Studies on Mechanization in Agricultural Practices by Farmers of Bakshi ka talab block in Lucknow, India

A DISSERTATION SUBMITTED
TO

DEPARTMENT OF ENVIRONMENTAL SCIENCE
BABASAHEB BHIMRAO AMBEDKAR UNIVERSITY
(A CENTRAL UNIVERSITY)
LUCKNOW
SESSION 2021-2023

IN PARTIAL FULFILLMENT FOR

THE DEGREE OF
MASTER OF SCIENCE
IN
ENVIRONMENTAL SCIENCE
BY

Vijeta Chaubey
(M.Sc. IV SEMESTER)

UNDER THE SUPERVISION OF

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LUCKNOW-226025 (U.P.), INDIA

(2023)

Enrolment No: 598/21 **Year 2023**

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CERTIFICATE

This is to certify that work embodied in this dissertation entitled,“ **Studies on Mechanization in Agriculture practices by Farmers of Bakshi ka talab block in Lucknow ,India”** has been carried by **Miss. Vijeta Chaubey** under our supervision. She has fulfilled the requirements of academic ordinance of Babasaheb Bhimrao Ambedkar University, Lucknow, for the award of degree of **Master of Science** in Environmental Science. To the best of my knowledge this thesis work is original and has not been submitted anywhere for the award of any other degree.

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Candidate's Declaration

I hereby declare that the work which is being presented in this dissertation entitled, "Studies on Mechanization in Agricultural practices by Farmers of Bakshi ka talab block in Lucknow , India" in partial fulfillment of the requirements for the award of the Degree of Master of Science, submitted in the Department of Environmental Science, Babasaheb Bhimrao Ambedkar University, Lucknow is an authentic record of my own work.

The text embodied in the dissertation, is a genuine work done by me and has not been submitted to any other university for the fulfillment of the requirement of any Degree/Diploma.

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Acknowledgements

The grace of God is always blessed to me and gives patient and power to overcome the difficulties across my way in accomplishment of this Endeavour. I cannot thank but only pray to bless me always.

It is matter of great privilege for me to work under the able and highly exception guidance of **Professor Rana Pratap Singh, Department of Environment Science, Babasaheb Bhimrao Ambedkar University**, who has nurtured my capabilities and always gave me ample freedom. His scholarly guidance, experienced words, meticulous practical training, disciplined and virtuous nature, unlimited sincerity and affection towards student had always inspired me and I feel extremely fortunate to be his student.

It's my privilege to express my sincere thanks and gratitude to **Professor Shikha Head, Department of Environmental Science, Lucknow Professor Rana Pratap Singh, Professor SK. Dwivedi, Professor Naveen K. Arora, Proessor Venketesh Dutta, Dr. Nandkishore More, Dr. Narendra Kumar and Dr. Jiwan Singh** for their encouragement and help extended during dissertation work.

I would like to offer my special gratitude to **Prof. D.P. Singh,** who, although no longer with us, continues to inspire by his example and dedication to the students he served over the course of his career

I wish to acknowledge my thanks and gratitude to my parents without whom I won't be here.

I wish to express my regards to research scholars**, Miss Sonam Gupta** for her valuable suggestions, continuous inspiration and sympathetic attitude rendered during the study and while writing the thesis.

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Abstract

Mechanization plays a vital role in improving agricultural productivity, reducing poverty, and promoting sustainable farming practices. In our study we have conducted a survey of 100 farmers in three villages of Bakshi ka Talab block in Lucknow ,India. The purpose of the study is to understand the Extent of Mechanization in agriculture practices in these three villages ,to analyse, how much Mechanization is adopted , what are the limitation in current mechanization practices and also provide suitable suggestion ,for this comprehensive data collected through a household survey of 100 farmers and later data was analysed with IBM SPSS for Interpretation of the result The study reports that, there is 56% farm Mechanization and use of traditional practices is 44 % in BKT block .

In agriculture practices , the use of Machinery for land preparation is 28 % followed by seed sowing 18% and harvesting 10.67% for wheat cultivation, 73 % Farmers are using rented tractors and rented machinery for specific crop cultivation like wheat ,which makes mechanization uneconomical in reference to these farmers with small land holding. The use of machinery in other crops like pulses , vegetable legumes is 30 % among small farmers and only medium farmers are using machinery 100% in all crops cultivation .Due to this seasonal nature of the agriculture, the farm machinery remains idle for much of the time . The current machines used in agriculture practices can save time and labour but can't bring productivity and profitability in longer run as these machines causes soil degradation, environment pollution and high cost of machine makes it uneconomical for small and marginal farmers. Hence Sustainable Mechanization is the need of present. If land holding is large then, sustainable agricultural machines, which are environmentally sound, economically affordable, adaptable to local conditions, and resilient in terms of changing weather patterns and climate should be adopted in farming. For small farms, manufacture of cost effective semi manual devices for small farms is suggested these devices can utilize solar energy and manually operated on small field, this will help the farmers to increase productivity and profitability from their small farms. Additionally Crop sharing contract, more easy access to custom hire centre near the villages, training and demonstration of farm machinery all has great potential of catalysing the adoption of Mechanization in agriculture practices, for improving the welfare of farmers.

Chapter 1

Introduction

The agriculture sector forms only about 18 percent of India's GDP (2019-2020) despite employing almost 65 percent of the total workforce (National Statistical Office (NSO), M/o Statistics & PI.2020). Uttar Pradesh is one of the largest states in India, with a vast agricultural sector that contributes significantly to the state's economy. Agriculture is the primary source of income for over 65% of the state's population, and the sector provides direct and indirect employment to a large number of people(Gulati et.,al2021).

Over the past few years, the agricultural sector in Uttar Pradesh has seen steady growth. To meet the growing demand for food grains and other food and non-food commodities, expansion of farm mechanization is becoming inevitable (Srivastava,1999). Agricultural transformation is a felt demand of the day. Mechanization has been well received around the world as one of the key elements of agricultural modernization (Vatsa,2013). Mechanization brings in timeliness and precision to agricultural operations, greater field coverage over a short period, cost-effectiveness, efficiency in use of resources and applied inputs, conservation of available soil moisture under stress conditions and provision of adequate drainage of excess rain and floodwaters. The country's farm mechanization is set to reach a new era. It is felt that the process of agricultural mechanization needs to be rethought and reengineered so that small- and marginal farmers are efficiently included (Agrawal,1983)

Farm mechanisation is considered essential to reduce manual labour and increase agricultural productivity The degree of mechanisation varies across different states in India, depending on the utilisation of various inputs such as irrigation, high-yielding seed varieties, chemical fertilisers, herbicides, and pesticides. (Yedke,2023).

The availability of mechanical resources and better tools and equipment has made it possible for states such as Punjab, Haryana, and the western part of Uttar Pradesh to achieve high land productivity rates. The same pattern should also move toward other nations. The availability of farm power and output are closely related (Singh, 2001)

Farm machinery has led to reduce in operating costs, better use of expensive inputs (such as seeds, fertiliser, plant protection chemicals, water, and agricultural machinery), and higher quality produce, minimising hardship in farming operations, increasing labour and land production, and raising the dignity of work (Goel et.al.,2014). Mechanisation has resulted in more effective tilling and harvesting, as well as a reduction in physical labour(Gulati et.al.2021). The Government has laid emphasis to provide financial assistance to the farmers

and other target groups for purchase of different kinds of farm equipment, demonstration of new equipment among farmers for spread of new technology, human resource development in operation, maintenance/ repairs and management of agricultural machinery, one of the latest important policies exist and in effect is the Twelfth Five Year Plan (2012–2017), it came with title; Faster, More Inclusive and Sustainable Growth and has new strategy for promoting farm Mechanisation.

1.1Importance of Farm Mechanization in Agriculture practices:

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). 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). 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 2010-11, small and marginal holdings of less than 2-hectare account for 85 % of the total operational holdings and 44 % of the total operated area. Considering the necessity of identifying and responding to the current and future challenges of food security Mechanization is crucial in every aspect of agriculture practices

Various machinery used in Agriculture production are Tractor, Power tiller Combine harvester Thresher Rice transplanter both Walking type and Riding type, Self-propelled vertical conveyor reaper, Zero till seed drill, Multi -crop, Laser land leveller, Power weeder etc.

After the green revolution the combine share of agricultural workers and draught animals in total farm power availability in India reduced from 60.8% in 1971-72 to 10.1% during 2012-13. On the other hand, the share of tractor and electric motor in farm power availability increased from 6.8 to 45.8% and 14 to 26.8%, respectively during the last 41 years. The share of tractor power was maximum and increased by 39% during the period (Mehta et al.,2014).

However, there are several challenges which are faced by farmers of Uttar Pradesh when it comes to adopting mechanization in their agriculture practices.

