perspective of Agricultural Mechanization in Supaul District of North Bihar- A Research

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Abstract: As a major sector, agriculture continues to be the life line for millions of farmers in Bihar; India. Change in the production and productivity in the field of agriculture being possible in Bihar due to a massive diversion from the traditional agriculture to new commercial agriculture. As urbanization in the state is still very poor, nearly 90 per cent of the population lives in rural areas. The State of Bihar is also lagging behind the national average On all socio-economic indicators like per capita income, average size of operational holding, per capita cultivated land, percentage of villages electrified, road length per thousand sq km, per capita deposit, per capita bank credit, credit deposit ratio, male-female literacy, and life expectancy etc. Bihar is considered to be at the bottom. State of Bihar and mostly its North region have flood effected area thats why farmers live at this place became poor due to crops affected by floods .Farmers used only traditional cropping system at this place due to poor economy and abandoned by industries and govt. policies. So if farm mechanization applied at this place then the condition of the farmers will improve due to increase in the production of crops. In this paper we are going to research on the present condition of the Bihar in farm mechanization and also proposed a research on perspective of agricultural mechanization in Supaul district of North Bihar.

Keywords: Agriculture, Planters, tillage, Farm mechanization, North Bihar, Supaul District.

I. Introduction

Technology and machinery enhanced the ability, quality, accuracy and efficiency of the human being. By using technology in any field the rate production and quality automatically increases. The country witnessed unprecedented growth in agriculture which has helped India to graduate from hunger to self sufficiency in food grains by increasing the food grain production from 51 million tonnes to 208 million tonnes [], with surplus for export. [] The technology back-up by agricultural scientists, in the form of “Green Revolution” combined with industrial growth, positive policy support, liberal public funding for agricultural research and development and dedicated work of farmers contributed to the phenomenal increase in agricultural, animal and fish production. Application of engineering in agriculture was equally appreciated by the farmers and today they feel proud to have improved machinery from Bakhars to rotavators, Persian wheel to drip and micro-sprinkler systems, cone-dibblers to pneumatic planters, sickles to combine harvesters, sieve to colour sorters, and, kolhus to solvent extraction plants, and hand mills to roller flour mills, etc. The farmers are not afraid of hot or cold desert and vagaries of weather as they have green houses and low tunnel plastic houses technology to grow crops in any place at any time of the year.

Farm mechanization helps in effective utilization of inputs to increase the productivity of land and labour. Besides it helps in reducing the drudgery in farm operations. The early agricultural mechanization in India was greatly influenced by the technological development in England. Irrigation pumps, tillage equipment, chaff cutters, tractors and threshers were gradually introduced for farm mechanization. The high yielding varieties with assured irrigation and higher rate of application of fertilizers gave higher returns that enabled farmers to adopt mechanization inputs, especially after Green revolution in 1960s. The development of power thresher in 1960, with integrated Bhusa making attachment and aspirator blower and mechanical sieves for grain and straw separation, was the major achievement of Indian engineers. These threshers were widely adopted by the farmers. Gradually demand for other farm machinery such as reapers and combine harvesters also increased. Equipment for tillage, sowing, irrigation, plant protection and threshing has been widely accepted by the farmers. Even farmers with small holdings utilize many improved farm equipment through custom hiring to ensure timeliness of farming operations. The present trend in agricultural mechanization is for high capacity machines through custom hiring and for contractual field operations. However, mechanization of horticulture, plantation crops and commercial agriculture is yet to be introduced in the country. The pace of farm mechanization in the country accelerated with the manufacture of agricultural equipment by the local industries. With the modest beginning of manufacture of tractors in 1960s with foreign collaboration, to-day the Indian farm machinery industries meet the bulk of the requirement of mechanization inputs and also export.

In this paper we are going to research on the use of the mechanization in the agriculture sector and impact of it in India and its poor states like Bihar.

