Mechanization in Agriculture:
Assessment of skill development gap and adoption of labour-saving technologies

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Mechanization in agriculture has proven to aid Indian farmers to become more efficient, productive, and competitive in the global marketplace. Owning to the smaller land sizes on average, achieving mechanization in agriculture in India is challenging However, various efforts have been going into promoting mechanization at a faster rate in India. These efforts have resulted in a significant increase in the availability of farm power per unit area from 2.02 kw/ha in 2016-17 to 2.49 kw/ha in 2018-19.

The study has sought to explore the mechanization status across five states in India. It explores 'machinery used agricultural operation wise' such as land preparation, sowing/transplanting, weeding, irrigation, applying fertilizer and spraying, harvesting, and spraying. The study attempts to bring out the skill gaps in the mechanization ecosystem. An attempt is being made to highlight the gaps in the implementation of the policies for increasing coverage of mechanization and promotion of labour-saving technology/ gender friendly tools. Further, it examines the awareness and usage of labour-saving tools by women.

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Vidya Vemireddy

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LIST OF ABBREVIATIONS

AERC	Agro Economic Research Centre
ACP	Agricultural Commercialization Programme
AIBP	Accelerated Irrigation Benefit Programme
ATMA	Agricultural Technology Management Agency
BGREI	Bringing Green Revolution to Eastern India
CDB	Coconut Development Board
CHC	Custom Hiring Centre
CIAE	Central Institute of Agricultural Engineering
CIH	Central Institute for Horticulture
CIWA	Centre Institute for Women in Agriculture
CMA	Centre for Management in Agriculture
CMSGUY	Chief Minister Samagra Gramya Unnayan Yojana
DASD	Directorate of Arecanut & Spice Development
DCCD	Directorate of Cashewnut & Cocoa Development
FAO	Food and Agriculture Organisation
FFB	Fresh Fruit Bunches
FIG	Farmer Interest Group
FMB	Farm Machinery Bank
FMTTIs	Farm Machinery Training and Testing Institute
FPA	Farm Power Availability
FPC	Farmer Producer Company
FPO	Farmer Producer Organization
HMNEH	Horticulture Mission for North East & Himalayan States
HYV	High-Yielding Variety
ICAR	Indian Council of Agricultural Research
KVK	Krishi Vigyan Kendra
LST	Labour Saving Technologies
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
MIDH	Mission for Integrated Development of Horticulture
MIS	Market Intervention Scheme
MoAFW	Ministry of Agriculture and Farmer's Welfare
NBB	National Bee Board
NHM	National Horticulture Mission

NHRDF	National Horticulture Research and Development Foundation
NMAET	National Mission on Agricultural Extension and Technology
NMOOP	National Mission on Oilseeds and Oil Palm
PM- KUSUM	Pradhan Mantra Kisan Urja Suraksha evem Utthan Mahabhiyan
PMFBY	Pradhan Mantri Fasal Bima Yojana
PSAMTT&D	Promotion and Strengthening of Agriculture Mechanization through Training Testing and Demonstration
RKVY	Rashtriya Krishi Vikas Yojana
SAME	Sub Mission on Agricultural Extension
SAU	State Agriculture University
SHG	Self Help Group
SMAM	Sub Mission on Agricultural Mechanization
SMPP	Sub Mission on Plant Protection and Plant Quarantine
SMSP	Sub-Mission on Seed and Planting Material

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EXECUTIVE SUMMARY

India has a GDP (current US$) of 3.1 trillion and GDP per capita (current US$) of 2256.6 in 2021 registering an annual growth rate of 8.7%. The agricultural sector is the largest employer of workforce and accounts for 18.8% (2021- 22) in Gross Value Added (GVA) of the country with a growth of 3.6% in 2020-21 and 3.9% in 2021-22. For financial year 2022-2023, fiscal policy statements projected growth of 3.5% in for agricultural sector. With green revolution in 1965, India was self-sufficient in food grain production. In 90s many policies were introduced with the aim of annual output growth rate of 4%. In 2000s, schemes like Rashtriya Krishi Vikas Yojna, Pradhan Mantri Krishi Sinchai Yojana, Pradhan Mantri Fasal Bima Yojna, Paramparagat Krishi Vikas Yojana, and more were introduced to achieve high growth in agricultural sector. Government also significantly focused on improving agricultural infrastructure (fertilizer factories, agricultural universities and research institutions).

Mechanization trends vary globally and depend on several factors such as land sizes, availability of workforce in agriculture, availability of machines, government policies and extension services. In many countries agricultural mechanization is still in a developing state, and some have advanced. In lower income countries, farmers use traditional manual tools and equipment resulting in low productivity. In higher income economies, the proportion of machine use is much greater than labour use. In these economies, even though the share of agriculture in GDP is low but their GDP per capita is very high as compared to lower income economies. In United States, Western Europe, Soviet Union, Brazil, Argentina, China, India, Africa the level of farm mechanisation is at 95%, 95%, 80%, 75%, 75%, 38%, 40% and 20% respectively. The corresponding values of the population engaged in agriculture is 2.4%, 3.9%, 14.4%, 14.8%. 9.4%, 64.9%, 55% and 60% respectively.

The need for mechanization in Indian agriculture

In 2017, the number of people employed in agriculture were 145.66 million which dropped down to 143.4 million during the pandemic. The rural to urban migration trend has been observed in all parts of the country which led to the situations like labour shortage in agriculture. With growing migration, labour shortages have been felt during peak season of agriculture relative to the lean seasons. With growing demand of labour in non-agricultural sector due to urbanization and increasing infrastructural capabilities, labour wages have been rising.

All of the trends highlighted above have been pivotal in incentivizing farmers to shift towards mechanization of agriculture operations. The transition to machines in agriculture ha attributed to area expansion under crops, timely operations and enhanced positive effects on yields. There is need of technologies to improve labour efficiency and reduce drudgery for labour intensive methods of production.

The level of agriculture mechanization in India stands at 40% which is less when compared to China (59.5%), Brazil (75%) and U.S (95%). The above discussed shift of labour from agriculture to non-agriculture sectors for various reasons of better employment opportunities, higher wages, urbanization and some government sponsored schemes like MGNREGA is also impacting the farm power availability. The gap has to be filled with mechanization of agriculture to ensure sustained productivity of the sector.

The need for skilling in mechanization

As new machines are developed, information needs to be transferred to farmers as well as people involved in jobs associated machine operations. Effective utilization of farm machinery requires information and required skills to operate them. While various initiatives by the government in the form of programs and schemes for farm mechanization have led to progressive increase in the availability of farm power per unit area for performing agricultural operations, a large part of the sector remains largely unskilled, posing a constraint to its progress in terms of productivity and efficiency. Farm power availability has increased from 2.02 kw/ha in 2016-17 to 2.49 kw/ha in 2018-19 but skilled manpower may not have grown proportionately. The challenge is to ensure adequate skilled manpower which can reap the benefits of productivity brought about by mechanization.

Recognizing the need to boost agricultural mechanization, the Government of India launched the ***Sub Mission on Agricultural Mechanization (SMAM) in 2014-15 under the National Mission on Agricultural Extension and Technology (NMAET)***.

Need for labour-saving technologies for women in agriculture

In Indian context of agriculture, women involvement in agricultural work force is of significance importance. SMAM have taken into consideration these issues and have a gender component as well with the aim of "Gender Mainstreaming" which is one of the important pillars of the National Policy for Farmers" formulated in 2007. (National Gender Resource Centre in Agriculture et al., n.d.). Under the scheme, women beneficiaries are to receive training programs on gender friendly equipment, support concessions for women on purchase and use of farm machines for various agriculture. A list of agricultural implements and hand tools suitable for farm women has also been developed by Research & Development organizations under ICAR with the intent to reduce drudgery and enhance women's efficiency in farm operation.

Objectives of the study

The government is dealing with multiple issues: (i) increase in demand of food with growing population (ii) labour shortage in agriculture and increasing labour wage (iii) shrinking profits in agriculture and (iv) increased involvement of women in agriculture. With the above context, mechanization and technology adoption is one stop solution. Farm mechanization is not only increasing the productivity through efficient use of other inputs and natural resources but also reduces the need of manual labour and cost of cultivation.

The project is implemented in two parts: (i) focusing on skill assessment in mechanization and (ii) focusing adoption of labour-saving technology among women. The objectives are designed to uncover the 'mechanization architecture' in India:

Skill assessment in mechanization:

1. To review the status of skill gaps across the value chain of farm mechanization.
    - Asses the status of farm mechanization - availability of machines, the gap of the farm power per hectare (actual vs required), cost of labour and prevailing wage rates.
    - Assess the availability of skilled manpower for different job roles under the farm machinery sector across the value chain; to estimate the requirements and gap of skilled manpower for different job roles under farm machinery sector.
    - Assessment of the additional farm machinery training centres to cope up the skill gap.

2. To study the impact of farm mechanization on employment of labour.
3. Assess the extent and the functioning of the SMAM schemes in view of women components within the scheme.
4. To study the socio-economic condition of the selected farmers households, status of agricultural equipment machinery with men and women farmers and their time use.
5. To formulate the strategy and programmes that may be required for filling up gap of skilled manpower in view of rapid mechanization of agriculture in upcoming periods.

Adoption of labour-saving technology among women:

1. To identify the factors/underlying characteristics affecting the uptake of labour saving-technologies and extension services among women farmers.
2. To estimate the willingness to pay and the costs associated with adoption of labour saving-technologies among women farmers.
3. To map time, use preference for women with adoption of labour-saving technologies.

The project is implemented as a coordinated study covering five selected states and involving fives Agro-Economic Research Centres (AERCs) under the Ministry of Agriculture & Farmers Welfare. It is coordinated by Centre for Management in Agriculture (CMA), IIM Ahmedabad which is an Agro-Economic Research Unit under MoAFW. The states under the study are Assam, Gujarat, Odisha, Uttar Pradesh and Tamil Nadu. The AERC's in Jorhat, Anand, Waltair, Allahabad and Chennai are involved for implementation of the study in the respective states under the research design and guidance of CMA-IIMA. The study involved preliminary field visits, study of literature, and collection of secondary data and information available. This includes the study/ development of relevant theory and conceptual frameworks. This is followed by the design of the survey instrument/ questionnaire based on the background and the study objectives. For household survey, the following design was implemented: For each state, districts were categorised into high and low level of farm power availability (FPA) based on the district level farm power availability data in 'Monitoring, Concurrent Evaluation and Impact Assessment of Sub-Mission on Agricultural Mechanization' by Ministry of Agriculture & Farmers Welfare (Department of Agriculture, Cooperation & Farmers Welfare) Mechanization & Technology Division published in 2018. Two districts were selected in different agro-climatic zones from each FPA category. From each district, two blocks are chosen such that they are representative of high and low prevalence of mechanization respectively. Within each taluka, 5 villages are selected at random. In each village, 30 households are surveyed which cover proportional sample from each category having operational land holdings (i) landless, (ii) marginal: less than 1 ha; (iii) small: 1-2 ha (iv) Semi-medium: 2-4 ha; (v) Medium: 4-10 ha and (vi) Large: 10 and above 10 ha.

The study evaluates the present situation of mechanization in the selected states with emphasis on skill development among farmers. This involved examining the different sources of farm power availability and identifying the share of mechanized power among all the sources. It highlights the role, functioning and spread of testing and training centres, custom hiring centre, farm machinery banks, agricultural manufacturers, trainees trained from FMTTIs and other training centres like SAUs, manufacturers, ICAR institutes and other relevant stakeholders as they contribute to demonstration, training, information dissemination and hiring services of various agricultural machinery and equipment. To achieve the stated objectives, information was taken from the following sources: State Government, FMTTIs, Custom Hiring Centres, farmers and secondary sources from the government. *We strive to achieve this using the following tools: stakeholder interviews, telephonic and online surveys, semi-structured interviews and case studies*.

Assessing skill gap and labour-saving technologies

The skill gap analysis undertaken in the study is an indication of the skill demand in mechanization in agriculture. To understand the existing skill gaps and its challenges faced by mechanization sector, questions have been raised regarding the gap in the demand and supply of the machines involved for performing agriculture operations, gap in demand and availability of the machine operators, extent to which the farmers/landless have been targeted for training for operating machines and its repair and maintenance etc. A tailor-made skill gap survey is developed for uncovering the above information. The survey consisted of 'agricultural operation wise machine' survey where questions were administered for machines used for agricultural operation namely land preparation, sowing/transplanting, weeding, irrigation, applying fertilizer and spraying, harvesting and spraying. In context of adoption of machines/LSTs, the study explored the three aspects of adoption. An experiment was conducted to capture perception and current status of information of LSTs among women. The experiment included displaying of videos of LSTs on a digital device followed by set of discussions and questions. A module is included in the household schedule to capture observations for perception of labour-saving technologies from women who are engaged in farming operations. The women respondents were shown videos of two labour-saving technology by the enumerators on their digital devices and noted their responses for both the tools. The tools were selected based on their wider prevalence and usage among states and crops. Tool 1 is the hand weeder used for weeding. Tool 2 is rice transplanter used for transplanting the paddy nurseries.

The fundamental requirement for a sustainable mechanization sub-sector is a strong linkage between the different stakeholders and optimizing the resources to meet the demand and supply of the sector. The stakeholders cannot work in isolation as Indian agriculture doesn't observe variation in land sizes alone but also in agro climatic zones, culture, mindsets, infrastructure, educational level of farmers etc. Below are the players of agriculture mechanization which are linked with farmers directly and indirectly: Farm Machinery Training and Testing Institutes (FMTTIs), Farmer Producer Organization, Central Institute of Agriculture Engineering, ICAR-Central Institute for Women in Agriculture (ICAR-CIWA), State agriculture universities, Krishi Vigyan Kendras, Local Artisans, Private Players and social organization in mechanization.

The use of labour-saving technologies is widespread, but there is a significant gap in their adoption by women due to barriers in access to capital, access to inputs and services (information, extension, credit, fertilizer), physical accessibility, and cultural norms. In this study we aim to uncover few of the constraints which hinder usage of LSTs by women For LSTs, various technology attributes such as experience of social network, easier to operate, strength required to operate, weight of the tools, size of the tool, efficiency and productivity, multi-functionality of the equipment, reduced labour requirements and appropriateness to crop and soil were explored. Along with these aspects, willingness to pay was captured for labour saving tools. It was observed that there is a difference in preferences of women from land owning household and women from households undertaking labour work. The responses from women of land-owning households, the chances of purchasing the LSTs increases when cost of equipment is matched with the labour cost incurred for performing the operations. Women weighted LSTs from cost saving perspective. The qualitative findings suggest that women involved in agriculture do value their time and concerned about the drudgery involved. Given the decision-making ability, and removal of market constraints, they are likely to benefit from the adoption. While the women who are operating their family farm may benefit from ownership, for women labourers, the adoption needs more thinking. LSTs

have huge potential to reduce the drudgery of the women in agriculture. They promise high benefits. There popularisation can be done through Krishi Vigyan Kendra networks but with a special focus and an innovative approach. The current model of popularising these tools is not as effective to reach masses and collaboration with private sector and other agencies can be leveraged. Rental of these small tools shall be explored through Agri business and agri clinic centres. Inclusion of these tools into CHC/ FMB can result into promotion and trial of these tools which can translate into sales and adoption. As the smart tool scheme of government is implemented, better awareness of the tools will lead to higher demand and adoption of the tools.

Findings across states

Assam: Major proportion (87% of the respondents wanted a focus on training for maintenance and repair of machine, 48% respondent wanted shorter duration of trainings, 39% respondent required a focus of training on operating the machines and only 5% indicated change in content of training. Power tiller operators are hired by 432 respondents and only 12.5% respondents have confirmed easy availability of the operators. Rest 82.18% have indicated that due to non-availability of the operators, they bring the operator from outside the village. Respondent stated that that their cultivation operations are hindered and there is slight possibility of not cultivating the land and some reported that their agriculture operations get delayed as they wait for operators. This is a challenge where machines are available but shortage of operators becomes an issue. A collaborative effort with KVKs can be deployed in the blocks which have been facing these issues. This gap was found highest in Gabharu block with 98% respondent stating that the operators are to be called from other villages followed by Kaliapani, Titabor and Naduar.

Gujarat: The study showed 70% of the respondents are engaged in weeding, 66% are involved spraying and irrigation 58% are in ploughing 55% of them in harvesting and 54% of them in threshing. Hired labour is higher in threshing, harvesting and weeding as compare to other agricultural activities. The state has machines and its adoption for all other activities accept weeding which is still manually done. Use of weedicides is increasing due to labour issues. Tractors are rented through other farmers and few from institutions like CHCs etc. Non-availability of the machine is faced during the peak agriculture time. There are issues with finding operators on time, inefficiency of the operators, inappropriate way of handling machines and higher fuel consumption. Men have access to extension services but women have limited access. Usually, operators of machines have learnt its operation through family and friends. There is lack of skilled operators. Labour saving were not prevalent and have a huge potential due to various horticulture crop production. SHGs models are successful in Gujarat and collaboration of gender friendly technology with women group can spread the adoption of LSTs.

Uttar Pradesh: A gap of machine is found at the village level in the state. The cost of hiring machines from outside the village is marginally higher from the one which are arranged from the village itself. The study showed that 86% respondent are engaged in ploughing, 73% are in sowing, 70% are involved in weeding, 62% are involved in spraying, 74% are engaged in irrigation activities, 73% are in harvesting and 70% are in threshing. Tractors, seed drills, combine harvesters are prevalent in UP. The access is easy through rentals from other farmers. But activities like irrigation and mechanized weeding is not popular. It is still manually done and weeding has seen use of weedicides. There is no formal training received for machine operations and hence there is lack of skilled operators.

Tamil Nadu: The Government of Tamil Nadu has implemented several schemes and initiatives to promote mechanization in agriculture, including subsidies for farm machinery, training programs for farmers, and the establishment of custom hiring centres. These efforts have contributed to an increase in agricultural productivity and efficiency in the state. Various innovative models have come across like the State Agricultural Machinery Information Data Centre at Chennai, Self -help group rental model for tractor, power tiller and sprayers, ongoing planning of mobile mechanic van to provide access to repair and services of machines. There is widespread use of tractors and combine harvesters. Irrigation technologies like drip etc is prevalent. For application of fertiliser and pesticides, there is popularity for power operated sprayer /orchard sprayer. Even usage of expensive machines like sugarcane cutters is observed. Women's participation is mainly involved in paddy transplanting, weeding, harvesting of horticulture and floriculture crops. Their involvement in paddy harvesting and threshing in limited due to high presence of combine harvesters. Most of the farm machinery were operated by men and some women reported that they need gender friendly tools and equipment. Women perspective of these tools/equipment have been positive due to the reason of time and cost savings.

Odisha: The state is a vulnerable state with occurrence of natural calamities. Still, persistence efforts of government are strengthening the mechanization agriculture. State Level Farm Machinery Training and Testing Centre in Bhubaneshwar imparts training for machine operations. Use of machines is limited. Even being the major rice growing state, usage of combine harvesters is limited due to availability, appropriateness on the soil type and land sizes. For information by households, majority of the respondents were interested to adopt advice from private shops or suppliers followed by community members or cooperative and family members.

Overview across states

Across states, it is found that land preparation operations are being done by tractors. But other activities vary. Weeding stands out as the only activity which has less mechanized tools across all the states. Even states like Tamil Nadu, Gujarat and Uttar Pradesh which have widespread use of machines, lacks adoption of weeding machines. Irrigation technologies also observe high difference. Adoption is higher in Gujarat and Tamil Nadu but not in other states. Assam and Odisha are still relying on manual operations for majority of the activities. The findings suggest labour issues in all the states and demand of affordable machines is observed. There are only few cases of formal trainings of the operator and the finding indicates informal trainings through family and friends. For skill assessment, skill should be considered on the basis of the information and awareness of the operators rather than only considering source of the skill i.e., training through formal institutes.

Recommendations:

- With uneven Mechanization across agriculture operations, it is imperative to understand the penetration of machines across the operations.
- With very low penetration of mechanization this study suggests the need for introducing and popularizing power operated weeders for narrow and wider row crops, as well as high clearance tractors with narrow tires for intercultural operations.
- Rice transplanters are required owing to the drudgery during transplanting. But the lack of confidence in the effectiveness of the transplanter is a barrier. Demonstration is important for technology adoption. Farmers adopt when they see the technology repetitively.

- For adoption of innovative and new machines like rice transplanters, power weeder/tillers and other tools, it is important to follow 3 As framework and focus on creating machine awareness, accessibility and affordability.

Awareness: Setting up of a data centre where all the machineries which are applicable for all the crops grown in the state are displayed. This will be one institute for creating awareness about all the machines including demonstrations and taking care of the training needs in the state. The inspiration for this model should be taken from the state of Tamil Nadu where they have created 'State Agricultural Machinery Information Data Centre' and displayed all the machines for creating awareness amongst the farmers. In collaboration with Krishi Vigyan Kendra, other non-government agency, farmers exposure visit should be organised.

Accessibility: Along with CHCs and FMBs, presence of machines/tools in villages shall be ensured through various collaborative rental models like women SHG groups, farmer/youth entrepreneurs in the village. Availability of machines/tools for purchase also leads to adoption. After receiving the information of the new technology, if farmers want to see it physically or undergo demonstration, the availability at nearby market place is of utmost important.

Affordability: Rentals have been popular and affordable amongst farmers. If the increase in demand of machines is matched with the supply of machines, affordability can be ensured.