1.2Some of the Common Problems faced by farmers include;

1. **Small land holdings:** It is challenging for farmers in Uttar Pradesh to embrace contemporary farming techniques and technology because the average size of landholdings there is modest. The ability of farmers to raise their productivity and profitability is also constrained by small land holdings. (Tripathi et al.,2015)

2. **Financial Constraints:** One of the key challenges to adopting mechanization is the financial constraint of purchasing or hiring mechanized farm equipment. Farmers may face difficulties in affording the high costs associated with acquiring or renting machinery(Tripathi et al.,2015)

3. **High Fuel Cost:** High fuel costs are identified as a significant limitation for the adoption of farm mechanization. The expense of fuel needed to operate mechanized equipment can be a barrier for farmers, particularly in areas where fuel prices are high (Pandey et al.,1987)

4. **Lack of Credit Facilities:** Limited access to credit facilities is another constraint faced by farmers in adopting mechanization. Insufficient availability of credit can hinder farmers' ability to invest in mechanized equipment, as they may not have the necessary funds upfront (Singh et al.,2015)

These are the general constraint faced by farmer across India. Different states have different district which have different social and economic background and the factors affecting Mechanization will also differ. In our study we have taken the District Lucknow, being the capital of Uttar Pradesh Lucknow comes in the list of Smart cities in India. The present study has been conducted in Bakshi ka Talab block of Lucknow district. A survey of 100 farmers were conducted in 3 villages of BKT block and the data was analysed with the help of IBM SPSS statistics software. Farm mechanization studies and survey in the villages of Bakshi ka Talab block is very limited therefore our study will help in in understanding the level of

adoption of Farm machinery in agriculture practices by various farmers and also assessing the major constraint in mechanization. The main purpose of the study is to give suitable suggestion which are appropriate for these farmers to obtain maximum productivity and profitability from their field.

In the above perspective following specific objective are made;

1.To assess the use of machinery by the farmers in their agriculture practices in Bakshi ka Talab block of Lucknow district.

2. Assessment of the major constraints faced by the farmers in adopting the mechanization in agricultural practices.

3. To Suggest approaches to enhance productivity, profitability in field and help improve socio-economic status of the farmers.

Chapter 2

Literature Review:

2.1 History of Farm Mechanization

This section will look into the historical perspective on the development and evolution of farm machinery use in India, supplemented by numerical data and facts from across the states of India as well as information on changes that have taken place over the years.

(Singh ,2015) studied the growth in use of farm machinery from year 1960-2012 .Table 2.1 summarizes growth in the use of farm machinery and related agricultural factors, as well as selected agricultural performance metrics, over recent decades. Agricultural land in India has expanded by only 5 percent since 1960, but grain yields have increased by 300 percent, partly due to the growth in land-saving technologies (irrigation and fertilizers). However, the use and density of farm tractors has also increased considerably during this time.

Table 2.1: Change in use of farm machinery and related factors of Indian agriculture, 1960-2012

Item	Unit	1960	1970	1980	1990	2000	2010	2012/ 2013
Agricultural land (net cropped area)	million ha	133	140	140	143	143	142	140
Irrigated area	%	18.32	23.04	28.84	34.03	41.11	44.99	47.62
Cropping intensity	%	115	118	123	130	133	136	139
Grain yield	kg/ha	700	860	1,000	1,300	1,600	1,950	2,130
Nutrient use (N, P, and K)	kg/ha	2.00	13.61	31.95	67.55	90.12	142.35	131.36
No. of irrigation pumps	million	0.4	3.3	6.2	12.9	19.5	28.0	52.8
No. of draft animals	million	80	83	73	71	60	50	48
Agricultural labor	million	131.1	125.7	148.0	185.3	234.1	263.1	—
Total no. of tractors	1,000	37	146	531	1150	2633	5005	5811
Tractors per 1,000 ha of net crop area	no./1,000 ha	0.3	1.0	3.8	8.1	18.6	35.4	41.5
Crop area per tractor	ha	3,594	959	264	124	54	28	24
No. of power tillers	1,000	—	9.6	16.2	32.3	114.7	259.2	312.7
Approximate share of area plowed by tractors[a]	%	—	3	10	20	40	80	90

Source: Singh (2015).

Bhattarai and others (2017) study revealed that there is extraordinary growth in tractor use in India during the last 40 years due to various national and regional policies as well as shifts in macroeconomic policies, which also affected the adoption and use of farm machinery, they concluded that even small and medium-size farmers with 2–3 ha of landholdings have started to own tractors on an individual basis. These owners hire out their tractors to fellow farmers and others in their villages for both farm and nonfarm uses, making their tractor purchasing decision more of an entrepreneurial move, based on a prospectus of its benefits from rental services, than a simple investment in plowing their own lands.

(Singh ,2018) studied trends in tractor use during 1980-2012 he found that tractor usage varies spatially across India as well. Table 2.2 shows the distribution of tractor availability across the states of India in 1982 versus 2012. In 1982, almost 60 percent of the tractors in India were concentrated in three northern states: Uttar Pradesh (27 percent), Punjab (21 percent), and Haryana (12 percent). This share had shrunk to less than 40 percent by 2012. However, the concentration is still high in these three states because they accounted for only 18 percent of the cropped area in India in 2010.

Table 2.2: Distribution of tractors across selected states in India, 1982 and 2012

State	1982		2012	
	Number (1,000)	% of India	Number (1,000)	% of India
Uttar Pradesh	141.4	27.16	1,106.1	19.03
Rajasthan	54.3	10.43	699.9	12.04
Madhya Pradesh	24.5	4.71	660.6	11.37
Punjab	106.7	20.50	517.7	8.91
Haryana	61.5	11.81	516.6	8.89
Gujarat	27.8	5.34	495.1	8.52
Maharashtra	21.5	4.13	419.2	7.21
Karnataka	20.4	3.92	363.9	6.26
Andhra Pradesh	20.9	4.01	342.4	5.89
Bihar	14.2	2.73	266.6	4.59
Tamil Nadu	14.2	2.73	186.7	3.21
Odisha	1.2	0.23	83.1	1.43
West Bengal	1.6	0.31	35.5	0.61
Kerala	1.3	0.25	11.6	0.20
All India	520.6	100.00	5811.1	100.00

Source: Data from India Ministry of Road Transport and Highways (personal communication March 2, 2018).

2.2Economical aspect of Farm mechanization

It is of utmost importance to examine whether the use of machines has been economical or not.

(Srivastava ,2017) revealed that the present level of farm mechanization is inadequate to offset the wage-push cost inflation in Indian agriculture. It is therefore necessary to promote efficient and appropriate farm mechanization suitable for small farm situation.

The **Doubling Farmers Income Report 2017**, which uses NSS-AIDIS data of 2012-2013 observes a growth in FCEFB in the decade that ran up to 2012, however its share in the Gross Capital Expenditure hasn't increased significantly. The survey points to the fact that bulk of the investments in FCEFB of rural households went to farm machinery and transport making up 36.9% of total investments. But a closer look at the break-up shows us that the combined share of small and marginal farmers in FCEFB is 9.5% in almost all the states. Thus despite being the largest group of cultivators, small and marginal farmers do not spend on mechanization. This could primarily be attributed to the infeasibility of investing in heavy machinery considering their marginal landholdings that works against economies of scale.

(Singh & Jindal, 1983) on the basis of a study covering 203 farmers having 218 tractors in different districts of Punjab it was brought out that the total use of the tractor, which on an average came out 397 hours per annum is much less than the possible extent of 1000 hours. The cost per hour turned out to be very high due to high fixed cost, which can be reduced by increasing the hours of working of the tractor. The machine becomes economical only if it is gainfully employed for rather than accounting for its unproductive use. Custom servicing increases annual use of farm machinery.

The committee set up by the **Planning Commission (1975)** observed that harvester , combines were generally demanded by big cultivators and it displaced a large number of agricultural labour in the harvesting season when the opportunities of employment in agriculture were higher for them. The committee justified the use of harvester combine only if their contribution to production arising out of saving in grain from vagaries of weather and shattering and from multiple cropping and change in cropping pattern was substantial.

(Laxminarayana et al.,1981) concluded that there is no social gain due to the use of harvester combines in terms of increase in cropping intensity or farm productivity. On the

other hand, there is net social loss in terms of considerable labour displacement that would seriously jeopardize the employment opportunities of the casual labour force and more particularly migratory labour coming from labour surplus areas.

(Singh ,2007) on the basis of a sample of 35 combine harvesters studied, reported that the average area covered by a combine harvester of small size was 192.1 acres of wheat and 173.6 acres of paddy. With an average rate of Rs.210 per acre, annual gross return of Rs.76,203 was estimated while the annual fixed and operating costs worked out to Rs.48,538 thus showing a net profit of Rs.27,664 during 1984-85.

Asian Productivity Organisation (1983) recognized time saved, freedom from overburdened work, improvement in social status, increase in overall production, timeliness of operations, reduction in cost, increase in the number of cropping and adoptions of inter-cropping as gains. Increased debt, cost of fuel and repair, unemployment, disparity in income were considered as losses due to farm mechanization.