II. Historical Background

Farm machines have not only increased the mechanical advantage, but also helped to reduce drudgery while performing the different agricultural operations. The contributions of agricultural mechanization in various stages of crop production could be viewed as saving in seeds, saving in fertilizers, saving in time, reduction in labour, increasing in cropping intensity and higher productivity. The historical background of the farm mechanization in India explained further in this section.

The traditional fabricators of agricultural equipment in India had done by blacksmiths and carpenters. The early agricultural mechanization in India was greatly influenced by the technological development in England. In 1889, Watts and Kaiser introduced ploughs, corn grinders and chaff cutters Cawnpore (now Kanpur) Experimental Farm in Uttar Pradesh. Sardar Joginder Singh (1897-1946), who was the Agriculture Minister in the Punjab Government (1926-37), introduced the steam tractors in India in 1914 for reclamation of waste land and eradication of 'Kans'. Horse drawn and steam tractor operated implements were imported during the latter part of the 19th century. The horse drawn equipment imported from England were not suitable for bullocks and he-buffaloes used in India and thus, were suitably modified by small scale manufacturers to suit Indian draught animals. With the establishment of Allahabad Agricultural Institute, Allahabad in 1942, the development activities in agricultural machinery accelerated and as a result bullock drawn Meston, Shabash and Wah-Wah ploughs were introduced in Uttar Pradesh, manufactured by the Agricultural Development Society, Naini in early forties.

The Indian farmers gradually responded to farm mechanization technology especially after Green revolution in 1960s. High yielding varieties with assured irrigation and higher rate of application of fertilizer gave higher yields and better economic returns. This enabled the farmers to start adopting mechanization. The development of power thresher with integrated Bhusa making attachment and aspirator blower and mechanical sieves for grain and straw separation in 1960s was the major achievement of Indian engineers which was widely adopted by our farmers. Gradually demand for other farm machinery such as reaper and combine harvester also increased. Demand of tractors in the country was met through importation until 1961 when Eicher Tractors Ltd. and Tractors and Farm Equipment Ltd started manufacturing tractors with foreign collaborations. To meet the additional demand, importation continued up to 1977. Meanwhile many other industries started manufacturing tractors with foreign know how such as Gujarat Tractors Ltd (1963), Escorts Ltd (1966), International Tractors (India) Ltd. (1966), and Hindustan Machine Tools Ltd (1977). Punjab Tractors Ltd. started their production with indigenous technology in 1974.

Many authors have done research on the farm mechanization and its effect on the production of the crops and farmers which have explained further in this section. Giles (1975) reviewed power availability in different countries, and demonstrated that productivity was positively correlated with potential unit farm power. The NCAER (1981) assessed the impact of tractorisation on the productivity of land (yield and cropping intensity), and economic growth (income and employment). The trends for European and Asian countries were, however, distinctly different. Binswanger (1982) defined the status of mechanization by the growth of mechanically power-operated farm equipment over traditional human and animal power operated equipment. Rijk (1989) reviewed the growth of mechanization in different Asian countries, and suggested computer software (MECHMOD) for the formulation of strategy for mechanization policy based on economics of use of animate and mechanical power for different field operations.

III. Methodology

In this section we are discussed about the agricultural mechanization, different impact of it on the different sectors of agriculture, impact on the farmers' life and different challenges for farm mechanization in India.

3.1 What is Mechanization

Mechanization or mechanisation is the process of changing from working largely or exclusively by hand or with animals to doing that work with machinery. In an early engineering text a machine is defined as follows:

Every machine is constructed for the purpose of performing certain mechanical operations, each of which supposes the existence of two other things besides the machine in question, namely, a moving power, and an object subject to the operation, which may be termed the work to be done.

Machines, in fact, are interposed between the power and the work, for the purpose of adapting the one to the other.

In some fields, mechanization includes the use of hand tools. In modern usage, such as in engineering or economics, mechanization implies machinery more complex than hand tools and would not include simple devices such as an ungeared horse or donkey mill. Devices that cause speed changes or changes to or from reciprocating to rotary motion, using means such as gears, pulleys or sheaves and belts, shafts, cams and cranks, usually are considered machines. After electrification, when most small machinery was no longer hand powered, mechanization was synonymous with motorized machines.