- Self-help groups should be involved in renting of smaller machines like power weeder/ tiller and other labour-saving tools like manual weeder etc. These groups should be imparted training for efficient use of these equipment.
- Labour displacement/ labour scarcity areas should be mapped and targeted for promoting manual technology. Efforts should be focussed on areas where there is lack of labour and farmers want to shift to manual yet sophisticated tools.
- There is difference in ergonomics of manual tools and power operated tools. If women use power operated tools, ergonomics won't matter much. But if its manually operated tool, then it will matter.
- Labour saving manual weeders shall be promoted for timely weeding operations. Timely operations will ensure that there is no loss of nutrient from soil due to weeds. This approach needs to be targeted especially in areas with low farm power availability like tribal belts etc. Manual tools will deliver drudgery less operations for women.
- Use of labour-saving weeding tool will also ensure non usage of weedicides and herbicides which are chemicals. Incidence of chemical farming is increasing due to menace of weeds. This approach should be especially targeted in vegetable and horticulture crops where lot of chemicals are used. Focus should be on use of labour-saving tools as part of promoting organic/natural farming by Government of India.
- There shall be inclusion of LSTs in Farm machinery bank or Custom hiring centres. This will lead to awareness of the LSTs and hence, increasing chances of adoption.
- Agri clinic and business centre should be allotted each LSTs for promotion and marketing. Bringing visibility about this equipment is required.
- Female extension agents should be focussed for promotion of technologies specifically made for women. Especially, female extension agents should be made part of the tool demonstration where women can be guided on the using the tools.
- It is observed that local artisans can make the tools at cheaper cost. Krishi Vigyan Kendras can be tied up with local artisans. There is already a training course for local artisan with KVKs. With financial support for raw materials and designs, local artisans can manufacture

LSTs. Local artisan/blacksmiths are prevalent at block level and in some villages. This will help in easy awareness of the tools along with ensuring availability. There are Blacksmith and agri tool cluster which can be leveraged to promote labour saving tools across villages.

- With focus on farm power availability, attentions should also be paid to introducing the gender friendly tools/ LSTs in the districts with low power availability. Hilly areas, tribal belts etc are easier to penetrate with these tools as they are cheaper, require manual efforts. Focus should be in particular areas to increase the reach of these tools and benefit women. For g: tribal areas have smaller land holdings, tractors are not efficient there (low farm power availability). They work manually and hence advanced manual tools like LSTs would be most beneficial to them.

Skill Demand and Skill Gap Analysis:

Using the approach for skill assessment discussed in chapter 4, analysis is presented along with following recommendations:

1) It is observed that majority of machine operators have been learning to operate the machines by their own/family/friends. They have basic training of how to operate the machine but primary surveys and discussions have highlighted the challenges like inefficiency of operators, rough usage of machine resulting in high maintenance cost and high fuel consumption while operations are undertaken.
2) There is a huge dearth of mechanics at village level. At times farmers can self- repair for basic issues but then they have to travel to block level for getting other repairs done.
3) Machines like combine harvesters require more skills to operate. There need will increase in future and hence to match the supply of operator, more training is required.
4) Innovative machines like paddy transplanter, power tiller and power weeder are not prevalent and hence their limited access limits farmers to learn its's operations. The major challenge is with any faulty operation resulting in crop loss if operated in ineffectively.
5) FMTTIs are national level institutions which are located in four locations in India. This restricts the reach of the farmers to institute of such importance in agriculture sector.
6) FMTTIs are effective to achieve high training targets but the quality of training may be hindered. With increased targets of training to be undertaken by FMTTIs, the effectiveness of trainings is compromised.
7) Leadership at the state institutes needs to be ensured. With short term period of personnel as head of the institute disrupts the progress and effective actions. This disruption was observed at a state level training institute with a great infrastructure and resource availability.
8) Certification conundrum is faced at institute level. For farmers, certification agency doesn't matter but what matter is the benefits after receiving the training and its certificate.
9) Inclusion of small tools and equipment along with other agri inputs will increase the tool visibility and hence, adoption. The inclusion will enable farmers to acquire small machines with their Kisan card etc. The trust on government cooperative societies for fertilizer is well established. This network can be leveraged for promotion of smaller machines and tools for larger benefits to the farming community.

Policy recommendations based on analysis:

1) An advance training shall be imparted to the operators who are not formally train but can operate the machines. They should be imparted with knowledge of maintenance and efficient functioning of the machines. This can be incentivised for long life and efficiency of the machines.

2) Each village should be identified with entrepreneurs who can be trained for after sale and repair work. A mobile van unit for repairs can be devised which can function on schedule basis in villages.
3) Block level training should be organized with the operators to disseminate the knowledge about how to increase the efficiency of the machines and basic repairs. The operator trainings will make the machine functioning efficient in order to deliver better results.
4) Formal training programs to acquaint the farmers/operators with the operational aspects of not so popular but effective machines will push for usage.
5) It is found that decentralised training institutes would be better for increasing the reach for training. District wise training institute will give options for farmers to approach these institutes and demand training. Smaller units will help to reach more people and achieve the training numbers. These units can be at district level government offices and hence no need of new infrastructure.
6) In order to have a better training quality, resources are required to maintain manpower, trainers and infrastructure. Training targets should be mapped across the resources available with the training institutes.
7) Continuous leadership is mandatory at the level of state training institutes for efficient working. These institutes have great infrastructure and can be leveraged for better training and display of machines.
8) The rationalization of agricultural schemes in India

   The Government of India has initiated various agricultural schemes to boost the agriculture sector in the country, including the Pradhan Mantri Fasal Bima Yojana (PMFBY), Pradhan Mantri Krishi Sinchai Yojana (PMKSY), the Rashtriya Krishi Vikas Yojana (RKVY) and many others. There are number of schemes mentioned in earlier sections which focus on promotion of machines and implements in agriculture. This is potentially cause for duplication of efforts, makes the schemes inaccessible to farmers, and hinders the effectiveness of the agricultural initiatives. Rationalizing these schemes would involve streamlining and consolidating them into a single comprehensive scheme that addresses the various issues and challenges faced by farmers across the country. The Government of India has taken steps towards rationalizing agricultural schemes, including merging the PMKSY and the Accelerated Irrigation Benefit Programme (AIBP) into a single scheme called the PMKSY-AIBP. Overall, rationalizing agricultural schemes could lead to more efficient and effective use of resources, better coordination among different initiatives, and ultimately, improved outcomes for farmers and the agriculture sector as a whole.
9) The rationalization of data available for spread of machines in Agriculture.

   The rationalization of data available for the spread of machines in agriculture refers to the process of organizing and optimizing the use of data to improve the deployment and adoption of agricultural machinery in farming operations. Currently, there are number of schemes and varying formats in which data is stored. Collecting this data is also tedious because it is scattered over multiple platforms in non-standard format. Bringing together all machine related data under one umbrella and standardising the format for all districts and states will create a robust data system. The spread of machines in agriculture has the potential to significantly improve farm productivity, reduce labour requirements, and enhance the efficiency of agricultural operations. However, the effective deployment of machines requires accurate data on factors such as existing machines, requirement of machines, crop types, soil conditions, weather patterns, and farm size, among others. By rationalizing data available for the spread of machines in agriculture, stakeholders can

better identify the areas where machines are needed and determine the most appropriate types of machinery for specific applications. This could involve collecting and integrating data from different sources, such as satellite imagery, weather sensors, soil sensors, and yield monitoring systems, among others. With a more rationalized approach to data, stakeholders can make more informed decisions about the deployment of machines in agriculture, such as which crops to plant, when to plant them, and which machines to use for planting, harvesting, and other tasks. This can help optimize farm operations, reduce waste and costs, and increase profitability Overall, the rationalization of data available for the spread of machines in agriculture can play a crucial role in the ongoing digital transformation of the agriculture industry, enabling farmers to leverage the power of technology to improve their operations and meet the growing demand for food in a sustainable manner.

CHAPTER 1

INTRODUCTION, BACKGROUND AND STUDY OBJECTIVES

India has a GDP (current US$) of 3.1 trillion and GDP per capita (current US$) of 2256.6 in 2021 registering an annual growth rate of 8.7%[1]. The agricultural sector is the largest employer of workforce and accounts for 18.8% (2021- 22) in Gross Value Added (GVA) of the country with a growth of 3.6% in 2020-21 and 3.9% in 2021-22.[2] For financial year 2022-2023, fiscal policy statements projected growth of 3.5% in for agricultural sector. [3] India has transitioned from an import dependent country towards an export-oriented economy for agriculture- commodities and leads in production of spices, pulses, milk, tea, cashew, jute, wheat, rice, fruits and vegetables, sugarcane, cotton, and oilseeds. From 1900 to 1950, food grain production showed average annual growth of less than 1%. In 1951, India had to import grains to meet the local demand. In the 1960s, attempt to increase food grain production was undertaken by importing high-yielding variety (HYV) of seeds from Mexico. With green revolution in 1965, India was self-sufficient in food grain production. In 90s many policies were introduced with aim of annual output growth rate of 4%. In 2000s, schemes like Rashtriya Krishi Vikas Yojna, Pradhan Mantri Krishi Sinchai Yojana, Pradhan Mantri Fasal Bima Yojna, Paramparagat Krishi Vikas Yojana, and more were introduced to achieve high growth in agricultural sector. Government also focused on improving agricultural infrastructure (fertilizer factories, agricultural universities and research institutions).

The need for mechanization in Indian agriculture

In 2016-17, agriculture sector constituted 36% of all employment. The employment increased to 40% in 2020-21 which marks the pandemic year in the country. In 2017, the number of people employed in agriculture were 145.66 million which dropped down to 143.4 million during the pandemic. Post pandemic, the drop in the number bounced back with 151.79 million people engaged in agriculture[4]. Agriculture has proved to be shock absorber in the Indian context during the pandemic and it absorbed back most of the manpower which migrated back from urban areas to rural areas. Though this back migration is temporary and will resume with opening up of more opportunities in the non-agriculture sector where the work force was easily absorbed before pandemic. The rural to urban migration trend has been observed in all parts of the country which led to the situations like labour shortage in agriculture. Simultaneously, the trend of urbanization has been increasing by 4 percent over the decade[5]. With growing migration, labour shortages have been felt during peak season of agriculture relative to the lean seasons. With growing demand of labour in non-agricultural sector due to urbanization and increasing infrastructural capabilities, labour wages have been rising.

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[1] The World Bank Data, https://data.worldbank.org/country/india

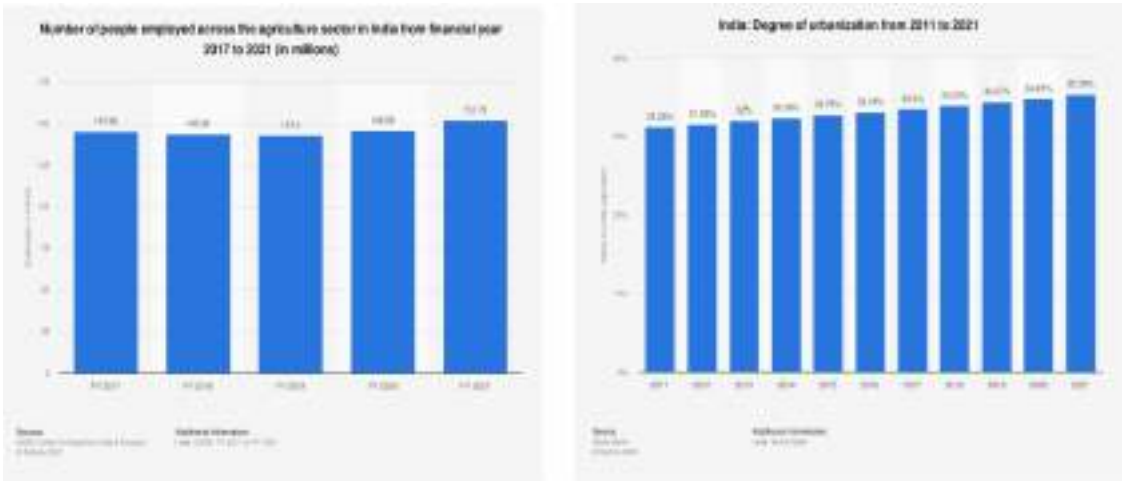
[2] Climate change and Environment: Preparing to face the future, https://www.indiabudget.gov.in/economicsurvey/doc/eschapter/echap07.pd

[3] Nominal Gdp To Grow At 15.4 % In Fy 2022-23, https://pib.gov.in/PressReleasePage.aspx?PRID=1895288#:~:text=Fiscal%20policy%20statements%20highlighted%20that,Bn%20in%20FY%202022%2D23.

[4] Centre for Economic Data & Analysis. (May 6, 2021). Number of people employed across the agriculture sector in India from financial year 2017 to 2021 (in millions) [Graph]. In *Statista*. Retrieved January 17, 2023, from https://www.statista.com/statistics/1284035/india-employment-in-agriculture-sector/

[5] Source: World Bank. (June 30, 2022). India: Degree of urbanization from 2011 to 2021 [Graph]. In *Statista*. Retrieved January 17, 2023, from https://www.statista.com/statistics/271312/urbanization-in-india/

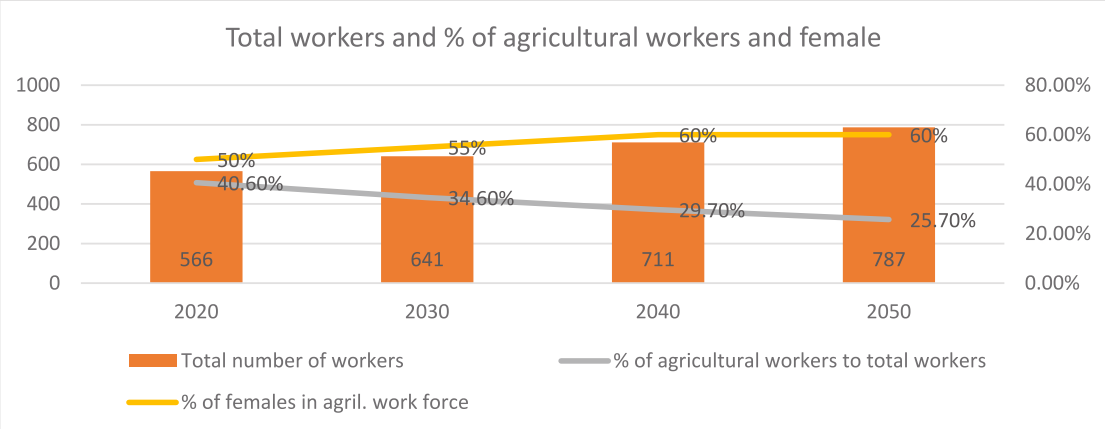
Figure 1.1 : Number of people employed in agriculture and degree of urbanization



Source: *Centre for Economic Data & Analysis (left) and World Bank (right)*

The 'Vision 2050'[6] Document gives the estimated number of agriculture work force showing the growing shortage of agriculture labour. There has been a decline in percentage share of agricultural workers to total workforce in India from 40.60% in 2020 to 34.60% per cent in 2030. By 2050, this % will drop down to 25.70%. On the other hand, the share of female in agriculture work force increases from 50% to 55% by 2030. During July 2018 to June 2019, the Periodic Labour Force Survey (PLFS), reported that in rural India, 53.2% of men workers and 71.1% of women workers were engaged in agriculture. The share of operational holdings cultivated by women increased from 11.7% in 2005–06 to 13.9% in 2015–16.[7]

Figure 1.2: Total workers and percentage of agricultural workers and female



Source: *Vision 2050 Document of Central Institute of Agricultural Engineering, Bhopal, 2015*

All of the trends highlighted above have been pivotal in incentivizing farmers to shift towards mechanization of agriculture operations. Literature so far offers mechanization as a key solution for growing shortage of labour as they save time, money and produce higher yield. In 1986, Hans Binswanger emphasized on the adoption of mechanized techniques in farming systems which were using animal draft (Binswanger, 1986). Mechanization has increased yield when integrated with other resources. With comparative advantage of machines in

6 Population Dynamics of Indian Agricultural Workers for 2050' from Vision 2050 Document of Central Institute of Agricultural Engineering, Bhopal ciae_vision_2050.pdf (icar.gov.in)

7 DoAC&FW. (2019). *Agriculture census: 2015–16*. New Delhi, Agriculture Census Division, Department of Agriculture, Co-operation & Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India.

agriculture, they are adopted and rental market have been supportive for the adoption. In 1987, the research also uncovered that mechanization happens rapidly for power-intensive operations in countries with high population densities and low wages, such as India, Bangladesh, and the Philippines [Herdt (1983); Pingali and Binswanger (1987)]. In 2007, Prabhu L Pingali emphasized that transitioning to machines in agriculture can be attributed to area expansion under crops and/or labour saving at the farmer level (Pingali, 2007). The usage also led to timely operations and enhanced positive effects on yields. In 2017, studies uncovered the need of technologies to improve labour efficiency and reduce drudgery for labour intensive methods of production.

Major reason for changing the power source for crop production from muscles (human or animal) to tractors:

- Expansion of the area under cultivation.
- Timely operations to maximize production potential.
- Multifunctionality of machines - tractors can be used for crop production, transportation, stationary power applications and infrastructure improvement
- Compensation for seasonal labour shortages (or, indeed, release of labour for more productive work.
- Reduction of the drudgery in arduous activity associated with the use of human muscle power

Major sources of farm power in Indian agriculture are agricultural workers, draught animals, tractors, power tillers, diesel engines and electric motors. The combined share of agricultural workers and draught animals in total farm power availability has reduced over the years. Still the level of agriculture mechanization in India stands at 40% which is less when compared to China (59.5%), Brazil (75%) and U.S (95%). The above discussed shift of labour from agriculture to non-agriculture sectors for various reasons of better employment opportunities, higher wages, urbanization and some government sponsored schemes like MGNREGA is also impacting the farm power availability. The gap has to be filled with mechanization of agriculture to ensure sustained productivity of the sector. The need for mechanization is further felt via pressure on the demand for food grains including cereals, fruits and vegetables due to growing population and increasing disposable incomes. Due to limits on arable land expansion, the most viable solution is to increase the crop yield. Along with technologies like improved seed varieties, agro-chemicals, composition of fertilizers (N:P: K ratio), farm mechanization is essential for augmenting the food productivity. As per the *Vision 2030 document by Indian Council of Agricultural Research*, domestic demand for food grains is expected to increase at around 2% CAGR in Calendar Year (CY) 00-30. Food grains demand is expected to reach 355 MT in CY30 vis-à-vis 192 MT in CY10. Fruits and Vegetables demand is expected to reach 290 MT in CY30 vis-à-vis 136 MT in CY10 (Vision 2050, CIAE, Bhopal).

The adoption and application of the package of farm machinery and technology for agricultural mechanization has played a significant role in improvement of cropping intensity, productivity and growth of farm power (GOI. 2018a). It leads to timely field operations and effective application of various crop production inputs such as use of micro-irrigation techniques improves water use efficiency, application of fertilizer with drip irrigation (fertigation) improves fertilizer use efficiency. Thus, the appropriate use of agricultural mechanization plays a major role in making agriculture cost effective.

The need for skilling in mechanization

Historically, post 1971, India acquired a huge momentum in agricultural mechanization due to expansion of credit facilities, assured minimum support price of food grains, rural electrification, expansion of agricultural engineering education, research and development capacity, and positive support of government in the form of exemption from excise duties on

production of tractors and power tillers and liberal import licenses for tractors (Sarkar, 2020). But the sector has a complex structural composition as the land size continue to disintegrate into smaller holdings which will deter individual ownership of agricultural machinery. As evident, sustained mechanization of agriculture involves rigorous production as well as promotion of agricultural machinery. It is complemented by effective dissemination to ensure successful adoption of technology. As new machinery is developed, information needs to be transferred to farmers as well as people involved in jobs associated with the entire value chain of mechanization. However, effective utilization of farm machinery requires more than transfer of information. Apart from being informed about the latest machinery, farmers have to keep pace with the required skills to operate them. While various initiatives by the government in the form of programs and schemes for farm mechanization have led to progressive increase in the availability of farm power per unit area for performing agricultural operations, a large part of the sector remains largely unskilled, posing a constraint to its progress in terms of productivity and efficiency (CIAE, Bhopal.[8]). Farm power availability has increased from 2.02 kw/ha in 2016-17 to 2.49 kw/ha in 2018-19[9] but skilled manpower may not have grown proportionately. The challenge is to ensure adequate skilled manpower which can reap the benefits of productivity brought about by mechanization.-

Recognizing the need to boost agricultural mechanization, the Government of India launched the ***Sub Mission on Agricultural Mechanization (SMAM) in 2014-15 under the National Mission on Agricultural Extension and Technology (NMAET)***. The aim was to provide a 'single window' for all the activities related to mechanization for accelerated and inclusive growth. It has been implemented to promote farm mechanization and increase the ratio of farm power to cultivable unit area up to 2.5 kW/ha in all states. The Mission envisages inclusive growth of farm mechanization in the country of farm power availability, human resource development, and productivity and quality assurance of agricultural machinery. Mechanization improves manpower productivity by relieving labour from the labour -intensive operations. As new machinery is developed, information needs to be transferred to farmers as well as people involved in jobs associated with the entire value chain of mechanization for sustained adoption. However, effective utilization of farm machinery requires more than transfer of information. Skills are integral to machine-based operations and farmers have to keep in pace with the required skills to operate them. Various initiatives by the government in the form of programs and schemes for farm mechanization have led to progressive increase in the availability of farm power per unit area. But, still a large part of the sector still remains to utilise the existing machineries due to lack of skilled manpower for operating and maintaining these machines. This poses a constraint for progress in terms of productivity and efficiency of crop, labour and machineries. Farm power availability has increased from 2.02 kw/ha in 2016-17 to 2.49 kw/ha in 2018-19 but skilled manpower may not have grown proportionately. The challenge is to ensure adequate skilled manpower which can reap the benefits of productivity brought about by mechanization.-According to an evaluation submitted by NABCONS[10], the training imparted by the FMTTIs and government sponsored institutions, was perceived as useful among the beneficiaries who received them. The report also stated that farmers reported a reduction in the hours devoted to field operations by 8 to 13 percent and technicians experienced an increase in their income by approximately 8 to

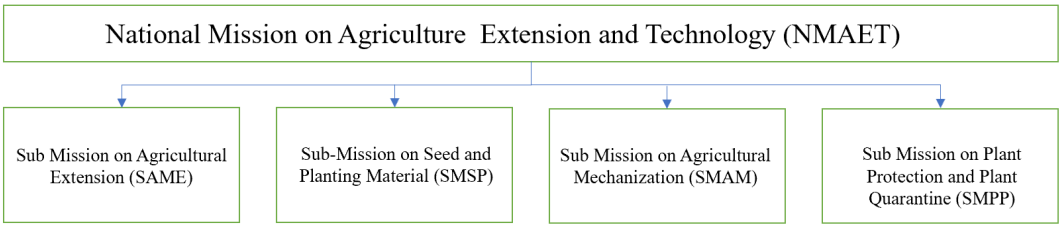
8 Country Report: Indian Agriculture – An Introduction, https://www.un-csam.org/Activities%20Files/A0902/in-p.pdf

9 Initiatives of Government of India to Promote Farm Mechanization, 2021, https://www.pib.gov.in/PressReleseDetailm.aspx?PRID=1696224

10 https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Ffarmech.gov.in%2FEvaluation%2520%26%2520Impact%2520Assessment%2520Study%2520Reports%2FPSAMTTD_REVISED_DRAFT%2520REPORT.docx&wdOrigin=BROWSELINK

20 percent. This shows that skill development has a significant impact on their beneficiaries. Further, training and demonstration has also influenced adoption of technology, enhanced skill for operation and maintenance and increased productivity.