2.3 Productivity and Mechanization

(Surender et al.,2021) in their study found out that the share of mechanical power in year 2020-21 is 74.42 per cent of total available power of 386.576 million kW. Of mechanical power, share of mobile power (tractor and power tiller) is 79.8 per cent in year 2020-21. Share of various sources of available farm power during different periods, plays significant role in increasing food grain productivity. The power availability per ha in year 2020- 21 was 2.761 kW. Of this power availability per ha from tractor, power tiller, diesel engine, electric motor, animal and human was 1.64 kW (59.38%), 0.03 kW (1.02%), 0.39 kW (14.028%), 0.54 kW (19.57%), 0.084 kW (3.025%) and 0.080 kW (2.98%), respectively. Declining trend of human and draft animal in the country suggests for availability of small power source (walk-behind type) at catchment or household level for reduction in drudgery of farm worker with overall increase in productivity.

(Singh, 2006) study revealed that the states having higher mechanisation indices incurred a lower cost of cultivation of the wheat crop on quintal basis due to increased yield. As the level of mechanisation increased, the draught animal use significantly reduced annually by 6·2%, but use of human labour reduced by −0·18% only, from 1971–72 to 1996–97.

(Singh and Singh ,2005) conducted a study comparing the performance of tractor farms and non-tractor farms in terms of gross output per hectare and crop yields for wheat, paddy, and sugarcane. They found that tractor farms outperformed non-tractor farms in both measures.

Similarly, a study by **NCAER (2009)** showed that farms with higher levels of mechanization had higher output per hectare. This trend was observed as farms transitioned from irrigated, non-mechanized farms to tube well, tractor-thresher fields.

However, a study by (**Singh and Chancellor ,1974)** found that differences in factors such as irrigation intensity explained a large portion of the yield difference between tractor and bullock farms for wheat. The use of tube wells was associated with greater yields compared to Persian wheel irrigation.

(Pathak et al.,2003) conducted a study to examine the impact of power sources on the output and productivity of five different types of farms located in Ludhiana District of Punjabi province. The results of the study indicated that tractor farms produced more paddy than bullock farms. Moreover, the yield of wheat was significantly higher on tractor farms than on bullock farms, especially after the cultivation of paddy or maize.

NCAER (1980) conducted a survey in seven states, representing three major agroclimatic zones, on farms owning tractors, utilising tractors on custom-hire, and possessing bullocks. A sample of 815 farming households was randomly selected from 85 villages. The survey found that, on average, tractor-owning farms produced greater yields than bullock farms, with yields varying by crop and ranging from 72% for sorghum to 7% for cotton. Moreover, when comparing tractor users to bullock farms, larger yields were also achieved. The impact of tractors on productivity seems to depend on various factors, such as soil quality, crop type, and the availability of inputs like fertilizers.

In some cases, as a regression analysis conducted by (**Singh and Chancellor ,1974)** on 26 maize farms in the Meerut District revealed, tractorization had no appreciable impact on productivity. Therefore, while tractors can be a useful tool for farmers, their potential benefits need to be evaluated in light of the specific conditions and constraints of each farming system.

2.3 Mechanization and its impact on Gross farm Income;

The adoption of farm mechanization has significantly contributed to the economic growth of the farming community.

(Berman and Bunka ,2019) observed that there was positive impact of farm mechanization on income. In case of Tractor Hired Farm net income was higher than Tractor Ownership Farm. Small and scattered land holding and inadequate sufficient funds to meet the initial cost of purchasing were the most serious problem faced by the farmers in the study area as out of total household 170 and 169 numbers of farmers found it most serious in case of small and scattered land holding and high initial cost to purchase the machineries respectively.

(Srivastava ,2017) revealed that the present level of farm mechanization is inadequate to offset the wage-push cost inflation in Indian agriculture. It is therefore necessary to promote efficient and appropriate farm mechanization suitable for small farm situation.

(Mwangi et al.,2015) studied the factors affecting adoption of new agricultural technology by smallholder farmers in developing countries and concluded that perception of farmers towards a new technology was a key for adoption to occur.

The **Doubling Farmers Income Report 2017**, which uses NSS-AIDIS data of 2012-2013 observes a growth in FCEFB in the decade that ran up to 2012, however its share in the Gross Capital Expenditure hasn't increased significantly. The survey points to the fact that bulk of the investments in FCEFB of rural households went to farm machinery and transport making up 36.9% of total investments. But a closer look at the break-up shows us that the combined share of small and marginal farmers in FCEFB is 9.5% in almost all the states. Thus despite being the largest group of cultivators, small and marginal farmers do not spend on mechanization. This could primarily be attributed to the infeasibility of investing in heavy machinery considering their marginal landholdings that works against economies of scale.

In the early 1970s, the AERC conducted several economic studies on mechanization, which revealed that mechanized farms had higher gross incomes than non-mechanized farms. Tractor-operated farms were found to have a gross crop output per cultivated acre of Rs. 3144, whereas bullock-operated farms had Rs. 2677, indicating only a slight difference between them.

According to **NCAER (1974),** tractor farms generated 21% higher revenue per hectare of gross cultivated area than bullock farms. Additionally, due to superior resource management, tractorized farms exhibited higher net returns per hectare of gross cropped area or net cultivated area than non-tractorized farms.

The **NCAER (1980)** study found that households owning and using tractors generated higher gross and net incomes per hectare compared to those relying solely on bullock labour. Tractor-owned households had a gross income per hectare that was 63% higher than households using only bullock labour, and households that used tractors made 31% more money per acre than bullock farms. On a cultivated hectare, the average net return from a tractor-owning farm was 152% higher than a bullock farm's, and a farm using a tractor generated a net 84% more income than a farm using bullocks. Although tractor-owning farms incurred higher cultivation costs than bullock farms, they still generated higher net income per cropped hectare. It is worth noting that other factors such as hybrid seeds, fertiliser, and irrigation also played a role in the higher net income of tractor-owning farms.

(Sirohi et al.,2006) study in an irrigated area of Maharashtra's Ahmednagar district further supported this, showing that tractor-owning farms had a gross return that was 33 to 34% greater than bullock-operated farms.

The study conducted by (**Balishter et al.,1991)** found that the use of mechanized farming techniques, such as tractors and tubewells, led to a significantly higher net return per hectare compared to non-mechanized farming. Specifically, mechanized farms with tractors and tubewells saw a 49% increase in net return per hectare, while partially mechanized farms with only tubewells saw a 29% increase in net return per hectare. These findings highlight the potential benefits of incorporating mechanized techniques in farming practices, particularly for improving profitability.

2.4 Impact of mechanization

In the last century, mechanical tools developed for farming gained popularity. Tractors are one of the most critical developments in this section. After Independence, India needs an accelerated method to make the economy self-sufficient in food grains. An increase in production with the desired pace was not possible in the traditional way of farming, mechanization was the only solution. Policy-makers were well aware of this fact and many schemes of the government and focused the cooperative societies on farm mechanization

since the ’50s. Punjab leads the agricultural development in India, and the adoption of farm mechanization took place at a higher rate. The need of the farmers led to the development of machinery, i.e., agriculture became more mechanized and increased productivity **(Gyanendra ,2000).**

During the ‘90s, the adoption of new technology revolved mainly around the concept of increasing productivity per unit time, and this lead to an increase in dependency for power (energy input). The farmers, mostly in Punjab, adopted mechanization and started intensive use of machinery like tractors and allied implements.

Nevertheless, some of the studies, like **(Sapre et al.,2021)** revealed that it leads to the displacement of workers. In contrast, farmers reported reduction in cost related to weeding, ploughing, and transportation with tractors, other equipment and machines like power tillers, combine harvesters etc. These are the frontline of farm mechanization, and government provides assistance for purchase of machinery.

There are two different views in the usage of tractors, the antagonist claimed that use of tractors would displace the labor force and on the other hand protagonist state that use of tractors would increase the practice of diversification and intensive cropping which would not only displace labor but also shift labor and it is helpful to create more employment **(Bhardwaj et al.,1990).**

The other reason for mechanization is the socio-economic aspect, which has two sets of ground reality. One of the socio-economic issues states that it will increase farm efficiency and productivity through the labor-saving technique **(Murali et al.,2012).** The other view is that technology helps to reduce the drudgery of women, who are burdened disproportionately as compared to men on farms **(Kishtwaria et al.,2012).**

Table 2.3: Progress of mechanization and power consumption in India

Pre green revolution era (before 1965)	Green Revolution Era (1965 – 1975)	Post Green Revolution Era (1975 -1990)	Post-Economic reform period (1990 onwards)
Farming with traditional Methods	HYVs, fertilizer, irrigation, Chemical inputs	Use of more scientific methods/machinery/implements/precision	Agricultural sub-sector growth was tremendous.
Farm power availability was about 0.27 kW/ha	Farm power availability was about 0.47 kW/ha	Farm power availability was about 0.48 kW/ha	Farm power availability was about 2.02 kW/ha
Share of animate power sources were 98 percent	The Share of animate power sources decreased to 62percent	Share of animate power sources decreased to 21.7percent	Share of animate power sources decreased to 11.8percent
Low productivity of food grain (0.58 t/ha)	The productivity of food grain increased (0.95 t/ha)	The productivity of food grain was about 1.184 t/ha	The productivity of food grain was about 2.11
Enhanced production through increase in cultivated area	Improved production/ productivity through adoption of HYVs, fertilizer, irrigation and chemical inputs	Improved production/ productivity through adoption of upgraded farm machines/implements/precision in addition to the adoption of other agricultural inputs	Liberalization, privatization, and globalization encouraged to export more, and it reflects in the increased productivity.