3.2 Farm Mechanization

Farm mechanization has been defined as the process of development and introduction of mechanized assistance of all forms and at any level of technological sophistication in agricultural production in order to reduce human drudgery, improve timeliness and efficiency of various farm operations, bring more land under cultivation, preserve the quality of produce, improve living condition and markedly advance the economic growth of the rural sector.

Farm mechanization is an important element of modernization of agriculture. Farm Productivity is positively correlated with the availability of farm power coupled with efficient farm implements and their judicious utilization. Agricultural mechanization not only enables efficient utilization of various inputs such as seeds, fertilizers, plant protection chemicals and water for irrigation but also it helps in poverty alleviation by making farming an attractive enterprise.

Traditionally humans and animals were used for field operations and processing activities. As a result of introduction of mechanical powers, the process of farm mechanization began. Adoption of agricultural tools/machinery and other implements provide technology to facilitate agriculture by efficient utilization of inputs, besides reducing drudgery. Traditionally, Indian farmers relied on equipments, which were simple and could be easily fabricated by village craftsmen. Since introduction of mechanical power, agricultural engineering started gaining importance and thus organized professional activities started. It is generally believed that the benefits of modern farm technology have been availed by large farms only. Even farmers with small holdings utilize selected improved farm equipments on custom hiring basis to improve productivity and thus, ultimate increase in quantum of production. Such use of improved farm implements and equipments is preferred with a view to reduce cost of production also.

3.3 Impact of Farm Mechanization on the Agriculture

Agricultural mechanization plays an increasingly important role in agricultural production in the Wor. It reduces drudgery, increases the safety and comfort of the working environment; it enhances productivity, cropping intensity and production. It increases income for agricultural workers and then improves social equality and overall living standards. If properly used, it also conserves and properly utilizes natural resources and reduces the cost of production. It allows for timelier farm operations, effectively deals with climate change, produces better quality agricultural commodities, etc.

It is necessary, therefore, to use modern equipment in agriculture and to use modern science and technology to re-invent agriculture. The region needs, inevitably, to accelerate the development of agricultural mechanization.

Resultantly gross food production increased from 50.8 M tons in 1950-51 to 199.3 M tons in 1996-97 and land productivity rose from 0.58 tons/ha/year to more than 2.14 tons/ha/year. From the different studies the following impacts of the mechanization on the agriculture given below.

- (i) That farm mechanization led to increase in inputs on account of higher average cropping intensity and larger area and increased productivity of farm labour.
- (ii) That farm mechanization increased agricultural production and profitability on account of timeliness of operation, better quality of work done and more efficient utilization of inputs.
- (iii) That farm mechanization increases on- farm human labour marginally, whereas the increase in off- farm labour such as industrial production of tractors and ancillaries was much more.
- (iv) That farm mechanization displaced animal power to the extent of 50 to 100% but resulted in lesser time for farm work.

3.4 Impact of Farm Mechanization on the Farmers

The effects of the farm mechanization on the farmers are in the form of new seed, fertilizer technology, new cultural techniques of farming, modern farming implements and changes in the timing of operations. Typically, however, improvements in technology also increase the productivity of capital and alter the technological rates of substitution of capital for manpower, reducing the amount of capital that is necessary to replace a unit of manpower at particular levels of output. Other innovations make it possible to reduce the amount of manpower in relation to land needed to produce specified levels of output.

Mechanization affects the coat structure of agricultural production by:

- Saving labour (manual and bullock)
- Easing jobs
- Increasing yield
- Saving land
- Facilitating the opening up of new land.
- Conserving natural resources

Most implements and machines bring about several of these effects simultaneously. A tractor, for instance, saves animal and human labour-hours and at the same time makes jobs (e.g., ploughing) easier too. If the tractor actually replaces several draught cattle on the farm, the land formerly needed to grow fodder for the bullocks becomes free for the cultivation of food or cash crops. In regions with scarcity of draught cattle, the tractor facilitates the cultivation of waste land or reduction of fallow land. A threshing machine saves labour hours of bullocks and labourers and decreases loss of grain during the process of threshing. A drilling machine saves seed and increases yield. These examples may suffice to demonstrate the different effects achieved by different machines and implements.