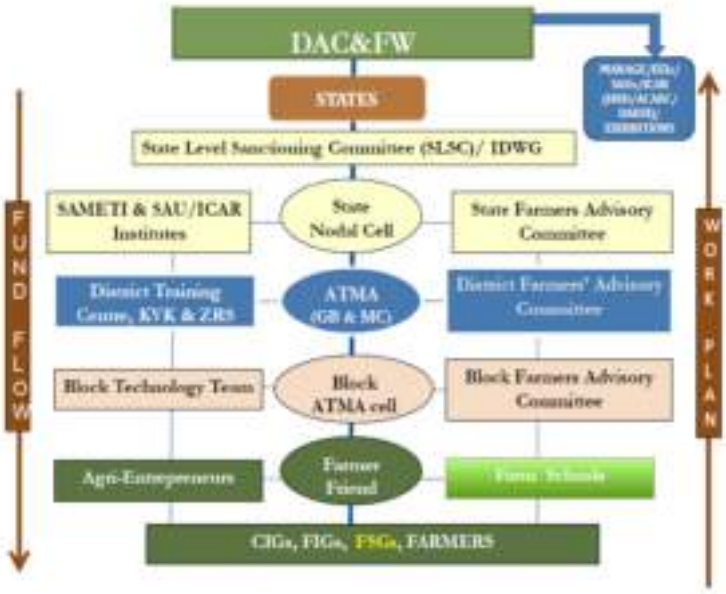
Figure 1.3: Sub missions of National Mission on Agriculture Extension and Technology



Source: *Compiled by Authors*

In 2014-15, the Government of India introduced "The National Mission on Agriculture Extension and Technology (NMAET)" that has under its ambit four interlinked sub-missions (Figure 1.3): (i) Sub Mission on Agricultural Extension (SMAE), (ii) Sub-Mission on Seed and Planting Material (SMSP), (iii) Sub Mission on Agricultural Mechanization (SMAM) and (iv) Sub Mission on Plant Protection and Plant Quarantine (SMPP). The overall aim of the mission is to restructure & strengthen agricultural extension to enable delivery of appropriate technology and improved agronomic practices to the farmers.

Figure 1.4: Program architecture for National Mission on Agricultural Mechanization and Technology



Source: *ATMA Guidelines, 2018*

Need for labour-saving technologies for women in agriculture

SMAM have taken into consideration these issues and have a gender component as well with the aim of "Gender Mainstreaming" which is one of the important pillars of the National Policy for Farmers" formulated in 2007. (National Gender Resource Centre in Agriculture et al., n.d.). This implies that the schemes have to ensure that 30% of total scheme beneficiaries are women and minimum 30% of resources as part of the sub-mission are to be allocated to women farmers and women extension functionaries. Under the scheme, women beneficiaries are to receive training programs on gender friendly equipment, support concessions for women on purchase and use of farm machines for various agriculture. A list of agricultural implements and hand tools suitable for farm women has also been developed by Research & Development organizations under ICAR with the intent to reduce drudgery and enhance women's efficiency in farm operation. Additionally, they will be provided with an additional 10% additional of financial assistance (in comparison with men) for purchase of various agricultural machines and equipment (Press Information Bureau, 2015). Despite the considerations made by the scheme, there exists challenges in implementation and lack of awareness about schemes specifically designed for women farmers (Srivastava et al., 2015). These prominent drawbacks can hamper the progress of adoption of technology by women. A thorough assessment of the situation can help understand the present situation as well as the factors that affect adoption of technology by women farmers.

The Sub-Mission on Agricultural Mechanization (SMAM) is implemented in all the states, to promote farm mechanization. The Mission envisages inclusive growth of farm mechanization in the country in the next five years in terms of farm power availability, human resource development, and productivity and quality assurance of agricultural machinery. Along with the FMTTIs, other government sponsored institutions such as ATMA institutions, KVKs under ICAR, National Innovation Foundation, Agricultural Engineering Colleges and State Agricultural Universities have been assigned with implementation and strengthening of the scheme.

In Indian context of agriculture, women involvement in agricultural work force is of significance importance. It has been found through various studies that women time use is higher than men where they work in agriculture activities and also devote their time for managing household work. The participation of female labour was found to be more in activities such as manual harvesting (93.3%), picking of vegetables (95.6%), animal dung collection and its disposal (94.4%). (Singhet al. (2004); Parimalam 2016); Sharma and Khandelwal (2002) and Aggarwal et al. (2013). Kaur and Singla (2017). There are technologies which can help reduce women's drudgery and provide sufficient time so that they can manage both agriculture and household work without comprising on their health. In 1994, a simulation exercise suggested that if given women also had access to same resources like men, that would increase women's output by 22% reducing the gap between man and women output. Women are involved as female agricultural labour, farmers, co-farmers, female family labour and (with male out migration, widowhood, etc.) as managers of farms and farm entrepreneurs. But, with mechanization, majority of the agricultural operations requiring machines are operated by men while women perform manual operations with hand tools. The significant and increasing work engagements of women are at the same time subject to gendered constraints and barriers. This ranges from the existence of gendered norms, motivations and ownership patterns, their predominance in the unpaid domestic and care economy, absence of recognition of their identity as independent farmers or equal workers (World Bank, 2017). In order to overcome the constraints, technological interventions therefore must integrate an understanding about production processes, gendered roles, constraints and demands into its purview (FAO, 2011). Carefully designed mechanization interventions can be particularly helpful towards breaking

the constraints that women presently face. As evident, there is a need to equip women farmers with suitable technology.

Objectives of the study

The government is dealing with multiple issues: (i) increase in demand of food with growing population (ii) labour shortage in agriculture and increasing labour wage (iii) shrinking profits in agriculture and (iv) increased involvement of women in agriculture. With the above context, mechanization and technology adoption is one stop solution. Farm mechanization is not only increasing the productivity through efficient use of other inputs and natural resources but also reduces the need of manual labour and cost of cultivation.

The project is implemented in two parts: (i) focusing on skill assessment in mechanization and (ii) focusing adoption of labour-saving technology among women. The objectives are designed to uncover the 'mechanization architecture' in India:

Skill assessment in mechanization:

1. To review the status of skill gaps across the value chain of farm mechanization.
    - Asses the status of farm mechanization - availability of machines, the gap of the farm power per hectare (actual vs required), cost of labour and prevailing wage rates
    - Assess the availability of skilled manpower for different job roles under the farm machinery sector across the value chain; to estimate the requirements and gap of skilled man power for different job roles under farm machinery sector
    - Assessment of the additional farm machinery training centres to cope up the skill gap
2. To study the impact of farm mechanization on employment of labour
3. Assess the extent and the functioning of the SMAM schemes in view of women components within the scheme.
4. To study the socio-economic condition of the selected farmers households, status of agricultural equipment machinery with men and women farmers and their time use
5. To formulate the strategy and programmes that may be required for filling up gap of skilled manpower in view of rapid mechanization of agriculture in upcoming periods.

Adoption of Labour-saving technology among women:

1. To identify the factors/underlying characteristics affecting the uptake of labour saving-technologies and extension services among women farmers.
2. To estimate the willingness to pay and the costs associated with adoption of labour saving-technologies among women farmers.
3. To map time, use preference for women with adoption of labour-saving technologies

The upcoming chapters, chapter 2 describes the approach adopted to conduct the study. Chapter 3 highlights the global differences in mechanization and status in India through secondary data, chapter 4 brings across status of machines and major skill gaps in the states, components of skills, and adoption of labour-saving technology, Chapter 5 will summarize and bring across the recommendations.

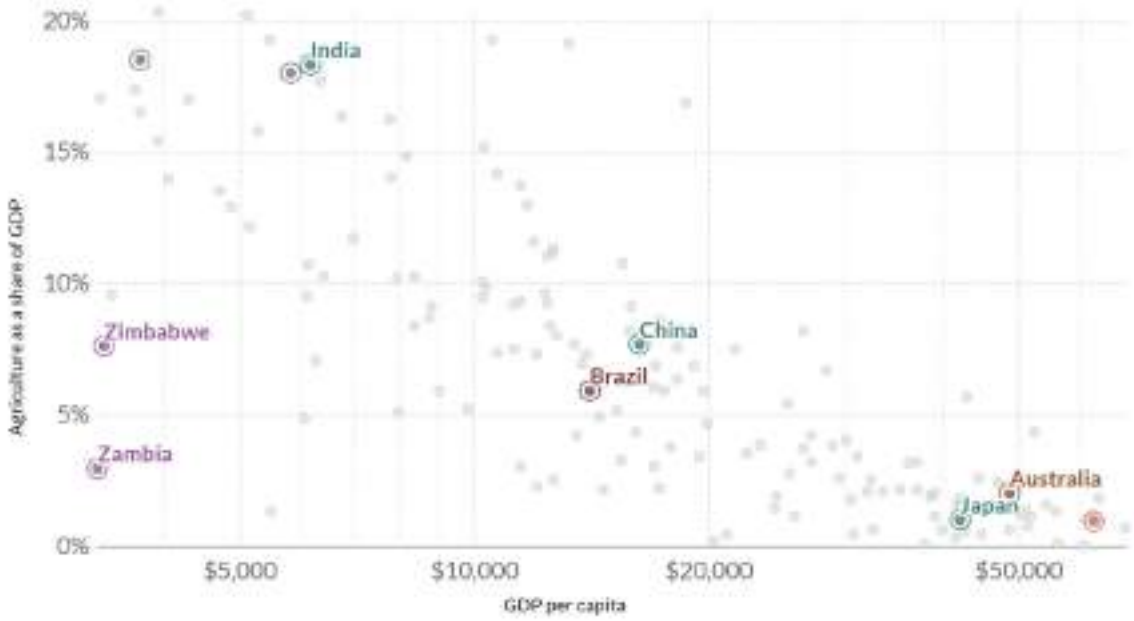
CHAPTER 2:

AGRICULTURE MECHANIZATION TRENDS: GLOBALLY AND INDIA

Globally, due to shrinking land, water resources and shortages of labour workforce, there has been a shift towards mechanization for production and post harvesting operations in agriculture. Evidence suggests that farm power availability and farm yield are linked i.e., crop productivity is directly correlated with farm mechanization. It not only saves labour costs and time but also reduces the cost of production in the long run. Further it reduces drudgery & post-harvest losses, while increasing the output and farm incomes.

Mechanization trends vary globally and depend on several factors such as land sizes, availability of workforce in agriculture, availability of machines, government policies and extension services. In many countries agricultural mechanization is still in a developing state and some have advanced. In lower income countries, farmers use traditional manual tools and Equipments resulting in low productivity. In higher income economies, the proportion of machine use is much greater than labour use. In these economies, even though the share of agriculture in GDP is low but their GDP per capita is very high as compared to lower income economies. Figure 2.1 below reflects this pattern and shows United States, Australia and Japan have higher GDP per capita as compared to China, Brazil, India.

Figure 2.1: Agriculture as a share of GDP vs. GDP per capita, 2020

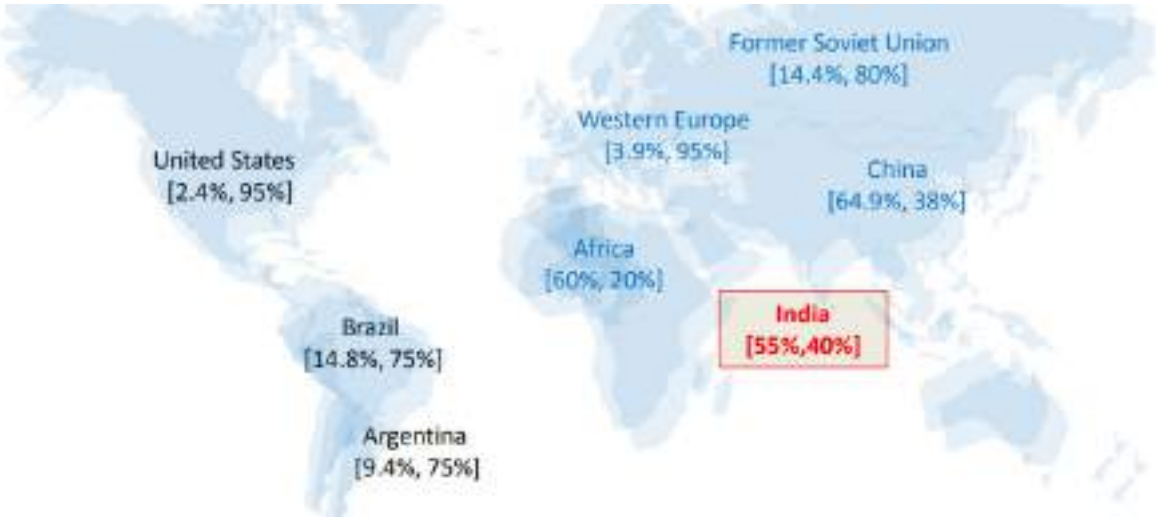


Source: *Data compiled from multiple sources by World Bank*

In the other countries, agricultural mechanization is still in the developing stage. In these countries farmers still use inefficient manual tools which resulted in low production. For instance, in Nepal, the land size is small, which has prevented farmers to adopt large machinery. Lack of appropriate machineries to conduct various farming operations has left farmers with no choice but to continue with traditional farming techniques In the other

countries, agricultural mechanization is still in the developing stage. In these countries farmers still use inefficient manual tools which resulted in low production. For instance, in Nepal, the land size is small, which has prevented farmers to adopt large machinery. Lack of appropriate machineries to conduct various farming operations has left farmers with no choice but to continue with traditional farming technique

Figure 2. 2: Population engaged in agriculture vis-à-vis level of farm mechanization



Source: *Agricultural Machinery Manufacturers' Association (AMMA, India)*

In United States, Western Europe, Soviet Union, Brazil, Argentina, China, India, Africa the level of farm mechanisation is at 95%, 95%, 80%, 75%, 75%, 38%, 40% and 20% respectively. The corresponding values of the population engaged in agriculture is 2.4%, 3.9%, 14.4%, 14.8%. 9.4%, 64.9%, 55% and 60% respectively. In figure 2.2, the indication [value1, value2] marks the population engaged in agriculture and level of mechanization over the country.

The below table 2.2 summarizes the features of agricultural mechanization across countries.

Table 2.1: Features of agricultural mechanization across the globe

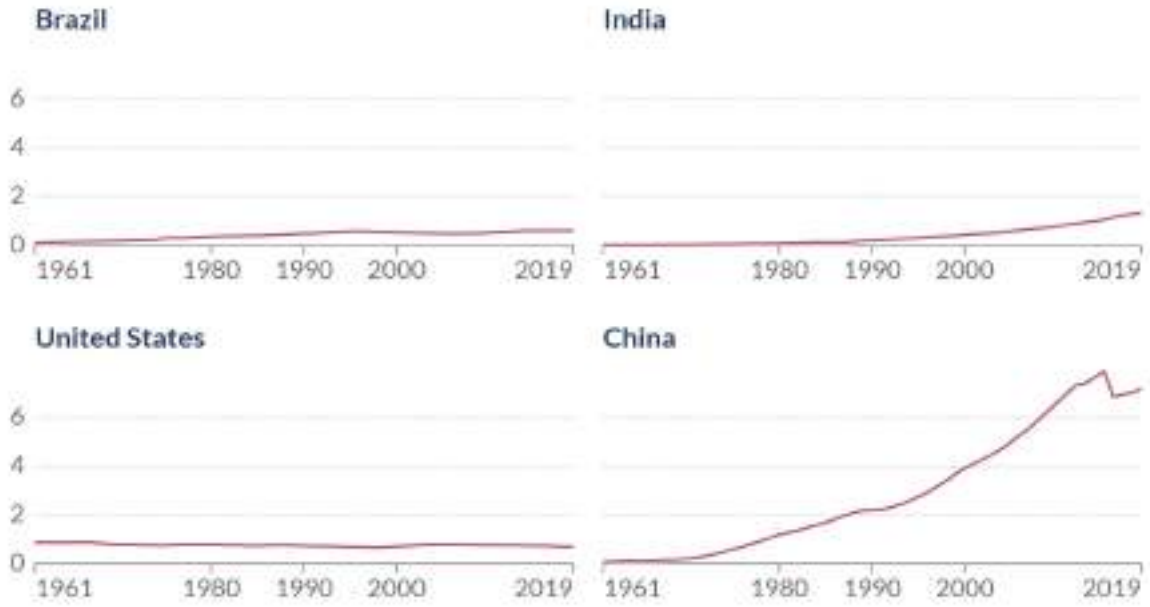
Geographies	Features of Agricultural Mechanization
Europe	Europe is over mechanized with high numbers of machines per ha. It has variation of small farms in higher altitudes to fairly large size farms with crops under plantation and fruit orchards. It witnesses demand for higher powered machines ranging from high power tractors and tractor mounted implements sprayers for orchards etc
USA	USA is highly mechanized with large and high horsepower equipment. Automation is observed as the new advancement in agriculture. Recently, thrust is towards Internet of Things in Agriculture (IoT in Agri).
Japan	Japan's agriculture is highly mechanized with about 500 tractors and 250 harvesters per 1,000 ha. Japanese agriculture comprises small, sophisticated and specialized machines. The trend is tilting towards automation. The industry exports machinery to Asia and other regions of the world.
Sub Saharan Africa	Sub Saharan region still remains least mechanized with 80% of agricultural area is cultivated by human power and only 5% with tractors. 70% of all tractors are concentrated in South Africa and Nigeria. There has been increased imports from India and China.

Geographies	Features of Agricultural Mechanization
North Africa / Middle East	The level of mechanization is significantly higher in Sub-Saharan Africa. There are 11 of tractors on an average per 1,000 ha. Large disparities can be observed in the region, for example in Morocco, the average of tractors per 1,000 ha is 6 while in Egypt it is 31 tractors per 1,000 ha.

Source: *Compiled by authors*

The spread of machinery across countries is plotted in the figure 2.3. Farm machinery is measured in units of horsepower. This is divided by total agricultural land to give the average machinery use per 1000 hectares of agricultural land [11]. The figure 2.3 shows the increases in horsepower over the years in Brazil, China, India and United states. For India, the horsepower availability per 1000 hectares has changed from 0.01 in 1961 to 1.32 in 2019. For China, over same period it changed from 0.05 to 7.16.