Source: Surendra Singh (2014); I.P. Abrol (2002). Post economic reforms tabulated by the researcher.

(Chandrasekaran et al.1999) studied the usage of farm power into different level of value chain process. For soil and seedbed preparation, 40 percent mechanized and 60 percent non-mechanized sources are used. Seeding and planting use a 29 percent mechanized source. While irrigation uses 37 percent, and harvesting & threshing use 65 percent of mechanization, the Indian farms have shown significant levels of adoption of modern tools for harvesting & threshing purposes. However, seeding, planting, and irrigation need special attention to be mechanized. Several reasons attribute to the lower level of adoption in the initial stage, but the most important of them is affordability. More than 80 percent of cultivators belong to small and marginal farmers, i.e., less than 5 Ha. It is the reason for the low level of adoption in India as compared to the other countries. In India, farm mechanization is about 40 percent-45 percent as against 95 percent in the USA, 75 percent in Brazil, 57 percent in China.

2.5 Mechanization and Employment of human labour

The mechanization of agriculture has become a topic of concern and debate, particularly in countries like India where there is a surplus of labor. However, recent research suggests that mechanization has actually led to an increase in overall employment of human labor.

For instance, a study conducted by (**Rao et al.,2018)** on "Tractorization in Kanjhawala Block in Delhi Territory" found that both tractor and non-tractor farms employed an average of 8.2 people per farm. This indicates that the labor force available for these farms was neither too excessive nor too insufficient. Therefore, mechanization in agriculture has not only increased productivity but has also created more employment opportunities for the local workforce.

The implementation of tractors in farming has resulted in more intense farming, thereby increasing the demand for labor, according to a study by GIPE, Poona in 1967. However, this does not necessarily mean that there was a loss of human labor after tractorization. In fact, the use of new seed technology and modern agricultural techniques, along with mechanization, had a positive impact on employment, as stated by UPAU in 1969.

(Kahlon et al.,1970) found that compared to bullock-operated farms, the aggregate labor decrease on tractor-operated farms with tube wells was only 1.3%.

A study by (**Billing ,2005)** analyzed changes in labor demand in Punjab and Maharashtra due to the adoption of new agricultural technologies. The implementation of enhanced

technologies led to an 11.5% decrease in the use of human labor in Punjab. However, in Maharashtra, the reduction was minimal, at 0.2%. The study did not account for the potential increase in employment resulting from the rise in cropping intensity brought about by mechanical agriculture.

(Singh and Goswami's ,1977) study on tractorized and bullock-operated farms in the Purnea district of Bihar showed that an average cropped hectare on a tractorized farm required 87.6 man-days of labor, while custom-hiring and bullock-operated farms required 113.9 and 120.6 man-days of labor, respectively. Interestingly, tractorized farms required a higher percentage of labor than bullock-operated farms for interculture, watering, harvesting, and threshing operations. However, it is worth noting that most mechanization studies were conducted in the 1960s and 1970s when tractors were first introduced. Therefore, the results of these studies should be interpreted with caution.

Some studies showed that the differences in timeliness of operations and productivity per hectare did not come out to be statistically significant on tractor farms as compared to bullock farms. These findings formed the basis for opposition to tractor technology, but it is important to note that such studies overlooked the shortcomings of inadequate infrastructure for machinery maintenance and repair and the time it took to develop the necessary mechanical skills, which significantly influenced these outcomes.

2.6 Government initiative on farm mechanisation

To understand the government's principal policies in the development of agriculture farm mechanization we categorized agriculture into four phases: (Kutumbal ,2019)

a) 1947 to mid-sixties
b) from mid-sixties to 1990
c) 1991- 2014
d) 2014 onwards

A. 1947-mid 60's (New Born India) India, before independence, had the largest cropped areas in the world, but with a partition, the area decreases by nearly one-third of the total cropped area. During the 1950s, the net irrigated area was 20.9 million ha (gross irrigated area 22.6 million ha). The country has spent about Rs. Forty-five thousand crores for irrigation development in the first four decades of independence. During 1950-51 to 1965-66,

through government channels, expansion of irrigation has been done from 7.2 million ha to 9.8 million ha – a growth rate of 2.1 percent per annum. (**Bala Parameswari, 2016)**

However, the shortage of food was the severe problem in the Independent India, Imports of food-grains constituted around 5 percent of total food grains available in the country in the ’50s. It further worsened during the ’60s when two severe droughts hit the country, which led to a sharp increase in demand for food-grains, and hence, imports increased by nearly 7 percent of the total availability of food-grains. During same phase ,Government abolished the zamindari system Although the nation took nearly 20 years to get rid of this system entirely, the question is whether land reform has a positive impact or negative impact on overall agricultural production? If efficient small farms replace inefficient large farms, then there is a benefit, but if smaller farms are not productive, then there is a loss.

According to **Binswanger and Rosenzweig's theoretical study (1986),** large farms inefficiently use their resources. The main reason behind the lower productivity of large farms is that the owner uses more hired labor and less family labor, which is cheaper than the hired worker and also shares the risk of uncertainty. Land ceiling and redistribution of land had a dual effect, on the one hand, many tenants now became cultivators, and on the other zamindars became large farmers and got handsome compensation for land settlement (**Bala Parameswari ,2016**). However, small and medium farm owners started to work hard on their farms.

According to (**Rao, 2021),** small and medium farm owners provide relatively more employment opportunities than large farmers. The effect and benefit of land distribution soon became visible on the economic growth of poor class and an overall increase in production and employment during the ’70s. Due to this reform, many landless cultivators now were the owners of a small piece of land. This was one major step to reduce inequality. Despite all these efforts, India remained dependent on the rest of the world to feed the rising population.

B. Mid 60’s to Pre-Reform Period (Green Revolution and parallel changes) In India, New Agricultural Strategy started with the Kharif crop in 1966. We can see the period from Mid-sixties to the ’80s as the second phase of Indian agriculture. The new agricultural strategy, also known as the **Green revolution strategy**, was successfully implemented in this period.

In the mid of two war “New agricultural strategy” was initiated as a pilot project in seven districts and called as **Intensive Agriculture District Programme (IADP)**. Generally, this program attached to HYVs, but it is an injustice if we do not consider the role of chemical

fertilizer. IADP intended to initiate research on the enhancement of productivity through HYV.

In 1965, The **Indian council of agricultural research (ICAR)** was re-established, formerly known as the Imperial Council of Research (16 July 1929). Today with 101 ICAR Institutes and 71 Agricultural universities, it is one of the largest national agricultural systems in the world. During the period of the Green revolution, this research institution became the key for all subsequent development in farming practices through its research and development. The effect of these researches resulted in increases in production of food grains by 5.4 times, horticulture crops by 10.1 times, fish by 15.2 times, milk by 9.7 times, and eggs 48.1 times since 1951**(Chand et al.,2015).**

Command Area Development Programme started during the fifth five-year plan 1974-75, which witnessed the launch of the irrigation project for different sizes of farmland. In the late ’80s, diversification increased from food grains to non-food grains like poultry, fisheries, vegetables, and fruits, which accelerated the GDP from agriculture during 1980-90. The area under principle food crops accounted for 137.10 million ha. (1985-86), and 138.61 million ha. (1990-91), while the non-food crops accounted for 34.53 million ha. (1985-86) and 40.68 million ha. (1990-91). (**Binswanger et al.,1986)**

Establishment of the **National Bank for Agriculture and Rural Development (NABARD)** on the recommendation of the Shivaraman Committee on 12 July 1982 to provide a rural credit facility saw a new era for agriculture in India. Agricultural price commission 1965, renamed as **CACP (Commission for Agricultural Costs and Prices),** has been the institution responsible for the recommendation of minimum support price based on the variable input price index. In terms of infrastructural and institutional transition, 1980-90 had a significant impact on the production and productivity of agricultural produce.