No doubt machines and implements which increase the yield or diminish losses of farm production are desirable not only from the point of view of higher income for the individual farmer but also in the interest of the country as a whole, to increase the food supply for its rapidly growing population. Above implements and machines are available at comparatively low prices or can be used by several farmers on a cooperative basis, they are within the reach even of own cry of small holdings, which constitute the majority of Indian farms. Whereas the quantum jump in production and productivity was brought about by a combination of factors, farm mechanization was often at the centre of controversy due to its impact on employment of human labour in a labour abundant economy.

3.5 Factors Affecting on the Farm Mechanization or Challenges For Farm Mechanization

As increasing demand for industrialization, urbanization, housing and infrastructure is forcing conversion of agricultural land to non-agricultural uses. The scope for expansion of the area available for cultivation is limited. According to agriculture census 2013-14, small and marginal holdings of less than 2 hectare account for 86 % of the total operational holdings and 45 % of the total operated area. The average size of holding for all operational classes (small and marginal, medium and large) has declined over the years and has come down to 1.08 hectare in 2013-14 from 2.82 hectare in 1970-71 (Anonymous, 2014).

Unlike other agricultural sectors, farm mechanization sector in India has a far more complex structural composition. It is facing various challenges related to farm machinery and equipment, technology, markets, operations, legislation, policy framework and other related areas. Land size, cropping pattern, market price of crops including Minimum Support Price (MSP), availability of labour and cost of labour are the major factors deciding the agricultural mechanization.

These challenges pose a serious impediment to the growth of the industry and agriculture. The key challenges faced by the farm mechanization in India (Mehta and Pajnoo, 2013) are as follows.

- a) The average farm size in India is small (1.08 ha) as compared to the European Union (14 ha) and the United States (170 ha). Therefore, there will be little mechanization unless machines appropriate for small holdings are made available. Due to small size of land holdings, it is difficult for the farmers to own machinery. As a result, the benefits of mechanization are enjoyed by only a section of the farmers who have large farm holdings.
- b) Mechanizing small and noncontiguous group of small farms is against 'economies of scale' especially for operations like land preparation and harvesting. With continued shrinkage in average farm size, more farms will fall into the adverse category thereby making individual ownership of agricultural machinery progressively more uneconomical.
- c) The major constraint of increasing agricultural production and productivity is the inadequacy of farm power and machinery with the farmers. The average farm power availability needs to be increased to minimum 2.5 kW/ha to assure timeliness and quality in field operations, undertake heavy field operations like sub-soiling, chiseling, deep ploughing and summer ploughing.
- d) Matching equipment for tractors, power tillers and other prime movers are either not available or farmers make inappropriate selection in the absence of proper guidance, resulting in fuel wastage and high cost of production.
- e) Almost 90 % of tractors are sold in India with the assistance of some financial institution. Sale of farm machinery is driven by factors like financial support, limit of funding (in terms of percentage of the cost), funding/financing institution and the applicant's profile (deciding the credibility of the loanee).
- f) The high cost and energy efficient farm machinery are capital intensive and majority of Indian farmers are not able to acquire these assets due to shortage of capital with them.

- g) Cropping pattern decides the extent of mechanization required for timely operations and achieving optimum results. The scope of mechanization increases with intensive cropping pattern. Price realized by the crop is also an important factor, as it indicates the cash in hand for the farmer.
- h) Hill agriculture, which covers about 20 % of cultivated land, has little access to mechanization. This situation has to be improved by developing and promoting package of technology for mechanization of hill agriculture to achieve higher productivity.
- i) There are wide technology gaps in meeting the needs of various cropping systems and regions. The Indian farmers have limited access to the latest equipment and technology. Further, there is little feedback from the farmers for product improvement and product acceptance.
- j) The quality of farm implements and machinery manufactured by small scale industries in the country is generally not of desired standard resulting in poor-quality work, longer down time, low output and high operational cost. The quality of equipment has to be improved.
- k) The after sales service of farm machinery is the other concern in India as the majority of farmers are cost conscious. There are inadequate service centers for proper upkeep of the machinery.