Figure 2.3: Farm machinery per unit of agricultural land, 1961 to 2019



Source: *United States Department for Agriculture (USDA) Economic Research Service*

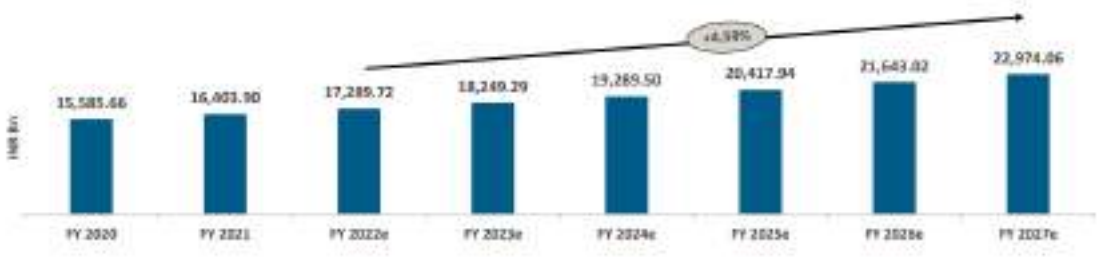
Global Agriculture Machinery Market – An Overview

Globally, agricultural machinery market was valued at ~ USD 155.68 billion in 2021 It is expected to expand at compound annual growth rate (CAGR) of 5.0% from 2022 to 2030.[12]

[11] Our World in Data, https://ourworldindata.org/grapher/machinery-per-agricultural-land?tab=table&country=~IND

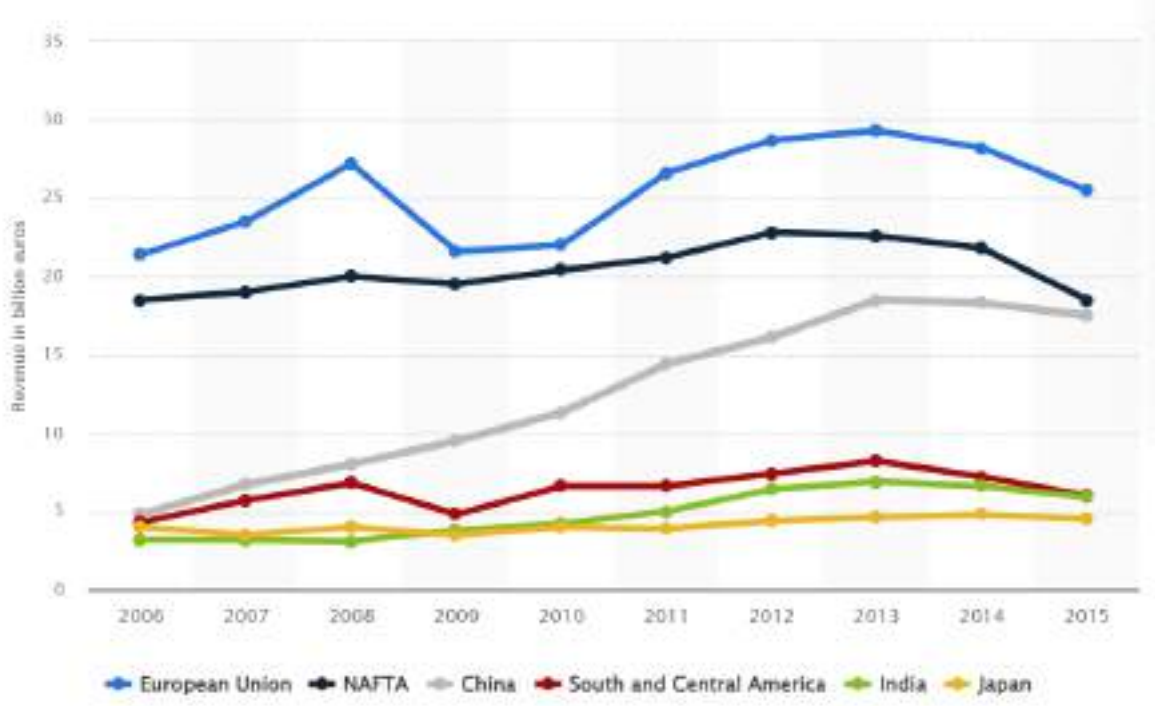
[12] Agriculture Equipment Market Size Report, 2022-2030 (grandviewresearch.com)

Figure 2.4: Global agricultural machinery market size and growth forecast (FY 2020 -FY 2027e)



Source: *Agricultural Machinery Market in India 2021*

Figure 2.5: Global farm machinery market size from 2006 to 2016 by region (in billion euros)

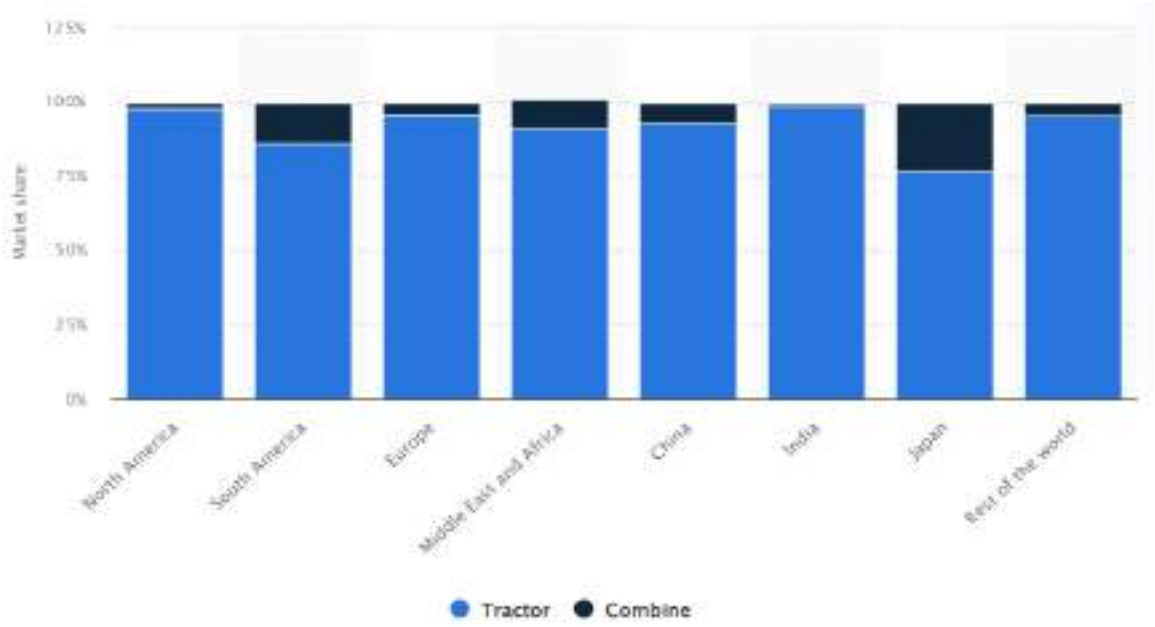


Source: *Agriculture equipment market share in 2020, by segment and region*

Globally, the split of tractor and combines have seen a variation with majority share formed by tractors. In India, where tractors form more than 95% of the market share, Japan has 75% to the tractor market share and rest 25% to combines[13]. The graph below shows the percentage composition of the market share of tractors and combines globally.

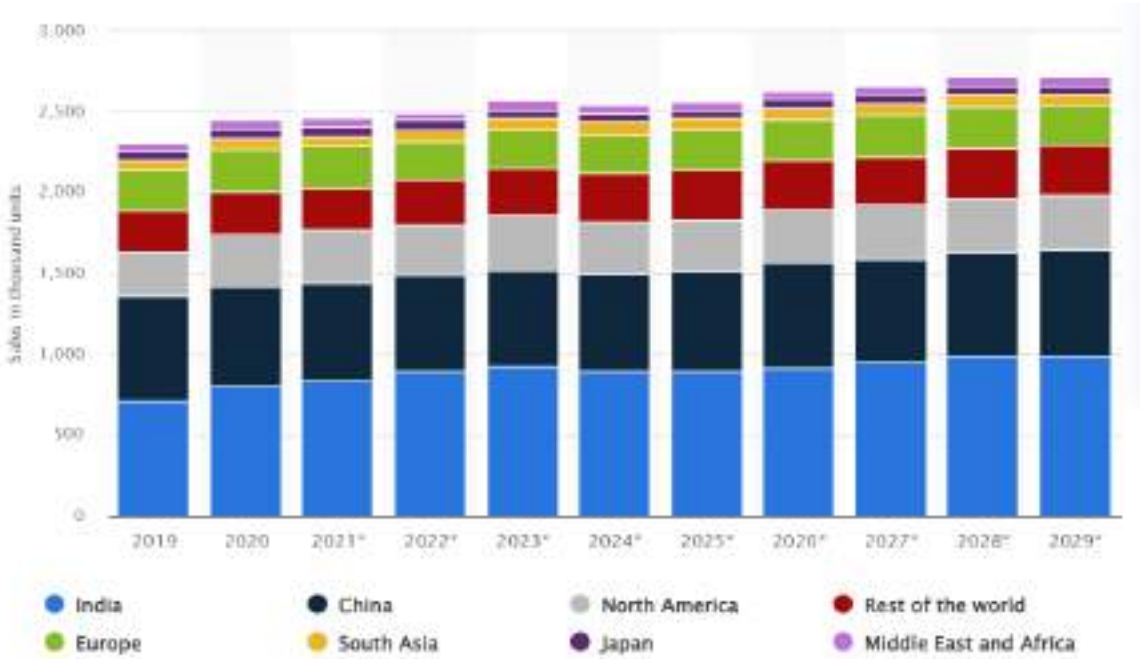
[13] Agriculture equipment market share in 2020, by segment and region, https://www.statista.com/statistics/1228263/agriculture-equipment-market-share-segment-region/

Figure 2.6: Agriculture equipment market share in 2020, by segment and region



Source: *Statista 2022*

Figure 2.7: Global agriculture equipment unit sales from 2019 to 2029, by region or country (in 1,000 units)



Source: *Statista 2023*

In 2020, agriculture equipment sales dominated the Indian market with a total of 810,000 units sold. The second largest market was China, who reported a total of 610,000 sales. By 2029, sales of agricultural equipment are forecasted to reach over 2.7 million units[14].

[14] Global agriculture equipment unit sales by region 2019-2029, Global agriculture equipment unit sales 2019-2029 | Statista

Farm Mechanization in China

In 2004, China established the "National Law on Agricultural Mechanization Promotion," which aimed to improve regional and worldwide agricultural mechanisation cooperation, technological transfer, information distribution and advantageous marketing development. China began agricultural mechanisation at state-owned farms with help from the former Soviet Union, which equated mechanisation with "tractorization," following the traditional route of technological transfer, which in this case was presumably deemed appropriate due to similar conditions. Land reclamation was used to build state-owned mechanised farms, and trial and error was used to run state-owned tractor stations (Machine Tractor Stations and Agricultural Mechanization Stations). Since 2004, the National Social and Economic Development Program is considerate of the trend toward industrialization and trying to develop an equitably affluent society by tackling difficulties in agriculture and rural areas. It took a number of steps to improve the agricultural sector, including lowering the burden on farmers by eliminating agricultural taxes and implementing producer-oriented subsidy policies. Farmers' taxes were decreased by US$36 billion in 2004, and grain producers, seeds, and farm machinery received US$18 billion in subsidies. The domestic market for large and medium-sized farm machines started to expand quickly. It paved the way for improved large tractors and combines to enter the market, as well as encouraging agro-machinery manufacturers to change their product structures. Domestic tractor production capacity has also expanded for medium and large tractors. In terms of agricultural machinery product structure, local manufacturing capabilities for large and medium-sized machinery under 200 horsepower has significantly improved in recent years to fulfil market demands for tillage, sowing, and harvesting. China has roughly 30 million hectares of paddy fields, and mechanisation of rice production has provided a large market potential in China since the mid-1990s, while also posing a difficulty for knowledge transfer by international enterprises. China's farm machinery producers have benefitted from a favourable market climate since the turn of the century, which has propelled the industry's expansion. China is currently self-sufficient in tractors and mid-sized cereal combines powered by 200 hp diesel engines, as well as having the capacity to produce over 200 000 medium and large-sized agricultural tractors, over 2 000 000 small tractors, and over 100 000 medium-sized combine harvesters per year.

China's machinery manufacturing industry grew in tandem with mechanisation as a means of supporting the latter and advancing the country's economic development. This method appears to have evolved from a policy of agricultural support aimed at raising yields and ensuring food security. There could be additional factors at play that explain farmers' readiness to accept automation technologies. Despite the emphasis on industrial development, China's development strategy never disregarded agriculture or consigned it to the background, instead devoting attention to it in order to preserve a balance between rural and urban development. It prioritised food production and food security for its extremely huge population. A notable order states that industry should be created first to support agriculture, and automation is one of the inputs that the government should promote.

Farm Mechanization in Brazil

Brazil witnessed mechanization following World War II. Tractors were initially imported into Brazil from the United States and Europe. From 1959 to 1969, the Brazilian government started encouraging domestic production of goods facilitating farm mechanisation. The market shrank significantly during the 1980s, but it began to revive in the 1990s. Since the year 2000, when MODERFROTA was introduced, there has been a considerable growth in the number of

units sold. The Rural Credit Plan for the Modernization of the Fleet of Agricultural Tractors, Implements, and Harvesters (MODERFROTA) is a rural credit scheme meant to support the rehabilitation of agricultural machinery fleets. Since its inception, annual investment in the project has not been consistent, but it has undoubtedly influenced the rate of growth of agricultural mechanisation. As a result, agricultural machinery and implement production and exports increased quantitatively and qualitatively, broadening the product range and tailoring it to the characteristics of each crop and location. Over the last 20 years, a double cropping agricultural system has been used, in which two crops are grown and harvested on the same land each year. This shift in cultural practise was enabled by the introduction of short cycle crop types, and it has played a significant role in improving grain production in Brazil. The system requires that farming operations be optimised and executed on specified dates; meeting these requirements has been accomplished by mechanisation.

Brazil has been inventing and providing technology items primarily for tropical crops, such as mechanisation of bean, sugar cane, and coffee production. Bean production has generally been concentrated on small farms, but the development of robotic harvesting equipment has piqued the interest of large producers, particularly those with irrigation systems. Mechanization of coffee harvesting is crucial for Brazil to preserve its international leadership in coffee farming while maintaining price and quality competitiveness. Due to labour shortages and expenses, manual harvesting is becoming increasingly challenging, and a wide range of mechanical coffee harvesting devices and equipment has recently been developed. Sugar cane production has traditionally required significant and arduous labour inputs, with crop leaves being burned before the cane is cut by hand. Mechanical sugar cane harvesting is presently used on approximately 35% of the planted area.

Farm Mechanization in South African Countries

Because of the high population density, agriculture in South African countries is characterised by small holdings. Agriculture is ignored in the South African region; low levels of engineering technology inputs (particularly power) into agriculture, along with a lack of targeted expenditures, have been noted as important barriers impeding the modernization of Africa's agriculture and food production systems.

Farm mechanization in Zimbabwe

Agriculture is the dominant sector of the Zimbabwean economy contributing an average of about 18 percent of the GDP. Hand tools and implements are currently being used in all the farming sectors. Typical examples of commonly used hand tools that have become symbols of specific farming systems include the use of hand hoes in communal farming areas, the use of knapsack sprayers in small-scale farming areas, and the use of cutters in large scale commercial tea and coffee estates. However, hand tool use is associated with communal farmers who cannot afford motorised implements and/or the small size of their cultivated areas makes it uneconomic to acquire expensive implements. Animal drawn implements form the major source of mechanised inputs in small landholdings. These include mouldboard ploughs, scotch carts, rippers, ridgers, cultivators, harrows and planters. Zimbabwe does not manufacture tractors but relies on imports from the region and the international community. Tractors are imported into the country in complete form, semi-knocked down (SKD) kits or as completely knocked down (CKD) kit forms.

Farm Mechanization in Zambia

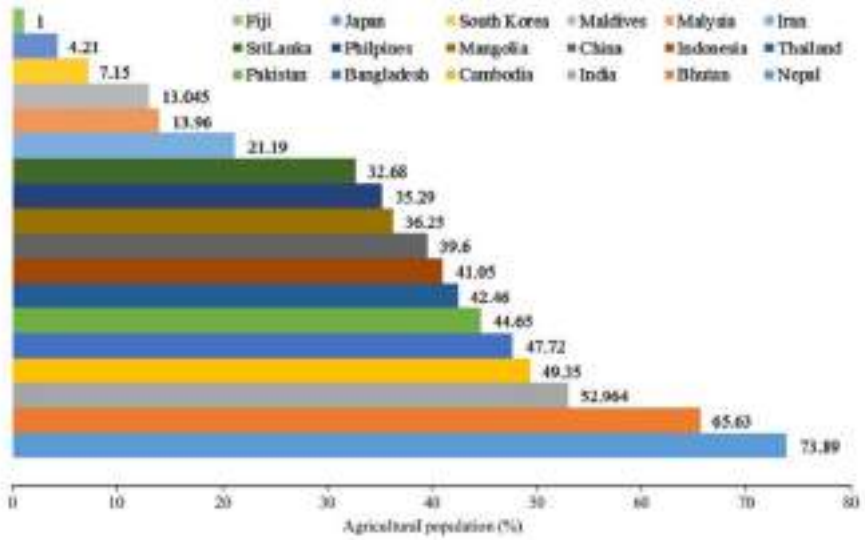
The agriculture sector employs over two-thirds of the labour force, however the majority of them work under the small-scale. The sector accounts for around 18% of the Gross Domestic Product (GDP). Because of its enormous store of unutilized arable land and the demise of the mining sector, agriculture is now recognised as the dominant sector of the Zambian economy. Zambia has a total land area of around 75 million hectares, however only 25 million of these are viable for agriculture or livestock production. Around 16 million hectares are suitable for rough grazing, while the remaining 9 million hectares are considered arable with good agricultural production potential.

In Zambia, the agricultural sector is divided into three categories: small-scale (smallholder) farmers, emerging farmers, and commercial farmers. Smallholder and emergent farmers account for roughly 76% and 20% of the farming community, respectively, with commercial farmers accounting for the remaining 4%. Most commercial farmers are concerned about the high cost of agricultural machinery and implements, as well as the high interest rates on loans to invest in mechanisation inputs. Both of these variables are linked to the country's high inflation rate. Between 1971 and 1975, the FAO estimates that a total of 5 990 tractors were brought into the country, with the overall number of tractors estimated to be around 13 000. (FAO, 1990). According to statistics, the number of commercial farmers increased by 38% between 1970 and 1988. As a result of the government subsidy programme, a large number of African farmers have entered commercial farming. Between 1969 and 1980, the number of subsistence farmers declined by an average of 0.5 percent each year, while emergent farmers increased by nearly 13 percent.

In order to ensure national and household food security, the government created an agricultural commercialization programme (ACP) in 2002 to raise the living standards of various categories of farmers and those who are unable to benefit from the opportunities created by the liberalised economic environment. The 2KR smallholder mechanisation support programme was created to address the lack of farm power and mechanisation, which is currently one of the barriers to improved agricultural productivity, particularly among small-scale farmers. For agricultural operations, the majority of small and medium-scale farmers still rely on hand labour, with only a handful employing DAP. As a result, land production and utilisation are low.

South East Asian countries

Figure 2. 8: Involvement of population in agriculture sector as percentage of the total employment in different Asian Countries

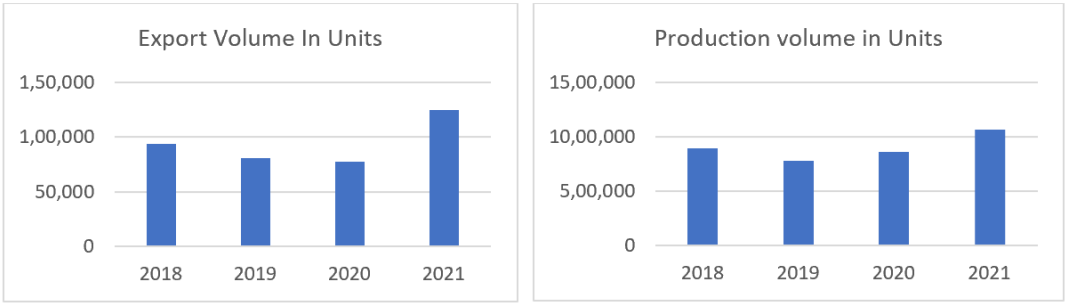


Source: *World Band (2017b)*

Farm Mechanization in India

In 2021, the annual export volume of tractors in India surpassed 10 thousand marks to 12.5 thousand units. It was a significant increase for the previous year which was at 77.4 thousand units. India is one of the biggest tractor manufacturing countries in the world alongside U.S. and China. In 2021, the annual production of tractors in India surpassed one million marks to 1.07 million units. It was a significant increase for the previous year which was at 863 thousand units. India is one of the biggest tractor manufacturing countries in the world alongside U.S. and China.

Figure 2.9: Annual production volume and export volume of tractors across India from 2018 to 2021



Source: *Statista*

Skill Development in China

China has developed organization system for Agricultural Mechanization. They have systems for the development of agricultural mechanization of agricultural machinery management, scientific research, identification, authentication, technology extension, education and training, safety supervision and managing, repairing, social service and etc. There are 31 agricultural mechanization management organizations at provincial level, 346 at regional level, 2745 at

county level and 34317 at town level across the country. There are 49 agricultural machinery test and appraise organizations at regional and city level, 122 agricultural machinery research institutes. 2413 agricultural machinery technology extension organizations at county level, 2900 safety supervision and managing organizations for agricultural machinery, 2213 agricultural machinery education and training organizations. The administrative regions above county level in China all set up the organizations of agricultural machinery management, technology extension and supervision, more than 260000 employees engaged in agricultural machinery management, extension, identification and supervision, of which the scientific and technological staff takes 50%.[15]

Figure 2.10: Organization system of China for agriculture mechanization

Number of Agricultural Mechanization Management Organizations across China			
Provincial level	31		
Regional level	346	Agricultural machinery test and appraise organizations	49 at regional and city level
county level	2745	Agricultural machinery research institutes	122
Town level	34317	Agricultural machinery technology extension organizations	2413 at county level
		Safety supervision and managing organizations for agricultural machinery	2900
		Agricultural machinery education and training organizations.	2213

Source: *Compiled by author*

Indian agriculture witnesses similar focus through government. The government schemes and initiatives have been enabling the machinery adoption among the farmers. For promotion of farm mechanization, the Ministry of Agriculture & Farmers Welfare initiated the Central Sector Scheme of *Promotion and Strengthening of Agriculture Mechanization through Training Testing and Demonstration (PSAMTT&D)* and during the XI Five Year Plan (2007 - 2012). The scheme aimed to promote agricultural machinery by popularizing new technology-based equipment, human resource development in the field of agricultural mechanization and improvement in quality of machines and equipment. The scheme has placed significant thrust on training of farmers through various government institutions as well as outsourcing the task to other organizations. In 2020, Government of India has initiated a drive for Skilling Migrant labourer in the area of agricultural machinery under the Aatma Nirbhar Bharat Abhiyan. We discuss the various schemes in the next chapter.