C. 1991-2014 (Post Reform period) There has been a significant impact of economic reform of 1991 on agriculture when, with liberalization, many small-scale industries initiated, which directly or indirectly were dependent on agriculture. As a result, farmers got a more diversified market. It is the period when the trade with the rest of the world and the export of agricultural output had increased. In 1995 with the introduction of WTO, the domestic market opened for the rest of the world due to the new international trade accord. Local traders and farmers were now in the competition with the international market. So there was a new challenge for policymakers, which lead to the New **Agricultural Policy of July 2000**. Under this policy, private sector investment was encouraged. Along with it, contract farming and

land leasing were popular tools to attract private players. The liberalization of the inter-state movement of agricultural produce was yet another aspect in this regard. Review of excise duty on farm machinery, chemical inputs were also reviewed. Later in the 21st -century pace of rural electrification increased. All these changes contributed directly or indirectly towards the overall production and yield. In this phase, Total production has increased more than five times since independence. According to fourth advance estimates of production of food grains for 2017-18, the total production of food grain increased more than five times from 51 million tonnes in 1950-51 to 284 million tonnes in 2017-18

. However, still, there is a long way to go as Indian agriculture employs more than 50 percent of the workforce. A possibility of such share affecting the degree of income inequality in India could be very positively argued.

After 2014, many institutional changes has been done in the country, policy and approach of these newly build institutions also got changed. The establishment of **NITI Aayog** in the place of Planning commission, scraped the 12th FYP (2012-17). The Aayog launched the new three-year action plan on the recommendation made by the **Taskforce on Agricultural Development**. Action plan majorly focused on four areas

, a) Remunerative prices by reforming APMC, under **eNAM (electronic National agricultural market),** where small farmers can sell their produce in competitive market places,

b) Boosting Productivity, by shifting to high-value farm products, use of the new farming technique for irrigation, **Pradhan Mantra Krishi Sinchayi Yojna (PMKSY)** launched for the credit facility, encouraging private sector for production and distribution of seeds,

c)Resolving the issue of land ownership,

d) relief measures at the time of disaster.

In the field of mechanization, the Government has been providing subsidy on farm machinery up to 40 percent of machine cost**. A state like Karnataka had established 700-800 custom hiring centres, to give machines on rent at affordable rates.**The other major step taken for the promotion of Agricultural mechanization was the *in-situ management of crop residue*, which was practiced in the state of Punjab, Haryana, Uttar Pradesh, and NCT of Delhi under the central assistance scheme (**Binswanger et al.,1978).**

Crop residue and stubble management is the need for environmental protection, and also agricultural scientists assert that it will increase productivity. This scheme provided 80 percent of financial assistance to custom hiring centres, self-help groups, registered farmer's societies, and private entrepreneurs for custom hiring, whereas 50 percent of financial aid

was being provided to individual farmers for the purchase of machines used for stubble management. To encourage this practice, the government recognizes village/Gram panchayats with an award for zero straw burning.

2.7 Future of Farm mechanization in India

The early introduction and hands-on acceptance of farm mechanization by large farmers, as a response to rising labor costs, mark the difference in productivity **(Rosenzweig et al., 2010).** Today, the farm size is significant and has a direct relationship with mechanization. Farms throughout in India are predominantly small. Indian agriculture comprises of 83.3 percent of small and marginal farmers**. (Agriculture census 2015-2016)**

As per Agricultural Census 2018, there were about 145 million agricultural holdings in India in 2015-16. Around 125 million were small and marginal farmers. The Average size has declined from 2.3 ha. (1970-71) to 1.41 ha. (2015- 16). Thus, there were significant land inequalities in India, which persist till date. So, it is better to utilize it as a strength. Therefore, the future of sustainable agricultural growth in India mainly would depend on marginal and small farmers. (Gajendra Singh 2018)

One of the studies by (**Lipton ,2006)** recognized the role of small farms in development and poverty reduction. The global experience of growth and poverty reduction shows that GDP growth originating in agriculture is at least twice as effective in reducing poverty as GDP growth originating outside agriculture (WDR, 2008)

(Rosenzweig et al.,2010) told that small holdings play an essential role in raising agricultural development and poverty reduction. Therefore, the first step one should take is to identify the hindrance in the adoption of farm mechanization, especially for small and marginal farmers. Some of them are land size, affordability to mechanization, absence of access to the credit market, and lack of low-capacity machines, and equipment. It is undebatable that an increase in production and productivity is the need of the future, with the rising population and limited land resources. Furthermore, it is also observed that during the peak season of Agriculture, there are shortages of agricultural laborers (due to migration of laborers to the urban area). From this point of view, machines become very important to adopt, that substitute labour and take relatively less time for work. But it is also evident that the cost of ownership of such equipment is expensive. So, the level of adoption is very low in India.

(Mehta et al.,2019) said that among the mechanized farms, the maximum number of farmers uses machines such as Tractors & Tractor driven implements for seedbed preparation and Harvester, threshers for harvesting. The rest of the work still consumes more laborers and

labour hours. In recent years few parts of this sector witness the Jugaad Technique known as an indigenous technique in farming. In this technique, the farmers, with the help of a local mechanic, develop the equipment as per their need and budget. Still, these techniques are not widespread because their creation is based on particular agro-climate and geographical requirements. However, the necessity of further modification of these machines arises for a backward agricultural region like Uttar Pradesh, Bihar, Jharkhand, Bengal, etc.

An effort of the public sector and private sector is needed so that the overall farmers' community get benefitted from these techniques.

The other part of farm mechanization is the usage of chemical fertilizers, pesticides, and HYV seeds which gains popularity during green revolution. The main reason for the quick adoption of chemical techniques in that era is affordability (farmers purchase as per his budget or need) and immediate result within one season ,(**Nawale ,1996)**.

However, a general observation indicates that the usage of fertilizers demands more water for irrigation, and also soil is getting degraded every year. As per the **DFI report (2018),** irrigation management under micro irrigation covers drip irrigation and sprinkler irrigation technique. It reveals a vast gap in potential area and actual area covered under this method of irrigation. 42.24 MN ha are the possible area, out of which micro irrigation covers only 7.73 MN ha area. There is an urgent need to fill the gap as we have a scarcity of water resources in the coming years. So the future objective of farm mechanization is not only to increase production and productivity but to increase sustainable productivity.

(Pokharkar et al.,1996), said that Research & development in the agricultural sector shoud be more likely to increase farm mechanization in agriculture to achieve sustainable development. It necessitates future research on the sustainability of usage of chemical mechanization. Along with it, finding out adequate ways to increase the adoption level of machine mechanization in farming is also required.

All these paper have suggested that the role of Mechanization in Agriculture is significant in every aspects of Cultivation practices .There was mixed opinion when it comes to economical aspect of mechanization for small and marginal farms who have maximum land holding in Inida .In our Study we also try to understand whether mechanization is suitable for small and marginal farmers and try to suggest some suitable approaches which can improve their productivity, profitability and socio economic status.

Chapter 3

Methodology:

- This study is Descriptive and cross-sectional and has adopted primary source of data to understand the Mechanization, in agriculture practices and its constraint in three villages of Bakshi ka Talab block.
- For primary data, we prepare a questionnaire consisting of 50 question that was distributed to farmers selected randomly in the fields.
- Selection of villages was as per convenience therefore it was a Convenience sampling . Interviews were conducted with the farmers at field.
- The quantitative data was filled in Excel Sheet with the help of data code prepared for every question in questionnaire. Data of 100 farmers was analysed with the technical support of IBM SPSS 26.00 software. The land holdings are very small and fragmented in the villages therefore it was decided to set acre as a denominator rather than hectare for the study.

3.1Study area

Lucknow district, the capital city of Uttar Pradesh spreads over an area of about 2500 km2 on both sides of river Gomti (a tributary of the Ganga River in the Ganga Plains). (Singh.et.al.2015) It has eight administrative blocks, namely, Kakori, Sarojini Nagar, Chinhat, Malihabad, Mal, Bakshi-ka-Talab, Mohanlalganj, and Gosaiganj (Fig. 1). The population of Lucknow is 4,589,838 (Census of India 2011). The normal annual rainfall of Lucknow district is about 960 mm with a subtropical climate with three distinct seasons of summer, monsoon and winter. The maximum temperature increases to 45 degree celsius during the month of May and minimum temperature drops to 5 degree Celsius during January. The district forms a part of Central Ganga basin and is a flat alluvial terrain with general slope towards southeast. The elevation of the district varies from 103 to 130 m above mean sea level. The city area is generally free from industries; however, most of the industries are located in the outskirts of the city in Chinhat block (Central Pollution Control Board 2007).The three villages, Gohanakala ,Paschim gaon and dhatingra was from the administrative Block of Bakshi ka Talab(figure 4.1).

Figure 3.1: Economical map of Bakshi ka Talab block showing three villages Gohankalan ,Dhatingra and Paschim gaon where the survey was conducted.

3.2Background of the Area

Bakshi ka Talab is a suburban area located in the outskirts of Lucknow, gohanakalan and dhatingra ,Paschim gaon are villages under the block BKT lucknow, Uttar Pradesh, Agriculture is an important occupation and farmers in the region grow crops such as rice, wheat, mustard ,maize ,sugarcane, and vegetables. However most of the land is occupied for plotting and building houses (figure4.2 ,4.4). The major area of the region is occupied by rice-wheat cropping system .The farmers in these villages are marginal ,small and medium farmers who uses a mix of traditional and modern farming methods, with irrigation being done through electric motor driven tube well . In addition to growing crops, animal husbandry is also an important part of the agricultural economy in this region. Farmers in these villages also raise livestock such as cows, buffaloes, goats, and poultry for milk, meat, and eggs.