3.6 Farm Mechanization Tools

(i) Tillage and planting machinery

The traditional animal drawn country plough has low output (30-40 h/ha). Tractor drawn MB plough, harrows, cultivators and rotavator are better machinery used by the farmers. There is need for high capacity machines for custom hire services. For precise application of seed and fertilizer, mechanically metered seed drill and seed-cum- fertilizer drill operated by animal and tractor have been developed and are being manufactured to suit specific crops and regions. Zero till drill and strip till drill have also been developed to reduce energy inputs in crop Production. CIAE has developed farm equipment like inclined plate planter and pneumatic planter for precision sowing. Following tools are used for the tillage and plantings of crops.

- Ploughs
- Rotavator
- Land levelers
- Cultivators
- Disc harrows
- Scrapers
- Tractor-mounted inclined plate planter
- Furrower
- Twin auger digger sugarcane planter
- Three-row rotary weeder

(ii) Interculture and plant protection equipment

Use of long handle wheel hoe and peg type weeders are being accepted as they reduce drudgery and weeding time to 25-110 hours from 300-700 hours in conventional practice. Animal drawn weeder and cultivator are also used for control of weeds. Self propelled and power operated weeders are being increasingly accepted on limited scale. Different designs of low cost hand operated sprayers and dusters are available for application of plant protection chemicals. Low volume and ultra-low volume (ULV) sprayers, which require comparatively smaller quantity of water, are also in use.

(iii) Irrigation and drainage equipment

Diesel and electric pump sets are common. The shift from conventional flood irrigation to sprinkler, micro sprinkler or drip irrigation systems is apparently visible indicating the importance of water use efficiency for covering more area under irrigation. The Government support in the form of subsidy is serving as a catalyst to compensate for the high initial cost of the system.

Importance of drainage for achieving improved productivity is being realized by the farmers and progressive farmers are going for subsurface drainage, which is high initial cost technology. The low-cost mole drainage technology and equipment has been developed for vertisols. The mole drain laying cost is about 70 US\$ /ha (4200 INR) and the same is recovered in one crop season. The farmers are getting attracted in favour of this technology. However, it is just a beginning of adoption of the technology. In years to come, it is expected to be common feature among the farmers. Efforts are on to popularize this technology through demonstrations and awareness programs.

(iv) Harvesting and threshing

Sickle is the major low cost traditional tool for harvesting. Self-sharpening serrated sickle is finding adoption. CIAE walk behind and self-propelled reaper harvesters, which facilitate quick harvesting, is getting acceptance.

Traditional threshing by animal treading has been almost fully replaced by power threshers operated by 5-15 hp engine or electric motor. Pedal operated paddy threshers reduce drudgery and have become popular in India. Whole paddy straw is obtained by using rasp bar type axial flow thresher. Combine harvesters are being used for harvesting wheat, paddy, soybean and gram in few states.

3.7 Strategy for Mechanization of Indian Agriculture

Agricultural mechanization should contribute to sustainable increase in productivity and cropping intensity so that the planned growth rates in agricultural production 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. India adopts a policy of selective mechanization under diverse conditions, which makes the agricultural mechanization a challenging task.

An appropriate mechanization technology suiting to the needs of the farmers is required to be adopted. This may be achieved by following a few points as mentioned below.