[15] Agricultural Mechanization Promotion in China—Current Situation and Future retrieved from Link: https://ecommons.cornell.edu/bitstream/handle/1813/10457/Invited%20Overview%20Bologna%20Li%2018Feb2005.pdf;sequence=1

CHAPTER 3:

NEED FOR MECHANIZATION IN AGRICULTURE: SCHEMES IN INDIA

Although India accounts for only about 2.4 percent of the world's geographical area and 4 percent of its water resources, it supports approximately 17 percent of the world's human population and 15 percent of the world's livestock. Agriculture is a significant sector of the Indian economy, accounting for 14% of the country's GDP and approximately 11% of its exports. Farmers in developing countries continue to rely mostly on traditional agricultural production methods, employing traditional tools and equipment in the majority of situations. For example, adequate mechanical devices are necessary for sowing the required quantity of seed at the proper depth and uniform administration of a specific dose of fertiliser. However, when such activities are carried out using indigenous means, their efficiency suffers. This has resulted in low productivity and excessive production costs, among other things (Onwude et. al). Mechanization of Indian farms is critical to improving input use efficiency, reducing human drudgery, increasing food grain yield and productivity, lowering production costs, and addressing labour scarcity and farm operation timeliness. Several studies show a strong correlation between mechanisation and agriculture productivity. Singh et al. (2011) in their paper has shown that states with a greater availability of farm power show higher productivity as compared to others. A study by Singh (2006) shows that farm power significantly contributed to increasing the yield. Hence the government of India has specific focus on farm mechanization and has developed various schemes for better coverage of machines across categories of landholdings.

Mechanization Schemes in India

This section discusses the need of mechanization in India and various mechanizations schemes over the period of years. Table 3.1 provides all the schemes that connect with mechanization currently operational

Table 3.1: Comparative study of all the schemes undertake for spread of farm mechanization

Serial No	Name of the Scheme	Origin Year	Objective	Coverage	Benefit
1	Sub Mission on Agricultural Mechanization	2014-15	To increase the reach of mechanization to small and marginal farmers and to the regions where farm power availability is low.	All states	Financial assistance for agricultural machinery, setting up Custom hiring centre, Farm machinery banks, Promotion and Strengthening of Agricultural Mechanization through Training, Testing and Demonstration

Serial No	Name of the Scheme	Origin Year	Objective	Coverage	Benefit
2	Promotion of Agricultural Mechanization for In-Situ Management of Crop Residue in the States of Punjab, Haryana, Uttar Pradesh, and NCT of Delhi	2018-19	To reduce air pollution caused by stubble burning	Punjab, Haryana, Uttar Pradesh, NCT of Delhi	- Financial assistance @ 50% of the cost of machinery is provided to the farmers and 80% of the project cost is provided to the Cooperative Societies of Farmers, Farmers Producers Organization (FPOs) for crop residue management machinery
3	Rashtriya Krishi Vikas Yojana (RKVY) or RAFTAAR	2007-08	pre-and post-harvest infrastructure	All states that contribute their share are eligible	- Till 2014, 100% central assistance was provided for State Plan Schemes - Since 2015, funding shared between Centre and States in 60:40 ratio (90:10 in NE and Himalayan States), and 100% for UTs
4	Pradhan Mantri Krishi Sinchayee Yojana - Per Drop More Crop	2015 (2006, 2010, 2014)	To increase area under Micro Irrigation technology to enhance water use efficiency	All states	- For Small & Marginal Farmers, 55% of the Cost of Implementation of MI shared by Centre and State in 60:40 ratio - For other farmers, 45% of the CoI of MI shared by Centre and State in 60:40 ratio - In NE and Himalayan states, the 55% & 45% cost subsidies are shared in 90:10 ratio between Centre and States - In UT, Centre bears 100% of 55% & 45% cost subsidies
5	PM – KUSUM	2019	To ensure energy security for farmers		-Farmers earn through selling power. Subsidy of 30% by central government, another 30% y state on solar pumps.

Serial No	Name of the Scheme	Origin Year	Objective	Coverage	Benefit
6	The Vegetable Initiative for Urban Clusters	2011-12	To address demand and supply side of vegetable sector in selected cities	Cover one city in each state (which either state capital or a city with population of over 1 million	Financial assistance is provided for 12 different activities.
7	Mission for Integrated Development of Horticulture	2014 (However financial allocations for the MIDH have been made for 2012)	The aim of horticulture mechanization under MIDH is to reduce the drudgery of the farm workforce.	All states: Assistance for horticulture mechanization will be provided to grower associations, farmer groups, SHGs	financial assistance for tractors, power tillers, land development, tillage and seed bed preparation equipment; sowing, planting, digging equipment, plastic mulch laying machine, self-propelled horticulture machinery
8	National Mission on Oil Seeds and Oil Palm	2014-15			- Financial assistance for farm implements as per rates/norms of SMAM
9	Bringing Green Revolution to Eastern India	2010-11	To increase production and productivity of rice and wheat crops by adopting latest technology	Assam, Bihar, Chhattisgarh, Jharkhand, Odisha, Eastern Uttar Pradesh and West Bengal	100% assistance limited to Rs 30,000 per unit for shallow tube wells. Other benefits as per the NFSM and SMAM norms

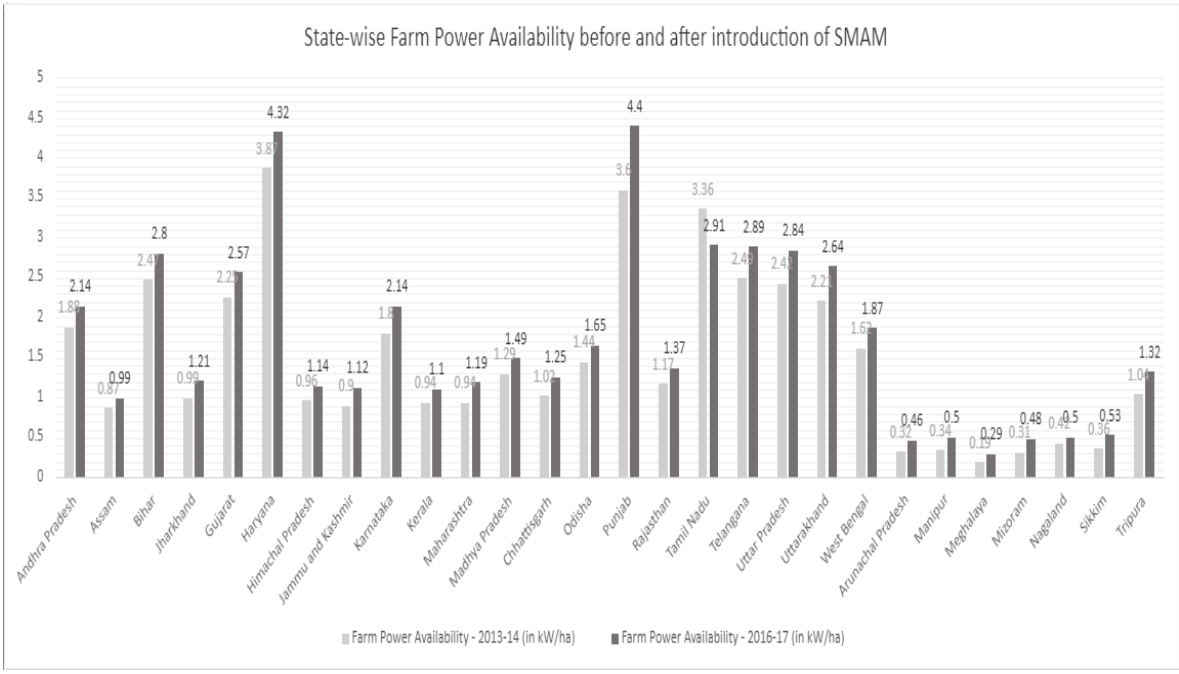
Source: *compiled by authors*

3.1. Sub Mission on Agricultural Mechanization

Ministry of Agriculture and Farmers Welfare launched a Sub-Mission on Agricultural Mechanization (SMAM) in 2014-15 and undertook various farm Mechanization activities like Establishment of Custom Hiring Centres (CHC), Farm Machinery Bank (FMB), High-tech Hubs and distribution of various agricultural machinery etc in different states. The aim of the scheme is to increase the reach of mechanization to small and marginal farmers and to the regions where farm power availability is low. These efforts have resulted in a significant increase in the availability of farm power per unit area from 2.02 kw/ha in 2016-17 to 2.49 kw/ha in 2018-19. The adoption of agriculture machines has also increased, leading to expansion in cropped area, cropping intensity, and agricultural production throughout the country [16].

[16] Initiatives of Government of India to Promote Farm Mechanization, https://pib.gov.in/PressReleasePage.aspx?PRID=1696224

Figure 3.1: State wise farm power availability before and after introduction of SMAM



Source: *Ministry of Agriculture and Farmers Welfare*

The stated objectives of the SMAM scheme are as follows.

- Enhancing the reach of farm mechanization to small & marginal farmers and to the regions where farm power availability is low.
- Promoting 'Custom Hiring Centres' to mitigate the adverse economies of scale caused due to small landholding and the high cost of individual ownership.
- Generating awareness among stakeholders through demonstration and capacity building activities.
- Developing hubs for hi-tech & high value farm equipment.
- Ensuring performance testing and certification at designated testing centres.

Figure 3.2: Components of Sub-Mission on Agricultural Mechanization (SMAM) in India

Promotion and Strengthening of Agricultural Mechanization through Training, Testing and Demonstration
Demonstration, Training and Distribution of Post Harvest Technology and Management (PHTM)
Financial Assistance for Procurement of Agriculture Machinery and Equipment
Establish Farm Machinery Banks for Custom Hiring
Establish Hi-Tech, High Productive Equipment, Hub for Custom Hiring
Promotion of Farm Mechanization in Selected Villages
Financial Assistance for Promotion of Mechanized Operations/hectare Carried out Through Custom Hiring Centres
Promotion of Farm Machinery and Equipment in North-Eastern/ Region

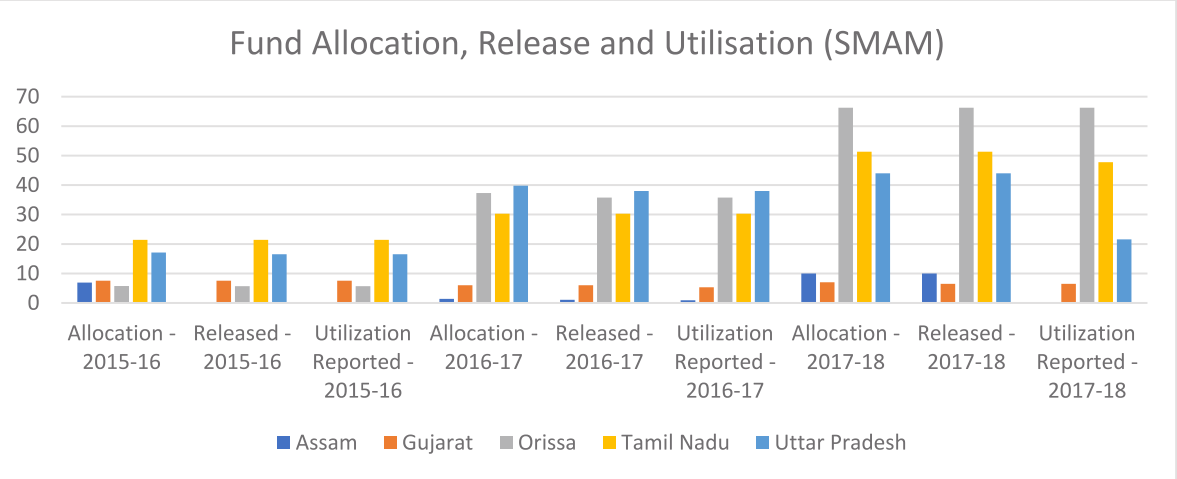
Source: *Compiled by the Authors*

Table 3.2 : State-wise funds allocation under Sub-Mission on Agricultural Mechanization (SMAM) in India (in crores)

	2019-2020	2020-21	2021-2022
Assam	15.41	10	10
Gujarat	25.84	25.84	25.84
Odisha	64.45	64.45	64.45
Tamil Nadu	71.08	71.08	71.08
Uttar Pradesh	66.18	66.18	66.18

Source: *Sub-Mission on Agricultural Mechanization (SMAM) in India (2019-2020 to 2022-2023)*

Figure 3.3: Fund allocation, release and utilisation in state of Assam, Gujarat, Orissa, Tamil Nadu, Uttar Pradesh



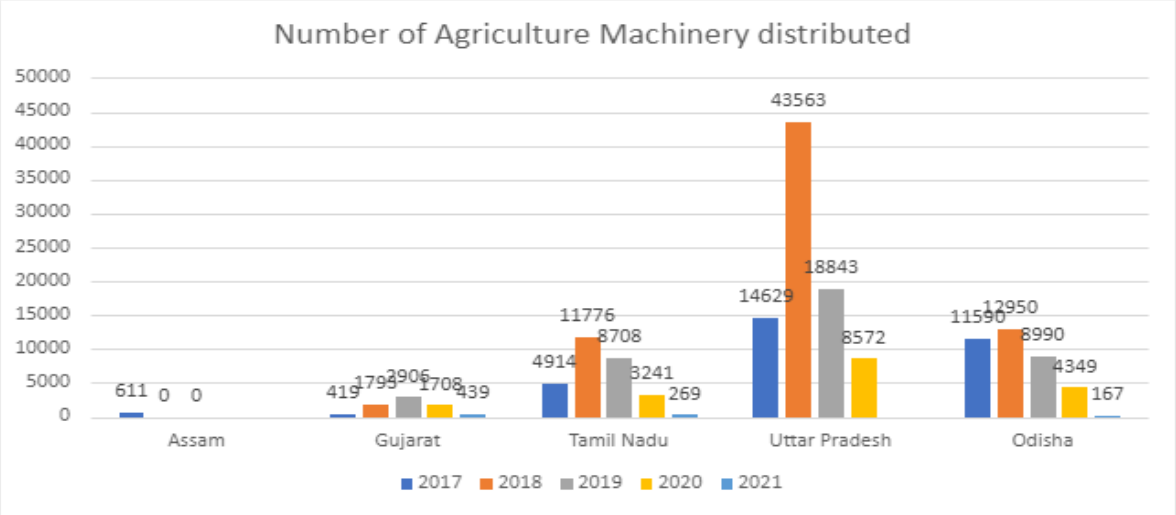
Source: *Sub-Mission on Agricultural Mechanization (SMAM) in India (2019-2020 to 2022-2023)*

Table 3.3: State wise number or beneficiaries under Sub-Mission on Agricultural Mechanization (SMAM) in India

	2020-21		2021-2022	
	Fund allocation	Number of beneficiaries	Fund allocation	Number of beneficiaries
Assam	10		10	
Gujarat	25.84	1708	25.84	1306
Odisha	64.45	7444	64.45	167
Tamil Nadu	71.08	3241	71.08	775
Uttar Pradesh	66.18	8572	66.18	12

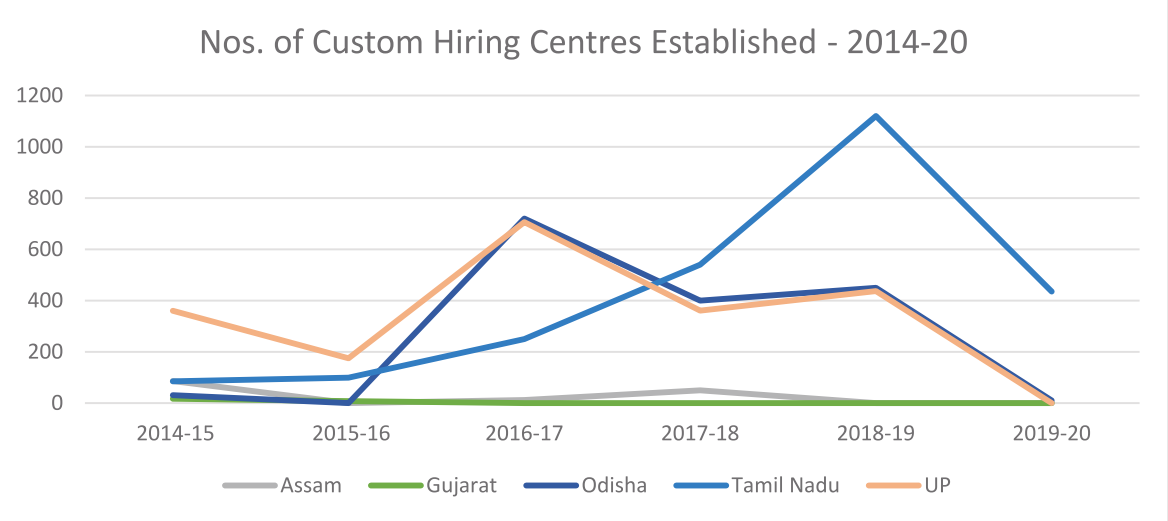
Source: *Sub-Mission on Agricultural Mechanization (SMAM) in India (2019-2020 to 2022-2023)*

Figure 3.4: Number of agricultural machines distributed in state of Assam, Gujarat, Orissa, Tamil Nadu, Uttar Pradesh



Source: *Department of Agriculture & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Govt. of India*

Figure 3.5: State-wise number of Custom Hiring Centres established under SMAM



Source: *Sub Mission on Agricultural mechanization, 2019*

Tamil Nadu has seen a high growth of CHC in year 2018-19 highlighting the high prevalence of CHC in Tamil Nadu among all the states under the study.

3.2. Promotion of Agricultural Mechanization for In-Situ Management of Crop Residue in the States of Punjab, Haryana, Uttar Pradesh, and NCT of Delhi

This scheme was brought in action in the year 2018-19 by the collaborative efforts of Government of Punjab, Haryana, Uttar Pradesh and NCT of Delhi and aims at reducing the practice of stubble burning (prevalent in Indo-gigantic plains of Punjab, Haryana) and the air pollution resulting from it. It does so by providing machinery required for in-situ management of crop residue at subsidised rates to farmers.

Under this scheme, 30961 Custom Hiring Centres (CHCs) have been established and a total of more than 1.5 lakh crop residue management machines have been supplied to these CHCs and individual farmers during the period from 2018-19 to 2020-21. (Press Information Bureau, GOI, 2021)

Objectives of the scheme:

- To reduce air pollution and loss of soil micro-organisms and nutrients caused by burning of crop residue.
- Promoting efficient management by the methods of retention/incorporation of crop residue into the soil
- Promotion of farm machinery banks for custom hiring of the machinery which helps make the machinery more affordable for individual ownership and for farmers with small landholdings.
- Spreading awareness regarding importance of effective management of crop residue amongst different organisations and stakeholders through education, training and demonstrations.

Financial Assistance and Subsidy Pattern

This is a centrally sponsored scheme under which financial assistance of 50 percent of the cost of the residue management machine is provided to farmers whereas 80 percent of cost of the project is being provided to Cooperative Societies of Farmers, Farmers Producers Organization (FPOs), Registered Farmers Societies and Panchayats for establishment of Custom Hiring Centres of crop residue management machinery. (MoAC&FW, GOI, 2020)

Table 3.4: Quantity of equipment/ machine in CHCs allotted under the scheme

Name of the equipment/ machines	Up to Rs 10 lakhs	more than 10 lakhs up to 25 lakhs	more than 25 lakhs up to 75 lakhs
Super Straw Management System (Super SMS) to be attached with Combine Harvester	1	1	2
Happy Seeder (10 tine)	1	2	3
Paddy Straw Chopper (combo)	1	1	2
Paddy Mulcher (7ft)	1	1	3
Hydraulically Reversible M.B. Plough (3 bottom)	1	1	3
Rotary Slasher	1	1	2
Tractor		1	4
Laser Land leveller		1	2
Reaper cum binder (self -propelled)		1	2
Straw Baler			1
Straw Rake			2
Potato Planter			1
Potato digger shaker			1

Name of the equipment/ machines	Up to Rs 10 lakhs	more than 10 lakhs up to 25 lakhs	more than 25 lakhs up to 75 lakhs
Raised bed planter			1
Pneumatic planter			1
Multicrop thresher			1
Total	6	10	31

Source: *Operational guidelines 'Central sector scheme on promotion of agricultural mechanization for in-situ Management of crop residue in the states of Punjab, Haryana, Uttar Pradesh and NCT of Delhi' Ministry of Agriculture and Farmer welfare.*

Area of Operation and Identification of Beneficiaries: The scheme is operable in the state of Punjab, Haryana, U.P. and NCR of Delhi and farmers from these states are eligible for the scheme. Following parameters are taken into consideration while selecting a beneficiary:

- Small and marginal operational holdings.
- Farmers not having machinery and equipment for in-situ crop residue management.
- Individual farmers already having tractor/combine harvester
- Farmers who have not already availed any subsidy during the last 2 years under any schemes of DAC&FW for the machinery and equipment identified for similar purpose as this one.

Implementation Agencies: The state agriculture department or the agriculture engineering department (wherever available) have been appointed as the state level nodal agency for the purpose of implementation and monitoring of the scheme. Separate district level execution committees have been appointed and active participation from Panchayati Raj institutes has also been ensured for the effective and timely implementation.

3.3. Rashtriya Krishi Vikaas Yojna

Introduction: The Rashtriya Krishi Vikas Yojna (RKVY) was launched by the National Development Council (NDC) from the year 2007-2008 for the purpose of encouraging and spurring growth in the agriculture and allied sectors. It was launched as an Additional Central Assistance (ACA) Scheme. It was introduced to encourage states to draw up comprehensive agriculture development plans while taking into consideration agro-climatic conditions, natural resources and technology with the aim of integrated and inclusive development of agriculture sector and its allied activities. The scheme is being implemented as a state plan scheme. The eventual goal of this scheme when it was brought in 2007 was to observe at least 4 percent increase in agriculture growth of the beneficiary states (Ministry of Agriculture, 2007).