. **Figure 3.2: Small land holding and plotting in agricultural field**

Figure 3.3: Women participation in agriculture activity in Paschim gaon

Figure 3.4: Village road of paschim gaon ,BKT

Chapter 4

Result and Discussion:

4.1Socio Economic characteristics of Respondent-

- **Age**-Out of the total 100 farmers, maximum farmers , 44.0% fall in the 50-60 age category ,followed by 20 % farmers who comes under the 60 and above cataegory ,which show the participation of elder people is more in these villages .Only 9 % youth is engaged in agriculture Clearly, the modern youth are disenchanted with agriculture and are shunning it as a profession, data is given in table 4.1.

Table 4.1: Age of Farmers

Age	N	%
20-30	9	9.0%
30-40	11	11.0%
40-50	16	16.0%
50-60	44	44.0%
60 and above	20	20.0%

- **Gender**-Man still dominates in agriculture with total 62 % out of total. Women participation is 38% However the usual work of a female agricultural labourer or cultivator is restricted to unskilled tasks like sowing, transplanting, weeding, and harvesting that frequently fit well within the context of household life and childrearing, they are basically helping their family in agriculture (table 4.2)

Table 4.2: Gender of Farmers

Gender	**N**
Male	62.0%
Female	38.0%

- **Religion and caste:** the sample farmer from these villages are mostly Hindu 83% and 17% was Muslim there is dominance of general caste with 39% followed by Scheduled Caste, Scheduled tribe and OBC data given in table 4.3 and 4.4

Table 4.3: Caste of responden

Caste	N	%
OBC	20	20.0%
SC	25	25.0%
ST	16	16.0%
GENERAL	39	39.0%

Table 4.4: Religion of respondent

Religion	N	%
Muslim	17	17.0%
Hindu	83	83.0%
Sikh	0	0%
Christian	0	0%

- **Education-**It is clear from the table 5.5 that only 12% percent of respondents were illiterate. There were about 6% percent graduates and 16 percent have taken primary education .The highest number of respondents were in the category who have went to middle school 34 percent followed by high school 20 percent, and 18 percent respondents standard up to intermediate, overall the literacy rate is good only 12 % farmers were illiterate 88 % are literate These findings are similar to findings by vishakha.et.al (2020) where most of the farmers from Lucknow district were having maximum middle school education followed by high school .

Table 4.5: Distribution of respondents according to their education

Education	N	%
Illiterate	12	12%
Primary	16	10%
Middle	34	34%
High School	20	20%
Intermediate	12	18%
Graduation	6	6%

- **Income From Agriculture:** It is clear from the table 5.6 that 49 % of farmers earning less than 50 thousand in a year, followed by 45 % farmers having medium income between 0.5-1 lakh from ,only 6 % farmers have income more than 1 lakh in a year from Agriculture .Due to low income most of the land has been sold for money causing smaller land holding among farmers (table 4.8). Due to Low income the mechanization rate among small and marginal farmers is less and they are still using traditional method for most of the agriculture practices,only land Preparation is mechanized(table 4.9). (Malesh ,2020) in his study also observe similar result and concluded that Small and marginal farmers hold most of the land and cannot buy farm machinery themselves, because of their economic situation. Faruq et.al.2020 in his study also obtained similar relation where annual income of the farmers showed significant relationship with their attitude towards farm mechanization.

Table 4.6: Distribution of respondents according to their Income from Agriculture

Income(annual income)	N	%
Low (Below 0.5 lakh)	49	49.0%
Medium ((0.5-1 lakh)	45	45.0%
High (above 1lakh)	6	6.0%
Total	100	100.0%

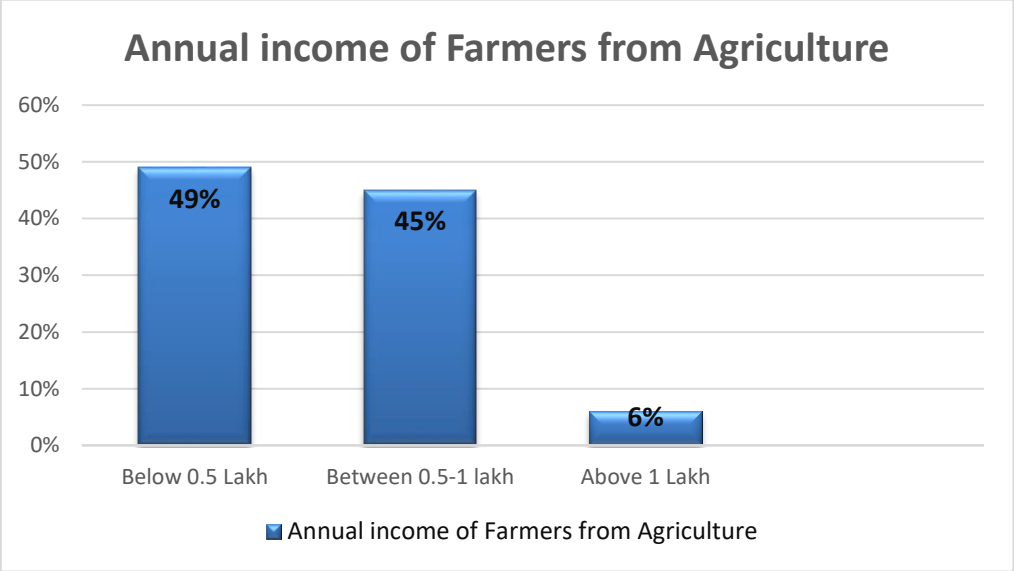

Figure 4.1: Annual income of farmers from agriculture

- **Knowledge of Machinery :** It is clear from Table 4.7 that the knowledge on operating farm machinery by farmers is not satisfactory 52% farmers knows only how to operate tractor with plough ,seed drill and thresher .36% farmers know how to operate 4-6 machines of agriculture ,only 12 percent farmers have knowledge of more than 6 machine as well as operating them .Farmers are using rented tractors , rented machines(73%) and Lack of proper knowledge of farmer to operate and maintain it properly causes machines going haywire, farmers have to spend extra money on repairing making it uneconomical and risky. Similar

result was obtained by Faruq.et.al.2020 where the training experience on using machinery by the farmers is not satisfactory in the study area but the variable showed positive significant relation with attitude towards farm mechanization. Thus, arrangement of proper training for the farmers by different agricultural development organizations is needed to be arranged on updated farm machineries to bring more favorable attitude towards farm mechanization.

Table 4.7: Distribution of respondents according to their Knowledge about Machines used in various agricultural practices

Knowledge about machinery	**N**	**%**
Low (3 or less)	52	52.0%
Medium (4-6)	36	36.0%
High (6 and above)	12	12.0%
Total	100	100.0%

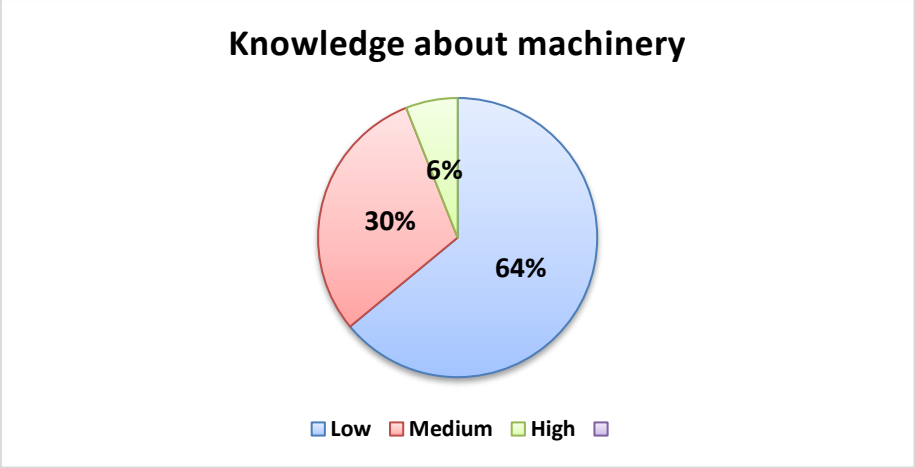

Figure 4.2: Knowledge of respondent regarding farm machinery

4.2 Land holdings

Majority of the Farmers in our report were marginal (48%) and Small(28%). Around 22% Farmers in the selected villages of Bakshi ka Talab engaged in agriculture were found Tenant, they were given land on *Batayi* by Owner of the land. The number of medium and large farmers found very less only 8% in our study (Table 4.8) ,the reason behind that they have given their land and machinery to tenant farmers for doing cultivation on their field . Gulati et al.,2017 also find similar result where 92.5% of all landholdings in the state fall into the small or marginal category, making up 64.8% of all landholdings in the state of Uttar

Pradesh. The Farmers were categorized into four group on the basis of land holdings viz., marginal (less than 2.5 acre), small (2.5 to 4.0 acre), medium (4.0 to 6.0 acre) and large (6 and above).