- a) The widely fragmented and scattered land holdings in many parts of the country need to be consolidated (virtual or real) to give access for their owners to the benefits of agricultural mechanization.
- b) There is a need to have more interaction among the farmers, research and development workers, departments of agriculture and industry to make farm machinery research and development base stronger.
- c) To achieve higher production levels, the quality of operations like seedbed preparation, sowing, application of fertilizer, chemicals and irrigation water, weeding, harvesting and threshing will have to be improved by using precision and efficient equipment.
- d) The rice transplanting operation can be mechanized 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).
- e) The benefits of agricultural mechanization should be extended to all categories of farmers with due consideration to small and marginal farmers, to all cropping systems including horticultural crops and to all regions of the country especially the rainfed areas.
- f) There is a need to innovate custom service or a rental model by institutionalization for high cost farm machinery such as combine harvester, sugarcane harvester, potato combine, paddy transplanter, laser guided land leveller, rotavator etc. and can be adopted by private players or State or Central Organizations in major production hubs.
- g) The high capacity rice combines may be introduced to paddy growing areas on custom hiring basis. It will help in timely harvesting and better yield of paddy crop.
- h) 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).
- i) The farm machinery bank may be established for machines being manufactured elsewhere in the country and supply to users/farmers on custom hiring mode.
- j) Provision may be made for special credit support at lower interest rates to rural individuals, venturing into entrepreneurial use of farm machinery through custom hiring (Mehta and Pajnoo, 2013).
- k) Manufacturing units that are set-up in areas with lower mechanization needs to be supported by extending tax and duty sops. This would result in easier reach of the equipment to farmers in those areas (Mehta and Pajnoo, 2013).
- l) There is a need for quality manufacturing and after sales support for reliability of farm machinery. This may be achieved by streamlining of testing procedure, training of engineers and conducting testing of farm equipment for standardisation and quality control in farm equipment manufacturing.
- m) There is a need for strengthening training programmes at various levels and for different categories of people on operation, repair and maintenance of agricultural machinery, tractors, power tillers, rice transplanters, combines etc. and for transfer of technology.
- n) The quality of life and work environment of farmers/farm women need to be improved. Their work involves considerable drudgery and discomfort. Proper ergonomic designs of agricultural equipment, incorporating latest safety measures and 'comfort features' should be made available.

IV. Proposed Research

This section explains and gives the preliminary research on "Impact of farm mechanization in Supaul district of Bihar". Bihar, as other eastern states of India, characterized by good soil, adequate rainfall, favourable hydrological profile & water resources, and congenial temperature regime, has high agricultural production potential.

Yet, its agricultural productivity is one of the lowest in the country, resulting in high poverty, unemployment, and overall deprivation in the State. In fact, this state represents the heart of the great Indo-

Gangetic Plains-one of the most fertile plains of the world. But, enigmatically, this plain continues to be “rich State inhabited by poor people”. The untapped production reservoir of the State must, therefore, be harnessed judiciously, not only to liberate the State from its socioeconomic and ecological glooms, but also to trigger the process of invigoration of the “Greatest Living Industry” of the nation. The world experience suggests that agriculture sector has been the pre-cursor of economic growth process. Bihar cannot be an exception. Let prosperity be ushered in Bihar by bringing another farm revolution.

Bihar is a land-locked state situated on the eastern part of India. It is situated between 83°-30' to 88°-00' longitude and 21°-58' to 27°-31' latitude. The state is roughly quadrilateral in shape situated on the north east side of India. It share international border with Nepal in its north, Uttar Pradesh on its west, West Bengal in the east and newly carved state of Jharkhand on its south.

The state is divided by river Ganga into two parts , the North Bihar with an area of 53.3 thousand sq. km. and the South Bihar having an area of 40.9 thousand sq. km. Bihar has 14 river basins namely ; (i) Ghaghra , (ii) Gandak , (iii) Burhi Gandak , (iv) Bagmati , (v) Kamla Balan , (vi) Kosi , (vii) Mahananda , (viii) Karmnasa , (ix) Sone (x) Punpun , (xi) Kiul-harhar , (xii) Badua , (xiii) Chandan , and (xiv) the main Ganga stem . All these rivers drain into the main Ganga stem. The six river system, from Karmnasa to Chandan, draining the southern part of Bihar originates primarily from Indian territories in the state of Bihar, Jharkhand and Chhatisgarh.