Objectives of the Scheme:

- To encourage and incentivise states to increase public investment in Agriculture and allied sectors.
- To provide autonomy to states in their planning and execution of agriculture and allied sector schemes.
- To make sure factors such as agro-climatic conditions, availability of technology and natural resources are taken into consideration while preparation of state agricultural plans.
- To reduce gaps in the yield of important crops with the help of problem specific interventions.

Financial Assistance: Funds will be provided to the states, entirely as a grant by the central government in following streams/components in the following pattern (table 3.5):

Table 3.5: Component of RKVY

Stream/Component	Amount Of Subsidy
RKVY (Production Growth)	35% of annual outlay
RKVY (Infrastructure and Assets)	35% of annual outlay
RKVY (Special Schemes)	20% of annual outlay
RKVY (Flexi Fund)	10% of annual outlay (states can take up production growth or infrastructure and assets projects depending upon state specific neds/priorities).

Source: *Rashtriya Krishi Vikas Yojna guideline book 2014*

Table 3.6: State wise allocation of funds under normal RKVY (Rs in Crore)

	2015-16	2016-17	2017-18	2018-19	2019-20
Assam	75.07	279.75	202.93	147.08	154.79
Gujarat	174.55	315.27	199.97	104.73	109.82
Orissa	193.18	342.59	205.19	134.54	136.29
Uttar Pradesh	288.22	321.98	369.03	279.39	288.22

Source: *Rashtriya Krishi Vikas Yojna*

Area of Operation and Identification of Beneficiaries:

This scheme is operable in all the states which are eligible to avail its benefits. In order to be eligible, the states must fulfil the following criteria:

- The base line share of agriculture and its allied activity sector is maintained in the state plan (excluding RKVY)
- The state has already prepared district and state agriculture plans.

List of allied sectors covered under the scheme

- Crop Husbandry (including Horticulture)
- Animal Husbandry, Dairy Development and Fisheries
- Agricultural Research and Education
- Agricultural Marketing
- Food storage and Warehousing
- Soil and Water Conservation
- Agricultural Financial Institutions
- Other Agriculture Programmes and Cooperation

For Agriculture Mechanization:

The scheme extends its assistance to individual beneficiaries for farm mechanization especially for improved and gender friendly tools, implements and machinery. It only provides assistance for large equipment e.g., tractor, combine harvester, sugarcane harvester, cotton picker etc. for establishing custom hiring centres under RKVY (Infrastructure & Assets) stream.

Implementation agency

The state agriculture department has been assigned as the nodal agency for the implementation of the scheme. They have the option of creating a separate implementation agency for the purpose of smooth and efficient working of the scheme in the state. The State Level Sanctioning Committee (SLSC) is responsible for approving State Action Plans designed by the implementation agency after which funds are released from the state to the nodal agency. At the district level District Action Plans are prepared by the concerned district agriculture departments. Panchayati Raj Institutes are also required to cooperate and help with the implementation of the scheme wherever possible and necessary.

3.4. Pradhan Mantri Krishi Sinchai Yojana

Introduction: Pradhan Mantri Krishi Sancheti Yojana is a national level mission which started in the year 2015 with the aim of increasing farm productivity and to provide access to means of irrigation to all agricultural farms in the country. To achieve the same one of the main objectives of the scheme is to produce 'per drop more crop' and bring rural and agricultural prosperity. PMKSY has been brought in by combining three schemes: Accelerated Irrigation Benefit Programme (AIBP) of the Ministry of water resources, River Development and Ganga rejuvenation, Integrated Watershed Management Programme (IWMP) of Department of Land Resources (DoLR) and the On Farm Water Management (OFWM) of Department of Agriculture and Cooperation (DAC). Under this scheme a total area of 4.82 lakh Ha has been covered for micro irrigation in the year 2021-22 (22.28 lakh Ha under drip irrigation and 2.54 lakh Ha under sprinkler) and 0.03 lakh Ha of area has been covered for potential of protective irrigation. (DAC&FW, GOI, 2022). A total of Rs.3645 Crore have been allocated for this scheme for the year 2020-21 and Rs.3026.65 Crore were allocated in the year 2019-20 whereas Rs.1000 Crore were allocated for the scheme in its initial year of 2015-16.

Objectives of the scheme

- To Achieve convergence of investment in irrigation at field level.
- To Increase the access of water on the farm and also to increase cultivable area under assured irrigation under the 'Har Khet ko Pani' component of the scheme.
- To Reduce on-farm wastage of water by increasing availability both in duration and extent.
- Encourage and increase the use of precision irrigation and other efficient water use technologies.

Programme components and their implementation agencies

Table 3.7: Component of Pradhan Mantri Krishi Sinchai Yojna

Programme Component Name	Implementation Agency
Accelerated Irrigation Benefit Programme (AIBP)	AIBP by MoWR, RD &GR
PMKSY (Har Khet ko Pani)	MoWR, RD &GR
PMKSY (Per Drop More Crop)	by Dept. of Land Resources, MoRD
PMKSY (Watershed Development)	Dept. of Agriculture & Cooperation, MoA

Source: *Operational Guidelines of Pradhan Mantri Krishi Sinchayee Yojana*

Eligibility and fund allocation criteria for states:

PMKSY has adopted a dynamic fund allocation methodology that requires states to increase the share of funds allocated for agriculture in order to become eligible for this scheme.

a) A State will become eligible to access PMKSY fund only if it has prepared the District Irrigation Plans (DIP) and State Irrigation Plan (SIP), and the expenditure in water resource development for agriculture sector in the year under consideration is not less than baseline expenditure. The baseline expenditure will be the average of expenditure in irrigation sector irrespective of state departments (i.e., creation of water 8 source, distribution, management and application from State plan schemes) in State Plan in three years prior to the year under consideration.

   Inter State allocation of PMKSY fund will be decided based on (i) share of percentage of unirrigated area in the State vis-à-vis National average including prominence of areas classified under Dessert Development Programme (DDP) and Drought Prone Area Development Programme (DPAP) and (ii) increase in percentage share of expenditure on water resource development for agriculture sector in State Plan expenditure in the previous year over three years prior to it (iv) improvement in irrigation efficiency in the state.

State Irrigation Plans and District Irrigation Plans:

State action plans and district action plans are an integral part of the planning and execution of this scheme. DIPs are prepared to identify the gaps in the current irrigation infrastructure after taking into consideration the District Agriculture Plans (DAPs) already prepared for Rashtriya Krishi Vikas Yojana (RKVY and resources that would be added during XII Plan from other schemes such as Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), Rashtriya Krishi Vikash Yojana (RKVY), Rural Infrastructure Development Fund (RIDF) etc. SIP or state action plans consolidate the DIPs and correlate with State Agriculture Plan (SAP) which are already available for RKVY and also prioritize resources and outline definite annual action plan with a medium to long term horizon.

3.5. PM-KUSUM

Introduction: The Pradhan Mantra Kisan Urja Suraksha evem Utthan Mahabhiyan (PM-KUSUM) was launched by the Ministry of new and renewable energy in the year 2019 with the aim of providing energy efficiency to the farmers and increase their adoption of non-fossil fuels. This scheme hence also aims at helping India fulfil one of its INDC of increasing the share of electric power from non-fossil fuels in India's installed capacity to 40 percent by 2030. An initial financial allocation of Rs.34,422 Crore as assistance from the centre was made for the same. However, an increase in the fund allocation was announced for the year 2020-21 after assessing the demand from the farmers and an additional Rs.22000 crores have been allocated to the scheme now. (Economic Times, 2020). Based on the same demand received from the states, sanction has been issued during 2019-20 and 2020-21 for installation of 4909 MW capacity of small solar power plants, installation of 3.59 lakh standalone solar pumps and solarisation of over 10 lakh existing grid connected pumps. (MoN&RE)

Objectives

The objective of this scheme is to increase the solar capacity and other renewable capacity by 25,750 MW by the end of 2022. The scheme had also increased its scope in 2020 to include solar energy generation in farm sector within its activities and the size of solar plats was also decreased to include small farmers within its purview as well.

Programme Components and implementation agencies

Component A: main objective of this component is to set up Decentralised Grid Connected Renewable Energy power plants of up to 10,000 MW on barren land. For achieving the same renewable energy-based power plants (REPP) of capacity 500Kw to 2MW will be established by farmers (individuals, group of farmers, cooperatives, panchayat, FPOs, Water User Association (WUA)) on barren/fallow land. However, it is also possible to install these power plants on cultivable land as crops can be grown below the solar panels as well. The power generated from these plants is purchased by local DISCOM at pre-fixed price/tariff. For this component DISCOMs are to be assigned as implementation agency. The states have the authority of nominating the implementation agency.

Component B: The main objective of this scheme is to set up 17.50 lakh stand-alone solar agriculture pumps. For achieving the same individual farmers are financially supported to install standalone solar agriculture pumps of capacity up to 7.5 HP for replacement of their diesel agriculture pumps/irrigation systems in off-grid areas (areas where grid supply of electricity is not available). DISCOMs/Agriculture Department/Minor Irrigation Department or any other department designated by the state will be an implementation agency for this component.

Component C: The main objective of this component is installation of 10 Lakh grid connected agriculture pumps. For achieving the same individual farmers who have grid connected agriculture pump are financially supported to install solarised pumps so that they can use the generated dollar power to meet their need and the surplus solar power can be sold off to DISCOMS at pre-fixed tariff. For this component DISCOMs/GENO/ any other department chosen by the state government can be the implementation agency. (MoN&RE, G.O.I., 2021)

Eligibility and Fund Allocation Criteria

Component A: individual farmers/ group of farmers/ cooperatives/ panchayats/ Farmer Producer Organisations (FPO).

Component B: all individual farmers are eligible for this component.

Financial Assistance under component B:

- CFA of 30% of the benchmark cost or the tender cost, whichever is lower.
- The State Government will give a subsidy of 30%
- remaining 40% will be provided by the farmer.
- In case the State Government provides subsidy more than 30%, the beneficiary share will reduce accordingly.
- Pattern of assistance in North Eastern States, Sikkim, Jammu & Kashmir, Himachal Pradesh and Uttarakhand, Lakshadweep and A&N Islands: CFA of 50% of the benchmark cost or the tender cost, whichever is lower, of the stand-alone solar pump. The State Government will give a subsidy of 30%; and the remaining 20% will be provided by the farmer. In case the State Government provides subsidy more than 30%, the beneficiary share will reduce accordingly.

Component C: Individual farmers having grid connected agriculture pumps are eligible for this scheme. Financial Assistance under component C:

- CFA of 30% of the benchmark cost or the tender cost, whichever is lower, of the solar PV component.
- The State Government will give a subsidy of 30.
- In case the State Government provides subsidy more than 30%, the beneficiary share will reduce accordingly.

Pattern of assistance in North Eastern States, Sikkim, Jammu & Kashmir, Himachal Pradesh and Uttarakhand, Lakshadweep and A&N Islands: CFA of 50% of the benchmark cost or the tender cost, whichever is lower, of the solar PV component. The State Government will give a subsidy of 30. In case the State Government provides subsidy more than 30%, the beneficiary share will reduce accordingly. (Ministry of New and Renewable Energy, G.O.I., 2019)

Progress so far

Component A: Letter of authorisation issued by Rajasthan, Haryana and Himachal Pradesh for installation of small solar power plants of around 750 MW capacity to over 650 applicants. Other States are at different stages of implementation.

Component B: LoA issued for installation of over 51,000 pumps. Due to COVID -19, progress was slow during the first half of 2020-21 but thereafter installation recovered and till 31.03.2020, over 40,000 solar pumps have been reported installed in the fields.

Component C: solarisation of three pilot feeders of its three DISCOMs by Rajasthan. The state also issued LoA for individual pump solarisation of around 10000 existing grid connected pumps. Other states are at different stages of implementation. (MoN&RE)

3.6. The Vegetable Initiative for Urban Clusters

Introduction: the vegetable initiative for urban clusters is a centrally sponsored scheme that was introduced in the year 2011-12. It addresses the challenges involved in making fresh vegetables available to urban areas at affordable prices. It does so by establishing a cycle of production and income for the farmers and supply of vegetables to consumers. An initial Rs. 300 Crore were allocated for the scheme in the year 2011-12 under Rashtriya Krishi Vikas Yojana and was proposed to cover 1 city (which either state capital or a city with population of over 1 million) in each state for that year.

Objectives:

- Address supply and demand side issued regarding vegetable produce in selected cities.
- Improve vegetable production, productivity, nutritional security and income for farmers.
- Establishing and efficient supply chain with good employment opportunities, income for service providers while making available processed agri produce at competitive and affordable prices for urban consumers.
- Promotion and integration of technology for enhancing production and productivity of vegetables in peri-urban areas of major cities.
- Creating employment opportunities for unemployed youth.

Programme Components and Pattern of Assistance: Few components and their pattern of assistance are mentioned below in the table 3.8.

Table 3.8 : Components and pattern of assistance for vegetable initiative for urban clusters

Sl. No.	Item	Maximum permissible	Pattern of Assistances
1	Seed production of Vegetables	Rs.50,000 per of ha.	100% of total cost to public sector and for private sector, 50% of the total cost as credit linked back ended subsidy limited to 5 ha per beneficiary. Indenting organizations for breeder seed required for producing foundation seed will be eligible for 25% assistance on the cost of procurement of breeder seed from ICAR/SAU.
2	Vegetable seedling production	Rs.104 lakh/ha	100% of total cost to public sector, 50% for private sector 50% of the total cost as credit linked back ended subsidy limited to 5 ha per beneficiary. Indenting organizations for breeder seed required for producing foundation seed will be eligible for 25% assistance on the cost of procurement of breeder seed from ICAR/SAU.
3	Seed infrastructure	Rs.200/lakh per project	100% of cost for public sector, for private sector-credit linked back ended subsidy @50% of cost of project.
4	Vegetable cultivation 1)open field	Rs.30000/ha.	75% of cost
	2) Hybrid veg	Rs.45,000/ha	75% of cost
5	Protected Cultivation		
	a) Green House Structure		
	I Fan & pad system	Rs.1465/Sq.m	50 % of cost limited to 400Sq.m
	II)Naturally ventilated system	Rs935/Sq.m	
	(i)Tubular structure	Rs.515/ Sq.m	50% of cost limited to 400Sq.m
	(ii)Wooden structure	Rs.515/ Sq.m	50% of cost limited to 2 units
	(iii)Bamboo structure	Rs.375/ Sq.m c	50% of cost limited to 5 units
	Shade Net House		
	(i)Tubular structure	Rs600/ Sq.m	50% of cost limited to 400Sq.m
	(ii)Wooden structure	Rs410/ Sq.m	50% of cost limited to 2 units
	(ii)Bamboo structure	Rs.300/ Sq.m	50% of cost limited to 5 units

Sl. No.	Item	Maximum permissible	Pattern of Assistances
	(c)Cost of planting material and other inputs of high value vegetables grown in green house/ poly house/shade net house neon	Rs105/Sq.m	50% of cost limited to 400Sq.m
6	Promotion of INM/ IPM	Rs2000/	50% of cost
7	HRD- Training of farmers @ Rs.1500/ per farmer for 2 days.	Rs1500 per farmer for 2 days	100%

Source: *Guidelines for 'The Vegetable Initiative for Urban Clusters'*

Implementing Agency:

1 Directorate of Horticulture/ Agriculture/State Horticulture Mission/State Governments

2. National Level Agencies (NLAs)

3.7. Mission for Integrated Development of Horticulture

Introduction: Mission for Integrated Development of Horticulture is a centrally sponsored scheme launched in the year 2014-15 with the aim of promoting holistic growth of the horticulture sector of the country. It covers fruits, vegetables, root & tuber crops, mushrooms, spices, flowers, aromatic plants, coconut, cashew, cocoa and bamboo. The scheme came into existence by subsuming ongoing schemes/missions MIDH subsumed ongoing missions/ schemes of the Ministry- National Horticulture Mission (NHM), Horticulture Mission for North East & Himalayan States (HMNEH), National Horticulture Board (NHB), Coconut Development Board (CDB) and Central Institute for Horticulture (CIH), Nagaland. All States including North Eastern States and UTs are covered under MIDH.

Objectives:

Main objectives are:

- Promotion of holistic growth of the horticulture sector through area-based region-specific strategies through the means of research, technology promotion, extension, post-harvest management, processing and marketing etc.
- Encourage farmers to form groups like FIGs/FPOs and FPCs to bring about economy of scale and scope
- Increase horticulture production, farmer income and nutritional security for consumers.
- Improve productivity through the means of quality germplasm, planting material and water use efficiency through micro-irrigation

Programme components and pattern of assistance

For all the components of the programme, Government of India (GOI) contributes 85% of total outlay for developmental programmes in all the states except the states in North East and Himalayas, and the 15% share is contributed by State Governments. In the case of North Eastern States and Himalayan States, GOI contribution is 100%. Similarly, for development of

bamboo and programmes of National Horticulture Board (NHB), Coconut Development Board (CDB), Central Institute for Horticulture (CIH), Nagaland and the National Level Agencies (NLA), GOI contribution will be 100%. (Department of Agriculture & Cooperation, 2014)

Along with the above as per directives of Planning Commission, implementing agencies such as State Horticulture Missions have been directed to ensure that at least 30% of annual budget allocation is earmarked for women beneficiaries/ farmers. Activities such as floriculture including protected cultivation of flowers, mushroom production and beekeeping are some of the activities which are attractive to women farmers. (MIDH, 2022). The components of the scheme are depicted below in the table 3.9

Table 3.9: MIDH with sub-components

Sl. No.	Sub Scheme	Target group/area of operation
1.	NHM	All states & UTs except states in NE and Himalayan Region
2.	HMNEH	All states in NE and Himalayan Region
3.	NBM	All states & UTs
4.	NHB	All states & UTs focusing on commercial horticulture
5.	CDB	All States and UTs where coconut is grown.
6.	CIH	NE states, focusing on HRD and capacity building

Source: *Operational guidelines of Mission for Integrated Development of Horticulture*

Implementation Agency

- At the National level: General Council under the chairmanship of Union Agriculture Minister and an Executive Committee headed by Secretary of Dept. of Agriculture & Cooperation are responsible for monitoring and implementing the programmes.
- At the State level: State Level Executive Committees under Agriculture Production Commissioner or Principal Secretary of Horticulture/Agriculture/Environment & Forests will be responsible for the implementation of the programme
- At the district level: district and panchayat level committees to oversee implementation.

Other intervention undertaken by MIDH: Apart from providing assistance to the States for holistic development of horticulture, there are National Level Agencies (NLAs) like DCCD, DASD, NHRDF, NBB, Spices Board etc. for which 100% grant is provided under MIDH for carrying out various interventions like Research & Development, capacity building, Skill development leading to overall development of horticulture in the country.

3.8. National Mission on Oil Seeds and Oil Palm

National mission on oil seed and oil palm was launched in the year 2014-15 with the aim of increasing the production of edible oil in India in order to meet the increasing demand and to increase edible oil security for India. The mission has had target of increasing production of vegetable oils sourced from oilseeds, oil palm and TBOs (Tree Born Oilseeds) from 7.06 million tonnes (average of 2007-08 to 2011-12) to 9.51 million tonnes by the end of Twelfth Plan (2016-17). A financial outlay of Rs11,040 crore has been made for the scheme, out of which Rs.8,844 crore is the Government of India share and Rs.2,196 crore is State share and this includes the viability gap funding also. Under this scheme, it is proposed to cover an additional area of 6.5 lakh hectare (ha.) for oil palm till the year 2025-26 and thereby reaching the target of 10 lakh

hectares ultimately. The production of Crude Palm Oil (CPO) is expected to go up to 11.20 lakh tonnes by 2025-26 and up (PIB, Delhi, 2021)to 28 lakh tonnes by 2029-30.

Objectives:

The mission citing the importance of oil palm was launched in 12 potential states in India with the listed purpose,

- 75,000 ha area to be brought under palm cultivation and increase the production of edible oils.
- Promotion of oil palms in all Northern-Eastern states.
- Address the demand for new oil palm plantations both from native and imported sources.
- Rendering assistance to farmers by providing planting materials, maintenance cost for palms, irrigation & bore well, and harvesting tools.
- Purchase Fresh Fruit Bunches (FFB) from farmers through processing industries.
- Ensure profitable rates for FFBs when international Crude Palm Oil (CPO) price drops.
- Help and support farmers through Market Intervention Scheme (MIS).

Further, it focuses on the Mini Mission–II for Oil Seeds and has the following vision to be fulfilled,

- Improvement of Seed Replacement Ratio (SSR) with a focus on the Varietal Replacement.
- Increasing the area of irrigation of the Oilseeds from 26% to 36%.
- To encourage the inter-cropping of oilseeds with cereals/pulses and sugarcane.
- To increase the availability of quality and efficient planting materials of Oil Palm and Tree Borne Oilseeds (TBOs).

Programme Components and Pattern of Assistance

Mini Mission 1 – oil seeds: The mission emphasising the importance of oil palm was launched in 2014-25 in 12 states with the aim of bringing 75,000 ha area under palm cultivation in order to increase the production of edible oils.