Table 4.8: Land holdings with farmers

Villages	Tenant Farmers	Marginal Farmers	Small farmers	Medium Farmers	Large farmers	Total farmers
Gohanakalan	5	15	12	2	0	34
Paschim gaon	8	16	7	2	0	33
Dhatingra	9	11	10	3	0	33
Total	22%	42%	28%	8%	0	100%

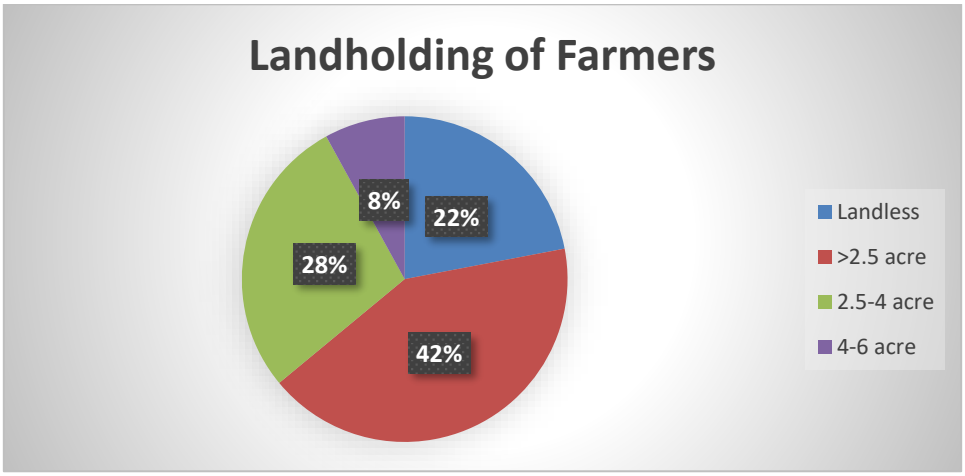

Figure 4.3: Landholding of farmers

Figure 4.4: Small land holding in Paschim gaon ,BKT block

Figure 4.5: Farmers working on their small farm in Gohanakalan

Figure 4.6: Women cutting weeds with traditional sickle in Datingara

According to our survey, it was discovered that the amount of land in these three villages of Bakshi ka Talab that was being farmed had decreased as a result of land fragmentation and the plotting of agricultural fields for commercial and residential use

Small land holdings mean that farmers cannot take advantage of economies of scale, leading to higher production costs and lower profits. Farm holdings are dispersed and small, which prevents mechanization. It also limits the use of modern technologies such as tractors and harvesters, which are more efficient on larger farms.(khan.et.al.2020).

4.3 Use of machinery in Land preparation and Sowing ;

Agricultural land preparation is a process of preparing the soil for planting, usually by plowing or removing vegetation. Land preparation involves removing any unwanted plants, rocks, and other debris from the ground, as well as adding nutrients and minerals to prepare the soil for planting.

Anil Kumar in 2019 found that Most (80 %) of the farmers of the district Shrawasti depend on rented tractors in ploughing their lands, where 20% farmers prepare their land through bulls. In the mobile power sources category, power availability from tractor was the highest (1.324 kW/ ha) (Goering, 1992; Bector et al., 2008; Mehta et al., 2014b).

This result was observed in our study as well where for wheat cultivation , 84 % farmers were using tractors in Land preparation which shows the maximum adoption of tractor in farm. However only 27 % were having their own tractors and rest 73% of the farmers are using rented tractors. The use of tractor driven cultivator was highest 44%. There has been increase in use of rotavator especially for wheat cultivation 34% , which was observed by (Mehal et al.,2014) in their study as well where **the use** of **rotavator** is **increasing** due to its versatility in doing a good quality tillage job with minimum number of passes.

Table 4.9: tool used for ploughing

Machines used	**N**	**%**
Rotavator	34	34.0%
Plough with tractor	6	6.0%
Plough with bulls	16	16.0%
Cultivator	44	44.0%
Total	100	100.0%

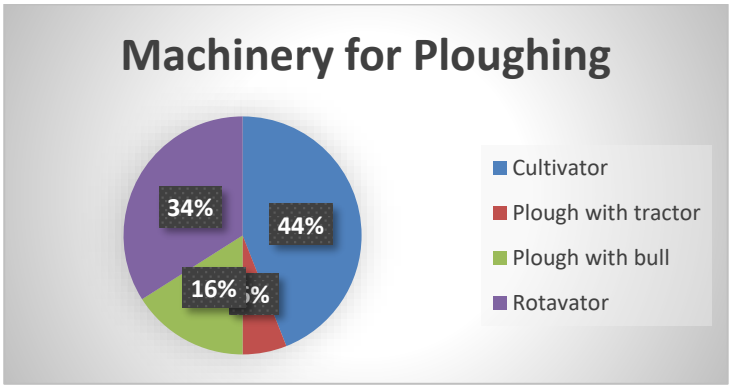

Figure 4.7: Machines used for ploughing

For **sowing**, the use Seed drill machines is 28% and Seed sowing machines is 26 % , used by Medium farmers(100%) , Tenant Farmers (50%) and some small and marginal farmers for wheat cultivation (44%) for which they rent these machines from other farmers .In Marginal and Small farmers ,Broadcasting 46% still is the most common technique for majority of crops.vegetable and mustard seeds .**Sanjay.et.al.2013** also observed the same in his study where broadcasting manually was the most common technique adopted by small and marginal farmers in different parts of the country **(table 4.10)**

Land preparation is the basic need in modern agricultural practices. (Mehta et al.,2019 in their study find that the landbed preparation operation is highly mechanized (more than 50%) which was observed in our study as well where 46% of machinery are used for land preparation and seed sowing(Figure 4.16) .This is due to the fact that this machines reduces time and labour and increases production therefore farmers are willing to spend money on using machinery. Some marginal farmers are still using traditional mode of plowing with bulls 16% due to very low income.(table 4.9)

Table 4.10: tool used for sowing

Respondent	**Seed drill**	**Seed sowing machine**	**Traditional (broadcasting)**	**Total**
Tenant farmers	6	5	11	22
Marginal farmers	5	10	27	42
Small farmers	7	13	8	28
Medium farmers	8	0	0	7
Total	**26%**	**28%**	**46%**	100%

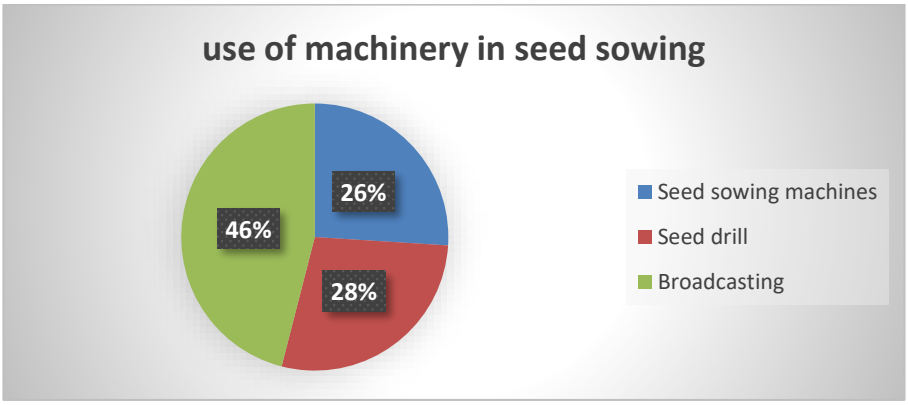

Figure 4.8: Use of machinery in Seed sowing

Figure 4.9: Use of tractor in agriculture practices in Gohanakalan

Figure 4.10: farmer plowing in the field in Paschim gaon

5.4Use of machinery in harvesting;

There are variety of machines available like harvester ,mini combine ,combine thresher ,winnowing for timely harvesting and processing of crop produced but because of their high costs, they are not affordable by marginal and poor farmer and therefore they are still using manual tool like sickle for harvesting and traditional practices are followed for separating

grains .small and marginal farmers involve majority of their family at the time of harvesting for cutting and threshing of produce(Mehta.et.al,2019). This was observed in as well where the use of machinery is declined in cutting and separating of agriculture produce(figure 4.12). Machines are used by medium farmers, small tenant and marginal farmers mostly preferred sickle for harvesting (68%) **(table 5.11)** and involvement of family members specially women was observed at time of harvesting(figure 4.13)**.**For wheat harvesting tenant, small and marginal farmers used rented combine harvester. Overall during wheat harvesting there was 32 % use of machinery and 68% was using traditional method of harvesting**. (table 4.11)** The reason of less mechanization is similar to previous studies conducted by Verma, Singh and Mittal (1994) which are high machine cost, small farm holding and low income of farmers.