The seven river system from Ghaghra to Mahananda drains North Bihar. Most of these river systems of North Bihar originate in Tibet and Nepal and hence they are international rivers. Any rainfall occurring in Tibet and Nepal directly affects the flow in these river systems and flooding of North Bihar is thus a recurrent phenomenon.

Agriculture is the backbone of Bihar’s economy, employing 81% of the workforce and generating nearly 42% of the State Domestic Product. The State with geographical area of about

94.2 thousand sq. km., has the natural endowment of fertile soil, good rainfall, plenty of water resources, and agro-climatic conditions suitable for growing three crops a year and almost all types of crops. According to 2001 Census the population of the state is 82.9 million and growing at the rate of more than 2% per annum. It is therefore important to sustain self sufficiency in food grain production with rate of growth of food grain production greater than population growth rate.

Agriculture is not only the source of livelihood but also it generates raw material for the agro based industries which has immense potential in the state. With a view to bring Second Green Revolution in the eastern region of the country (particularly in Bihar) the agricultural activities being undertaken based on ‘Rain God,’ will have to be linked with science. There is need to move towards farming system from cropping system. Institutional assistance, technological transfer and innovation are the pre-requisites for the success of second green revolution. Blinking away the constraints and removing challenges before the agricultural sector of Bihar will not be possible, unless agricultural mechanization is emphasized. In Bihar, agricultural sector is faced with mainly four key challenges:

- (i) nano size of land holdings,
- (ii) low yields and high risks,
- (iii) biotic and abiotic constraints in raising crop yields, and;
- (iv) weak institutions accompanied by poor infrastructure.

A strong argument depicting comparative backwardness of the state in regard to Agricultural Mechanization can be its low KW/hectare use of machinery. The same for Bihar was 1.00 Kilo Watt/hectare. It was much lower than Punjab (3.75 KW/ha i.e., the highest in India and even lower than the national average (1.5 KW/ha. The level of agricultural mechanization was meant for the period 2009-10. As per the execution guidelines of the Agricultural Mechanization Programme/Scheme 2009-10 it was to be launched in all the districts of Bihar. The programme of Farm Mechanization included:

- (i) MMA,
- (ii) ISOPOM,
- (iii) Jute Technology Mini Mission – II,
- (iv) NFSM,
- (v) RKVY, and;
- (vi) State Plan for Promotion of Power Tiller (SPPPT).

Under these six schemes, farmers are provided with the implements, machines and/tools like the following:

- (i) Tractor, (ii) Power Tiller, (iii) Zero till Seed-Cum-Fertilizer-Drill, (iv) Raised-bed Planter, (v) Sugarcane-Cutter Planter, (vi) Potato planter, (vii) Potato digger, (viii) Tractor driven reaper, (ix) Seed cleaner-cum-grader, (x) Mobile foot harvester, (xi) Power weeder, (xii) Power thresher, (xiii) Winnower, (xiv) Conoweeder (xv) Irrigation pipe, (xvi) Sprinkler, (xvii) Pump set (diesel/electric driven), (xviii) Rotavator, (xix)

Combine harvester, (xx) wheel-ho, (xxi) Multi row seed drill, (xxii) Sprayer duster, and; (xxiii) Other power driven/human driven agricultural implements, machines, etc.

V. Conclusions

Bihar agriculture has the potential to grow rapidly so as to meet the existing shortages and assume primacy in the national agricultural economy. The State has immense agricultural resources, to facilitate a Second Green Revolution in the Country. Bihar must aim at an annual agricultural rate of 5-6%. However, despite the strength of the agriculture sector, it is a paradox that this sector is growing at a snail's pace. The rate of growth has been below its potential.

There has been a conspicuous failure to exploit those resources to the desired level. This study has endeavored to identify the factors behind the dismal performance of the sector. Agriculture is the single largest private sector occupation in the State and can be considered the riskiest business. Increasing income of the land owning and landless rural population through increased production by enhancing productivity¹⁴ and intensity of farming, and by generating more employment in agriculture and other rural based production activities alone is not the solution and there is a need to integrate these endeavors with effective risk management strategies to cover potential losses in yield and hence incomes.

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