Pattern of Assistance under Mini Mission 1

Categories under which assistance is provided for Mini Mission 1 are:

- Effective selection and processing of the seed components.
- Proper and effective selection and purchase of high breeder and quality seeds receive a 100% assistance which are classified as under,
  1. Production of breeder seed
  2. Purchase of breeder seed/parental lines (for production of hybrid seed)
  3. Distribution of Mini kit (Varietal Diversification)
  4. Seed Infrastructure Development
  5. 75 % of assistance is extended for the following components,
  6. Production of foundation seed
  7. Production of certified seed
  8. Distribution of certified seed
- Maximum assistance of 75% is released by the NMOOP and 25% by the State Government, for the methodologies framed and executed for the seed production.

- Assistance is extended for educating the farmers with the latest technologies.

Mini Mission 2- Oil Palm: aims at increasing the Seed Replacement Ratio (SSR) with a focus on Varietal Replacement and to increase the area of irrigation of oilseeds from26% to 36%. Also aims at increasing the availability of quality seeds and planting material for Oil Palm and TBOs (Tree Born Oilseeds).

Pattern of Assistance for Mini Mission II

1. 85% of the planting material which is equal to Rs12,000 per hectare is provided to the farmers.
2. 50% of the maintenance cost of new plantation for four years is incurred.
3. 20,000 per hectare is disbursed for inter-cropping of oilseeds during the gestation period.
4. Rs50,000 per unit of electricity is distributed for the installation of irrigation and harvesting structures.

Mini Mission III (Tree Born Oilseeds- TBOs): Aims at expanding the area under plantation for TBOs and providing proper maintenance to the seedlings. Also includes providing technical support and training with the assistance of Government Institutions.

Pattern of Assistance for Mini-Mission III

The Mini Mission-III oversees the following financial assistance for the TBO components,

- It incurs 100% cost on the integrated development of the nurseries & plantation from the existing wasteland/degraded forest land.
- It provides Rs.1000/Hectare as incentives for carrying out intercropping of TBOs.
- It distributes 100% of the total cost on the Research and Development on TBOs with the aids of the institutions like ICAR, ICFRE, CSIR and IITs.
- Amount up to Rs.50 lakh per annum is allocated for the promotion of seed collections of TBOs and facilitating marketing of collected TBO seeds.

Implementation Agency

- National and State level committees are established to oversee the activities of the mission.
- National Level Committee comprises of:
  - An Executive Committee (EC) to guide and monitor the overall progress of the mission. It is headed by the Union Minister of Agriculture and consulted by the heads of several DACs.
  - A Standing Committee (SC) to oversee the activities and approve the Annual Action Plan (AAP) of the States.
  - A Mission Monitoring Committee (MMC) to review the physical and financial progress of the three Mini Missions.

State Level Committee is formed by the State Government to decide the priorities, examine the AAPs and evaluate the progress of each Mini Missions implemented in the States. It is chaired by the Chairman of Agriculture Production Commissioner/Principal Secretary/Secretary (Agriculture) of the State.

3.9. Bringing Green Revolution to Eastern India

Launched in the year 2010-11 to address the problem of limited productivity of “rice-based cropping systems” in Eastern India. The main objective of the scheme is to enhance water potential for enhancing the rice production in eastern India which is otherwise underutilised. This scheme involves the following seven states: Assam, Bihar, Eastern U.P, Chhattisgarh,

Jharkhand, West Bengal and Orissa. During its initial year of 2010-11 the programme focused on promotion of better crop production technologies of major crops and water harvesting. In the next 2 years the programme changed to provide a focused approach on medium- and long-term strategies for asset building activities of water conservation and utilisation. During 2013-14 marketing support was added to the programme which also included post-harvest management. (Dept. of Agriculture and Coperation, 2015)

Objectives

- To increase production & productivity of rice and wheat by adopting latest crop production technologies.
- To promote cultivation in rice fallow area to increase cropping intensity and income of the farmers.
- To create water harvesting structures and efficient utilization of water potential.
- To promote post-harvest technology and marketing support.

Programme components and pattern of assistance

BGREI comprised of three broad categories of interventions: (i) block demonstrations; (ii) asset building activities such as construction of shallow tube wells / bore wells / dug wells, pump sets, seed drills, etc.; and (iii) site specific activities for facilitating petty works such as construction/renovation of irrigation channels/electricity for agricultural purposes in a cluster approach for convenience and cost effectiveness. Pattern of Assistance for Bringing Green Revolution to Eastern India Programme in table 3.10

Table 3.10: Year-wise allocation of funds for the Bringing Green Revolution to Eastern India (BGREI) program

Serial Number	Year	Allocation (Central Share)	Release (Central Share)
1	2010-2011	INR 435 Crores	INR 402.70 Crores
2	2011-2012	INR 400 Crores	INR 396.91 Crores
3	2012-2013	INR 1000 Crores	INR 998.03 Crores
4	2013-2014	INR 1000 Crores	INR 623.57 Crores
5	2014-2015	INR 1000 Crores	INR 845.84 Crores
6	2015-2016	INR 500 Crores	INR 397.11 Crores
7	2016-2017	INR 630 Crores	INR 553.57 Crores
8	2017-2018	INR 450 Crores	INR 329.01 Crores

***Sources*:** Guidelines for Bringing Green Revolution to Eastern India (BGREI)

Monitoring Mechanism

The monitoring mechanism for the Bringing Green Revolution to Eastern India (BGREI) is executed by two teams as given below:

- National Level Monitoring Team
- District Level Monitoring Team

The CPRI, Cuttack (Central Potato Research Institute) is the nodal agency for the implementation and to guide, supervise, monitor and suggest technical interventions for BGREI program in coordination with SAUs/ICAR Institutes and concerned State Department of Agriculture. It

shall devise the tools/formats for monitoring in consultation with DAC and enforce accordingly to improve the output of program. (Dept. of Agriculture and Coperation, 2015)

Table 3.11: Interventions and assistance under Bringing Green Revolution to Eastern India

Serial Number	Name of Interventions	Pattern of Assistance	Interventions to be covered	
			Rice	Wheat
1	Demonstration			
1.1	Demonstration of Improved Packages of Practices	INR 7,500 per HA	Available	Available
1.2	Cropping System Based Demonstrations	INR 12,500 per HA	Available	Nil
1.3	Demonstrations on Stress Tolerant Rice Varieties	INR 7,500 per HA	Available	Nil
2	Production of Seeds			
2A	Hybrid	50% of the cost limited to INR 5,000 per quintal	Available	Nil
2B	Certified Seeds of HYVs	50% of the cost limited to INR 1,000 per quintal	Available	Available
3	Distribution of Seeds			
3A	Hybrid Rice	50% of the cost limited to INR 5,000 per quintal	Available	Nil
3B	Certified Seeds of HYVs	50% of the cost limited to INR 1,000 per quintal	Available	Available
4	Nutrient management and soil ameliorants			
4A	Micro-nutrients	50% of the cost limited to INR 500 per HA	Available	Available
4B	Lime	50% of the cost limited to INR 1,000 per HA	Available	Nil
4C	Bio-fertilizers	50% of the cost limited to INR 300 per HA	Available	Available
4D	Gypsum	50% of the cost limited to INR 750 per HA	Available	Available
5	Integrated Pests Management (IPM)			
5A	PP Chemical/ Bio-pesticides/ Bio-agents	50% of the cost limited to INR 500 per HA	Available	Available
5B	Weedicides	50% of the cost limited to INR 500 per HA	Available	Available
6	Asset Building			
6A	Dug Well	100% of the cost limited to INR 30,000	Available	Nil
6B	Bore Well	100% of the cost limited to INR 30,000	Available	Nil

Serial Number	Name of Interventions	Pattern of Assistance	Interventions to be covered	
			Rice	Wheat
6C	Shallow Tube Well	100% of the cost limited to INR 12,000	Available	Nil
6D	Drum Seeder	INR 1,500 per machine or 50% of the cost whichever is less	Available	Nil
6E	Zero Till Seed Drill	INR 15,000 per machine or 50% of the cost whichever is less	Nil	Available
6F	Seed Drill	INR 15,000 per machine or 50% of the cost whichever is less	Available	Available
6G	Rotavator	INR 35,000 per machine or 50% of the cost whichever is less	Available	Nil
6H	Self-Propelled Paddy Transplanter	INR 75,000 per machine or 50% of the cost whichever is less	Available	Nil
6I	Pump Set	INR 10,000 per machine or 50% of the cost whichever is less	Available	Available
6J	Cono-weeder	INR 600 per machine or 50% of the cost whichever is less	Available	Nil
6K	Manual Sprayer	INR 600 per machine or 50% of the cost whichever is less	Available	Nil
6L	Power Knap Sack Sprayer	INR 3,000 per machine or 50% of the cost whichever is less	Available	Nil
6M	Power Weeder	INR 15,000 per machine or 50% of the cost whichever is less	Available	Nil
6N	Paddy Thresher	INR 40,000 per machine or 50% of the cost whichever is less	Available	Nil
6O	Multi-crop Thresher	INR 40,000 per machine or 50% of the cost whichever is less	Available	Available
6P	Laser Land Leveller (for a group of farmers)	INR 1.5 Lakhs per machine or 50% of the cost whichever is less	Available	Nil

Sources: *Guidelines for Bringing Green Revolution to Eastern India (BGREI)*

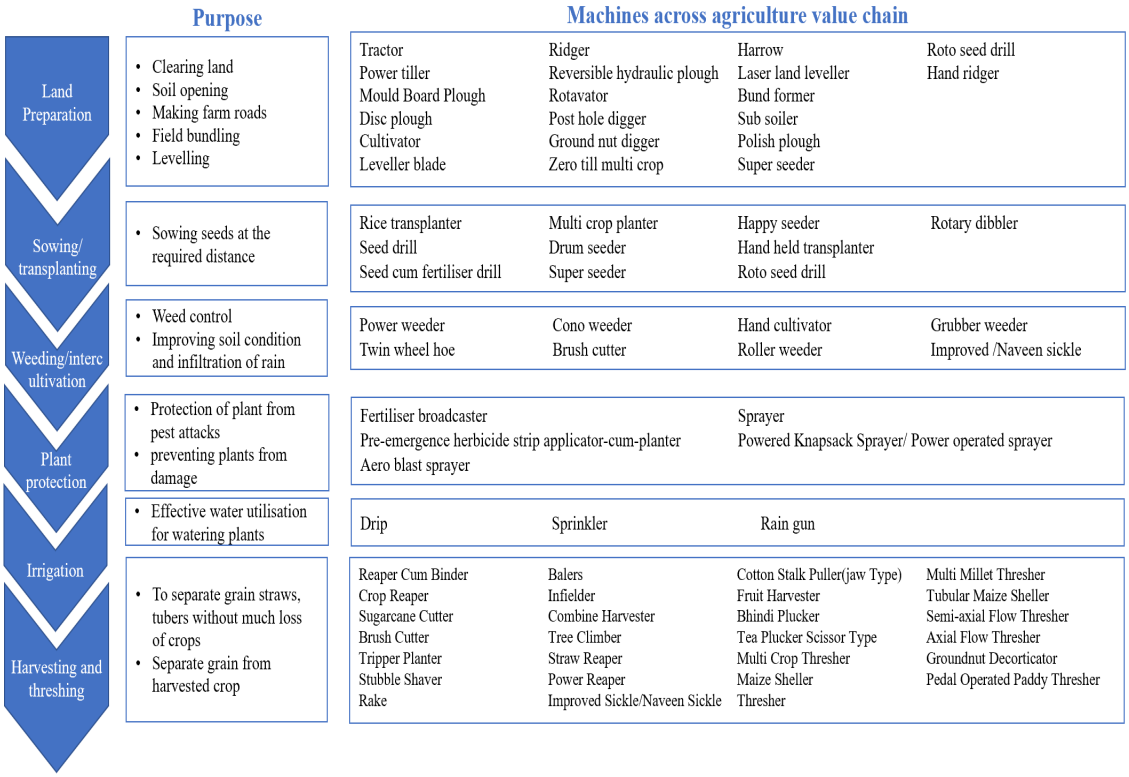
CHAPTER 4

STUDY OBJECTIVES AND METHODOLOGY

Definition and classification of agricultural mechanization

The World Programme for the Census of Agriculture 2010 (FAO) classifies equipment into manually operated equipment, power operated equipment and machine operated equipment[17]. Traditional farming methods include basic equipment like ploughs, tillage, and seeder which can be manual or animal operated. These are replaced with multiple machineries which are power operated. Some of the major machines are highlighted below in the figure 2.1 across the respective activities.

Figure 4.1: Classification of machines for operations across agriculture value chain



Source: *Compiled by authors*

It is being observed that most labour -intensive operations such as land preparation and threshing are the first to undergo mechanization. There is strong incentive to mechanize as it replaces the high requirement of labour or draft power. The operations which require more precision like in weeding and transplanting are highly intensive operations and difficult to mechanize. The farm operations can be categorized as:

I. Highly power intensive operations

II. Intermediate power and control intensive operations

[17] 2010, World Programme for the Census of Agriculture 2010

III. Highly control intensive operations.

The table 4.1 categorizes each operation in agriculture value chain based on their labour intensity and control of the activity:

Table 4. 1: Categorization of operation on labour intensity and control

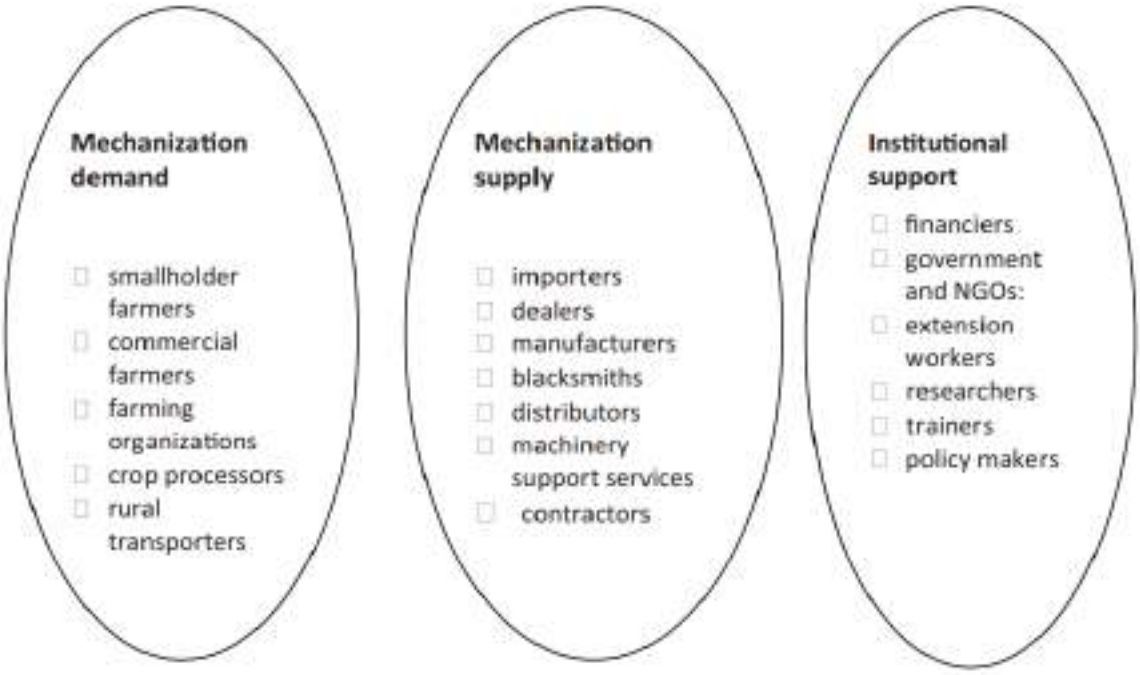
	Highly power intensive	Intermediate power and control intensive	Highly control intensive
Tillage	✓		
Direct Seeding		✓	
Transplanting			✓
Weeding			✓
Plant protection		✓	
Harvesting		✓	
Threshing	✓		
Water Pumping	✓		
Milling	✓		

Source: *Compiled by authors*

Stakeholders Perspective in Agricultural Mechanization

From a stakeholder perspective, agricultural mechanization involves different actors who have a direct or indirect interest in the use of technology in farming. These stakeholders include farmers, input suppliers, machinery manufacturers, financial institutions, policymakers, and consumers. Under purview of our study, we explore agricultural mechanization with focus on activity wise spread of machines, use of labour-saving technology by women in agriculture and skill training for agricultural operations. Farmers are the primary stakeholders in agricultural mechanization, as they are the ones who use the machinery to cultivate crops or rear animals. They stand to benefit from mechanization through increased productivity, reduced labour costs, and improved yields. However, farmers may also face challenges such as high costs of equipment acquisition and maintenance, inadequate financing options, and lack of technical expertise. They are the demand side of the mechanization ecosystem. Machinery manufacturers are the one taking care of the supply to meet the demands, as they produce the equipment and technology used in agriculture. These manufacturers benefit from increased demand for their products, as well as the development of new and innovative technologies that can improve farm efficiency and productivity. Their supply ecosystem includes suppliers, contractors, importers and dealers of machines. The enabling role to match the demand and supply of the machines is played by the financial institutions and policy makers. Banks and microfinance institutions play a critical role in agricultural mechanization as they provide farmers with the necessary financing to purchase equipment and other inputs, which can help to overcome the high upfront costs associated with mechanization. Policymakers influence the shape of the regulatory environment and provide incentives for farmers to adopt mechanization. Governments also invest in research and development to improve the effectiveness and efficiency of mechanization technologies.

Figure 4.2: Agricultural mechanization strategies stakeholders

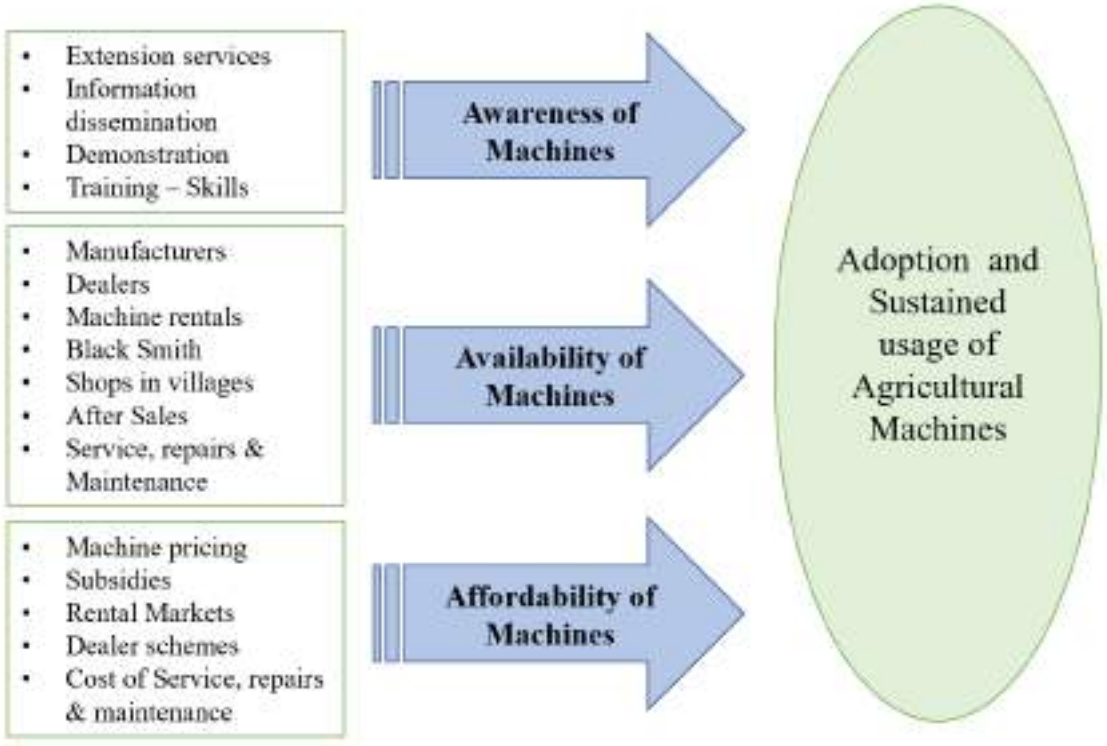


Source: *FAO, Agricultural Mechanization in Sub-Saharan Africa Guidelines for preparing a strategy, 2013*

Understanding the stakeholders' perspective in agricultural mechanization is important because it allows for a holistic and comprehensive approach to implementing agricultural mechanization policies and practices. By considering the interests and concerns of all stakeholders involved in the agricultural sector, policymakers, researchers, and practitioners can identify and address potential challenges and opportunities associated with the adoption and use of agricultural mechanization.

Agricultural mechanization has been proven to improve farm efficiency, productivity, and profitability. To promote the adoption of machines, several strategies are employed, including access to finance, technical support, awareness and education, collaboration and partnerships. The adoption can be further categorized into 3A's framework. These three A's are termed as Awareness, Availability and Affordability of the machines. The adoption and sustained usage of machines will be decided by 3A's. If a machine is to be used by a farmer, then several questions arise: who provides information on that particular machine, where to purchase the machine, who will operate the machines, who provides training to operate the machine, who repairs and maintains the machine, where are the spare parts available for the machine.