Table 4.11 Use of machinery in wheat harvesting by farmers

Type of farmer	**Threshe r**	**Combine harvester**	**Traditional (sickle)**	**Total**
Tenant farmers	4	4	14	22
Marginal farmers	6	0	36	42
Small farmers	7	3	18	28
Medium farmers	3	5	0	8
Total	20%	12%	68%	100%

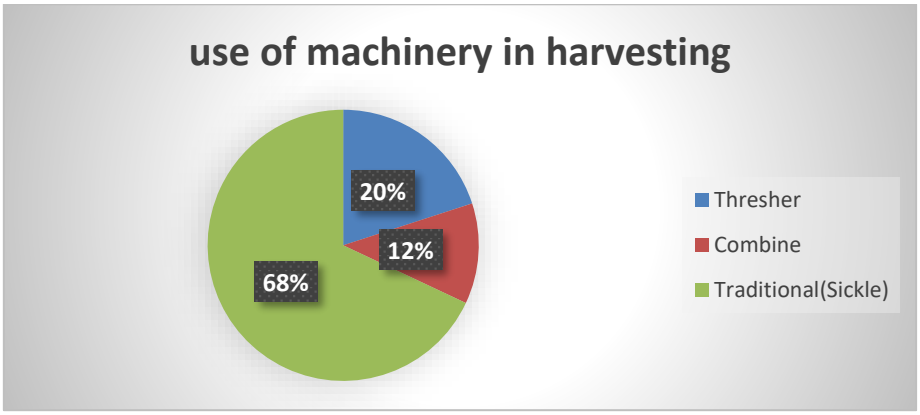

Figure 4.11: Use of machinery in harvesting

Figure 4.12: farmer cutting the crop with traditional sickle in Paschim gaon

Figure 4.13 : Involvement of women at time of harvesting in Paschim gaon

Figure 4.14: Use of thresher machine in datingara

Figure 4.15: Use of thresher in datingara

Overall Mechanization summary in BKT block

Overall Farm mechanization was 56% and use of traditional practices were 44 % in BKT block, which was calculated by formula given below, (Figure 4.16).

$$\frac{\boldsymbol{Modern\ machinery}}{\boldsymbol{Total\ farm\ \ machinery\ (traditional + modern)}} \times \mathbf{100}$$

In our study the land preparation was having most mechanization 32% ,and use of seed sowing devices was second highest in terms of mechanization 18%. However the extent of mechanization is low only 10.6% (figure 4.16) in harvesting process as the majority of the farmers comes under small and marginal category they don't have enough money to use rented machines ,as they already spent enough money in land preparation , seed ,fertilizer and pesticides purchase .However since farm land are small so not using combine harvester would not impact productivity . (Laxminarayana et al.,1981) in her study also concluded that there is no social gain due to the use of harvester combines in terms of increase in cropping intensity or farm productivity. On the other hand, there is net social loss in terms of considerable labour displacement that would seriously jeopardize the employment opportunities of the casual labour force .

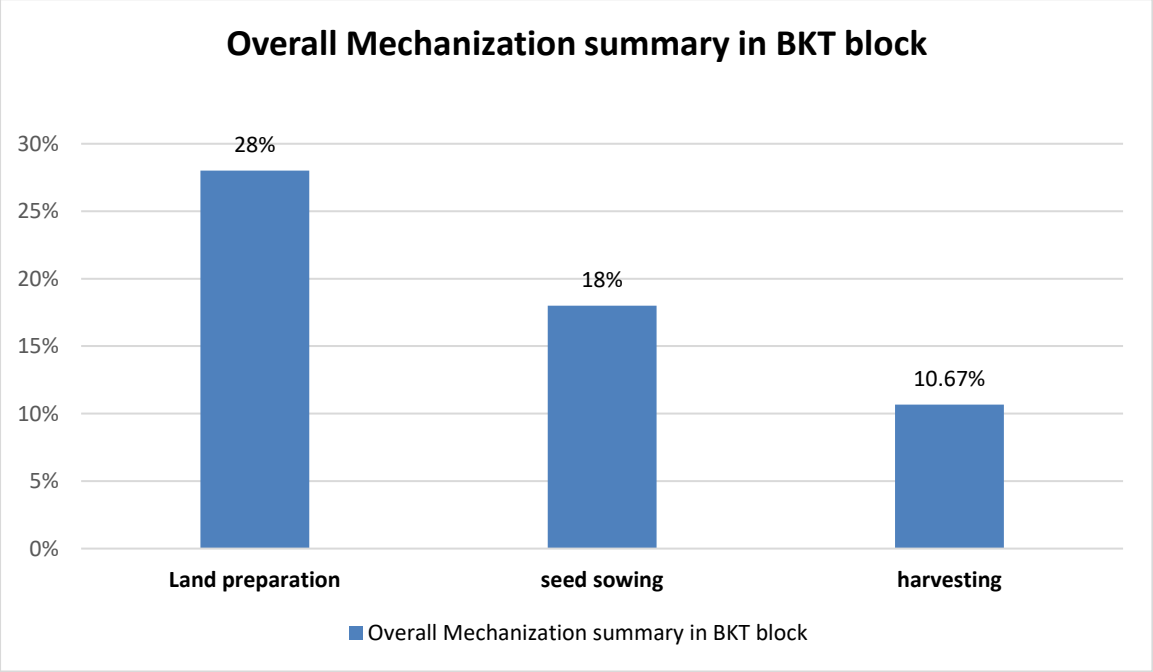

Figure 4.16: Mechanization summary in BKT block

Chapter 5 Summary and Conclusion ;

The income for majority of farmers is low(49%) or medium(45%) and plays a very crucial role in adoption of mechanization. The profit obtained from agriculture is not good enough to sustain their livelihood therefore most of farmers are doing multiple works either raising livestock or labour in other agriculture field. Farmers are using rented tractors rented machines and lack of proper knowledge of farmer(52%) to operate and maintain it properly leads to machines going haywire, farmers have to spent extra money on repairing making it uneconomical and risky. The lack of repair and replacement of machinery in Bakshi ka talab block is another hindrance in efficient small farm mechanization. Thus, arrangement of proper training for the farmers by different agricultural development organizations is needed to be arranged on updated farm machineries to bring more favorable attitude towards farm mechanization. There is no custom hiring Centre nearby neither the farmer have knowledge about custom hiring therefore they end up paying more money for renting machines There is overall 56% mechanization in agricultural practices like land preparation seed sowing and harvesting but it's use by farmers in uneven, the small and marginal farms are using rented tractors and rented machinery for specific crop cultivation like wheat ,which makes mechanization uneconomical in reference to these farmers with small land holding. Only the medium Farmers are using machinery completely whereas tenant ,marginal and small farmers still rely on traditional method of farming for vegetables ,pulses and legume crops ,Due to this seasonal nature of the agriculture, the farm machinery remains idle for much of the time. Thus, idle machinery means unnecessary high costs unless proper alternate use of such machinery in the off-season is made. Therefore, we can conclude that the current machines used in agriculture practices can save time and labour but can't bring productivity and profitability in longer run as these machines causes soil degradation, environment pollution and high cost of machine makes it uneconomical for small and marginal farmers. Hence Sustainable Mechanization is the need of present.

Overall land Fragmentation , lack of knowledge and less source of income are the major constraint identified in these three villages of block Bakshi ka Talab

Chapter 6 Recommendation:

1.Promotion of semi manual devices in agriculture practices for smaller landholding-

Based on our study we observed that current machinery like diesel driven tractor, thresher ,combine harvester ,seed drill are effective only for big farms and medium farms whereas for small farms with low income, small and fragmented land holding ,purchasing or renting these machinery is both uneconomical and non- profitable for their farms .Therefore there is a need of production of small semi manual devices which are semi manually operated and uses solar energy for battery by farmers for their small field .These machines are not only environment friendly but also economical for small farms .There are various engineers who have proposed design of small and cost effective machines that can be used in agriculture practices by small and marginal farms ,various innovative idea are published in papers every year .Government should start using these innovation into actual ground basis by setting up cottage industry near the villages where these machines can be manufactured at large scale .Also setting these industries will also generate employment for the locals increasing the rural economy.

2.Crop sharing contract –

Most of the big farmers give their land to tenant and profit is divided either in the form of cash or crop but most of the time profit is share unevenly causing exploitation. Landowner provide machinery and land and tenant offer labour in the field. This method can be utilized by small and marginal farmers as well where they can merge their fragmented land and share it for crop cultivation however there has to written documentation of contract between farmers for profit sharing to avoid any future conflict.

3.Easy Access to custom hire centre

There are various custom hiring centre across India where agriculture machinery can be purchased at low prices by small and marginal farms and upon completion of work it will be returned to them. However the custom hiring centre in BKT block or even in Lucknow is very limited. Therefore there is need of more centre in the villages so that farmers can save some money in leasing machinery.

5.Demonstration and training on how to operate machinery is required.

Based upon study it was found that the knowledge of farmer in operating machines is low which makes the machine operating difficult , risky and uneconomical .so some training and

demonstration is must before using any machines .Again for this purpose setting up custom hire centre would be beneficial where free live training and demonstration can be given to farmers before lending it to them.

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