Figure 4.3: Framework of 3A's of adoption



Source: *Compiled by the Authors*

In the following state chapters, the study will explore various aspects of this framework for which the methodology and approach is as follows:

Methodology and approach

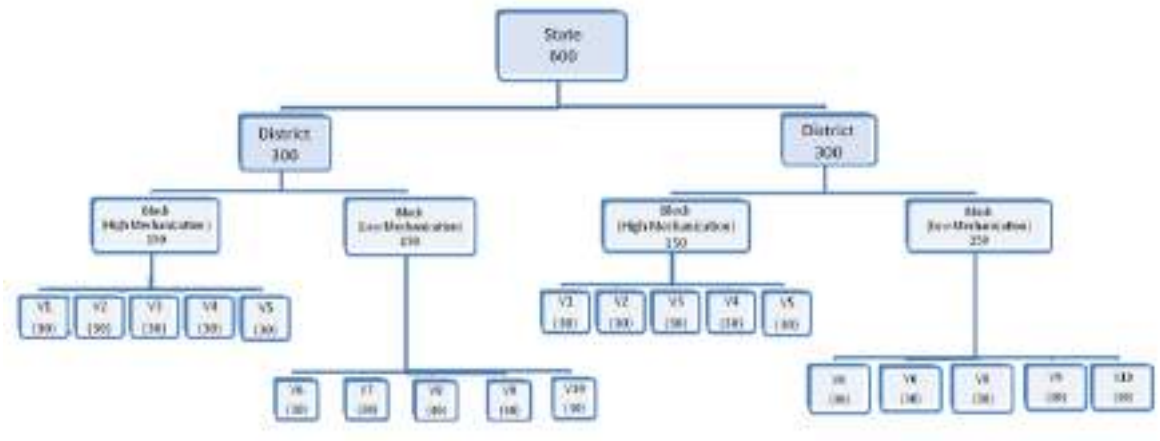
The project is implemented as a coordinated study covering five selected states and involving fives Agro-Economic Research Centres (AERCs) under the Ministry of Agriculture & Farmers Welfare. It is coordinated by Centre for Management in Agriculture (CMA), IIM Ahmedabad which is an Agro-Economic Research Unit under MoAFW. The states under the study are Assam, Gujarat, Odisha, Uttar Pradesh and Tamil Nadu. The AERC's in Jorhat, Anand, Waltair, Allahabad and Chennai are involved for implementation of the study in the respective states under the research design and guidance of CMA-IIMA. The study involved preliminary field visits, study of literature, and collection of secondary data and information available. This includes the study/ development of relevant theory and conceptual frameworks. This is followed by the design of the survey instrument/ questionnaire based on the background and the study objectives.

Sample Design

For household survey, the following design was implemented: For each state, districts were categorised into high and low level of farm power availability (FPA) based on the district level farm power availability data in 'Monitoring, Concurrent Evaluation and Impact Assessment of Sub-Mission on Agricultural Mechanization' by Ministry of Agriculture & Farmers Welfare (Department of Agriculture, Cooperation & Farmers Welfare) Mechanization & Technology Division published in 2018. Two districts were selected in different agro-climatic zones from

each FPA category. From each district, two blocks are chosen such that they are representative of high and low prevalence of mechanization respectively. Within each taluka, 5 villages are selected at random. In each village, 30 households are surveyed which cover proportional sample from each category having operational land holdings (i) landless, (ii) marginal: less than 1 ha; (iii) small: 1-2 ha (iv) Semi-medium: 2-4 ha; (v) Medium: 4-10 ha and (vi) Large: 10 and above 10 ha.

Figure 4.4: Household sampling



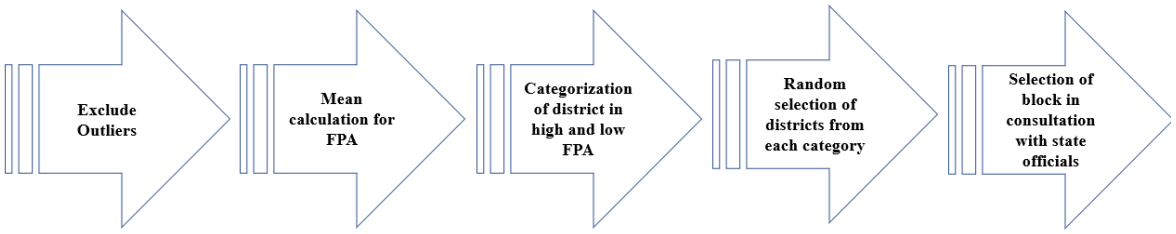
Source: *Compiled by the Authors*

The study evaluates the present situation of mechanization in the selected states with emphasis on skill development among farmers. This involved examining the different sources of farm power availability and identifying the share of mechanized power among all the sources. It highlights the role, functioning and spread of testing and training centres, custom hiring centre, farm machinery banks, agricultural manufacturers, trainees trained from FMTTIs and other training centres like SAUs, manufacturers, ICAR institutes and other relevant stakeholders as they contribute to demonstration, training, information dissemination and hiring services of various agricultural machinery and equipment. To achieve the stated objectives, information was taken from the following sources: State Government, FMTTIs, Custom Hiring Centres, farmers and secondary sources from the government. *We strive to achieve this using the following tools: stakeholder interviews, telephonic and online surveys, semi-structured interviews and case studies*.

Selection of Districts: Selection of district was done on the basis of farm power availability (FPA) data from the report 'Monitoring, Concurrent Evaluation and Impact Assessment of Sub-Mission on Agricultural Mechanization' published in 2018 by Ministry of Agriculture & Farmers Welfare (Department of Agriculture, Cooperation & Farmers Welfare) Mechanization & Technology. The detailed steps for shortlisting the districts are as below:

1. Extraction of the FPA data for respective states.
2. State mean is calculated for FPA for respective states.
3. Districts are categorized on basis of above and below mean into high FPA and low FPA category
4. Exclusion of outlier districts with highest and the least FPA
5. Using randomization for selection of one district each from high FPA and low FPA category

Figure 4.5: Selection of sample for the study



Source: *Compiled by the Authors*

Selection of blocks: After the finalization of two districts in each state based on the high and low FPA, two blocks were selected from each district. Consultation with state agriculture officers was conducted for selection of blocks. In each district, two blocks were selected based on high and low level of prevalence of mechanization in the blocks.

Approach

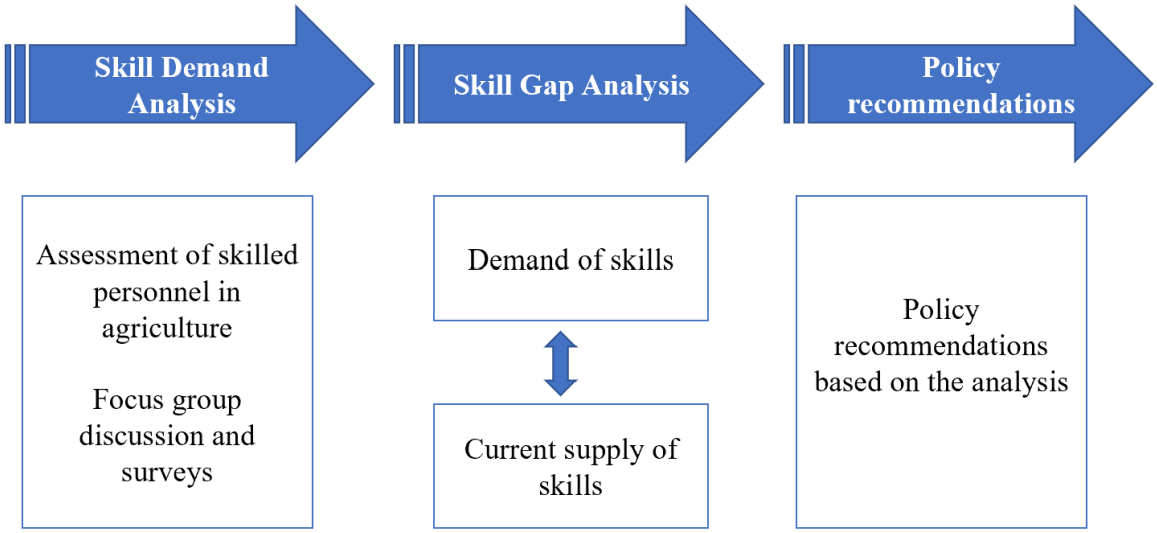
Assessing Skill Gap

Skill assessment is an evaluation of each individual's ability to perform a specific skill or set of skills. In the study, skills of respondents for operating, repairing and maintaining the machines are captured. It explores whether those skills were obtained through formal training or informal learning/experience along with mapping whether there is requirement and scope for further training to improve skills or new skills to be imparted. The skill gap analysis undertaken in the study is an indication of the skill demand in mechanization in agriculture. To understand the existing skill gaps and its challenges faced by mechanization sector, following key questions will be answered:

a) What is the gap in the demand and supply of the machines involved for performing agriculture operations?
b) What is the gap in demand and availability of the machine operators?
c) To what extent have the farmers/landless have been targeted for training for operating machines and its repair and maintenance?
d) To what extent do the operators of tractors meet the basic criteria of information for training?
e) To map the gap in the availability of the competent repair and maintenance mechanic, spare parts availability in the village eco system.
f) What are the main challenges faced by machine owners for its operation and maintenance?

A tailor-made skill gap survey is developed for uncovering the above information. The survey consisted of 'agricultural operation wise machine' survey where questions were administered for machines used for agricultural operation namely land preparation, sowing/transplanting, weeding, irrigation, applying fertilizer and spraying, harvesting and spraying.

Figure 4.6: Method of assessing skills gap



Source: *Compiled by the Authors*

This gap between demand and supply will indicate where skills development policies are to be shaped and moulded accordingly.

Labour Saving technologies

The use of labour-saving technologies is widespread, but there is a significant gap in their adoption by women due to barriers in access to capital, access to inputs and services (information, extension, credit, fertilizer), physical accessibility, and cultural norms. Enabling the adoption requires a deeper understanding of nuances in the adoption behaviour w.r.t to LSTs. There are many aspects of LSTs adoption which relate to gender which are undocumented, and understanding these will be important for raising agricultural productivity and women's welfare. In this study we aim to uncover few of the constraints which hinder usage of LSTs by women.

To understand the adoption of labour-saving technologies by women following key questions will be answered:

a) What are the sources for women to gather information for agriculture technology/inputs etc?
b) Whether they have undergone any kind of agriculture trainings?
c) What is their decision taking power in household?
d) What is women's access to funds to adopt to an LST?
e) What are perceived benefits of LST and how it may impact women?

A module is included in the household schedule to capture observations for perception of labour-saving technologies from women who are engaged in farming operations. The women respondents were shown videos of two labour-saving technology by the enumerators on their digital devices and noted their responses for both the tools. The tools were selected based on their wider prevalence and usage among states and crops. Tool 1 is the hand weeder used for weeding. Tool 2 is rice transplanter used for transplanting the paddy nurseries.


Image: Wheel hoe on left, Paddy transplanter on right

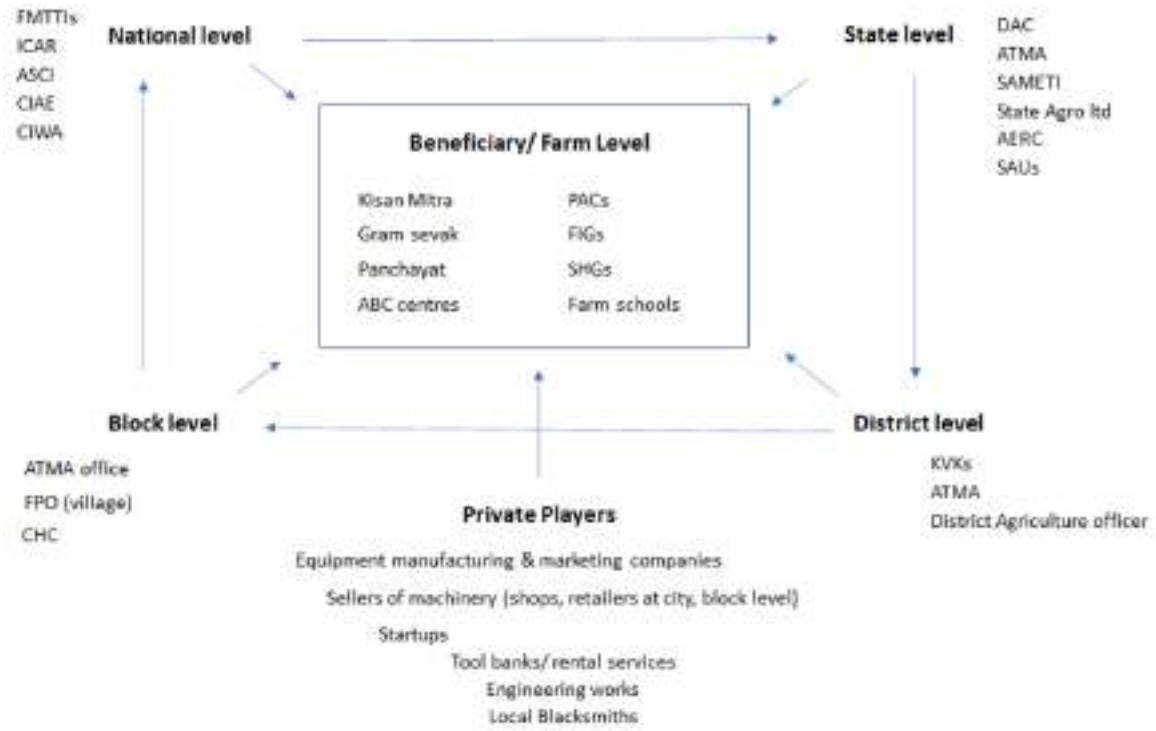
	Tool 1: Hand weeder	**Tool 2: Rice transplanter**
Operation	Weeding	Transplanting
Usage	To remove weeds in between the two rows of the crop	To transplant the nurseries of paddy to the field
Capacity	0.015 hectare per hour	0.092 hectare per hour
Benefit	Weeding without squatting position	Transplanting without bending position
Cost	Rs 800/- to 2500/-	Rs 3600/-

CHAPTER 5

MECHANIZATION ARCHITECTURE

The fundamental requirement for a sustainable mechanization sub-sector is strong linkages between the different stakeholders and optimizing resources to meet the demand and supply of the sector. The stakeholders cannot work in isolation as Indian agriculture hosts significant variation in land sizes, agro climatic zones, culture, infrastructure, educational level of farmers etc. Below are the players of agriculture mechanization which are linked with farmers directly and indirectly.

Figure 5.1: Stakeholder mapping for agriculture mechanization



Source: Compiled by the Authors

5.1. FMTTIs: Farm Machinery Training and Testing Institutes

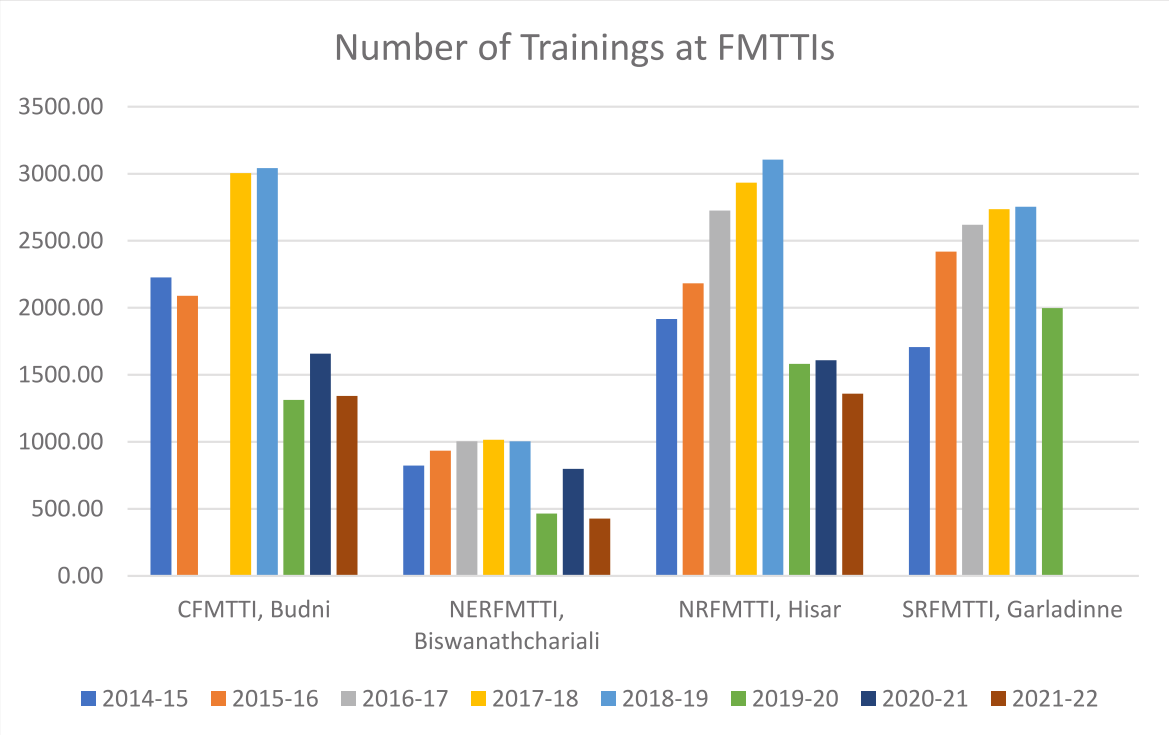
With the huge potential of farm mechanization for crop productivity and food security, Government has emphasised on Farm Machinery Training and Testing Institutes (FMTTIs). For promotion of farm mechanization, the Ministry of Agriculture initiated the Central Sector Scheme of *Promotion and Strengthening of Agriculture Mechanization through Training Testing and Demonstration (PSAMTT&D)* and during the XI Five Year Plan (2007 - 2012). This scheme was sub assumed under SMAM. The four Farm Machinery Training and Testing Institutes (FMTTIs) established in four states of Madhya Pradesh (Budni), Haryana (Hisar), Andhra Pradesh (Garladinne) and Assam (Biswanath Chariali) played a lead role in the development of human resource through the provision of numerous different training and academic courses. The salient features of FMTTIs are presented in table 5.1.

Table 5. 1: Salient features of the FMTTIs

Name of Institutes	Location	Year of Establishment
Central Farm Machinery Training Testing Institute	Budni, Madhya Pradesh	1959
Northern Region Farm Machinery Training and Testing Institute	Hissar, Haryana	1963
Southern Region Farm Machinery Training and Testing Institute	Anantpur, Andhra Pradesh	1983
North Eastern Region Farm Machinery Training and Testing Institutes	Biswanath Chariali (Assam)	1990

These institutes are imparting training to/for like farmers, technicians, undergraduate engineers, entrepreneurs and foreign nationals on selection, operation, maintenance, energy conservation and management of agricultural equipment. During the year 2019-20, a total of 10065 trainees were trained and the annual target of 9000 in different courses. The achievement is higher than expected showing a strong efficiency of these institutes. To support the efforts of the FMTTIs, trainings are outsourced through identified institutions such as ICAR Institutions, ATMA Institutions & the National Innovation Foundation. The Ministry of Skill Development and Entrepreneurship funds the training program. Under the Aatma Nirbhar Bharat Abhiyan of the Government of India, the skilling of migrant agricultural labourers was conducted in 2020.

Figure 5.2: Number of trainings conducted by four FMTTIs from 2014-22



Source: *Sub Mission on Agricultural Mechanization*

Importance Of Training

Operating tractor requires multioperation skills due to varied functions of the tractor. The technicalities of hydraulics, hitching mechanisms, PTO shaft operations require training. It

is expected for an operator to understand the proper time to insert the equipment, the depth setting for operations like cultivation and ploughing. If these are not sound, then there is damage to the equipment attached with the tractor which leads to inefficient operations in the field and results in wear and tear. Similarly, the hitching operations if not done right lead to wear and tear of machine, decreases the efficiency of operations, increases the time requirement to complete the operations and consumes more fuel. All manufacturers give instructions about the gear to be used according to the operations. Cultivator is operated on L2/ L3 gear and covers one acre covered in one hour. But operators are less aware and operate on higher gear. If the recommended practices are followed, then the efficiency of the tractor will improve. During seed sowing operations with tractor operated - seed cum fertiliser drill, it becomes important for the owner and the operator to calculate the number of seeds used in 1 acre and accordingly use the seeds to maintain the required seed rate. With paddy transplanter, the seed rate is 5 to 10 kgs and 40 kgs when done in manually. Transplanting after puddling should be done only after 48 hours to avoid any mortality in plants or negative impacts on yields. The emphasise on training is vital since the awareness and education of using a machine leads to better performance of the machine, increases efficiency of the machine and the operations, reduces fuel consumption, takes less time and avoids wear and tear of machine leading to longer shelf life.

Interactions With FMTTIs

Several interesting insights came from primary interactions with FMTTIs. FMTTIs are esteemed institutes in the agriculture mechanization sector. Not only for testing but have been leading institutes for machine training. They have multiple courses for various categories of beneficiaries: user level courses for beginners, technician level courses for who already have initial training and know about farm machines, need based training program are designed on basis of the beneficiary demands, academic level course are for engineering graduate, U-5 courses which are gender friendly courses and Foreign national training. In India, there are only few tractor operators who are formally trained through various training institutes. They acquire the skills from family, friends, and relatives. The technical training is as important as knowing how to operate the machine but since these trainings don't bring any income generation along with them, it is difficult to attract the informally trained operators to formal training institutes. Besides adoption level issues for uptake of formal trainings, the institute also faces internal challenges. Compared to past years, the training targets have increased, and training duration decreased. The increase in these targets and constrained infrastructure prove to be challenging to provide quality trainings. Lack of qualified manpower affects the whole system and even when FMTTIs are best suited for providing trainings, the budget allotments, manpower and infrastructure need to be improved. There has been focus on new certification agency for providing course and certification to trained beneficiaries. Earlier, FMTTIs were the apex body of these certifications, and this has created complexity in the certification process.

Challenges of FMTTIs:

- FMTTIs face lack of resources in terms of infrastructure and staff
- FMTTIs targets have been increased over the years resulting into shorter course duration in order to conduct high number of trainings.
- All the FMTTIs have different databases for their record. A standard format in maintain database will help the policymakers, private sector and researchers for better understanding and policy formulation.

5.2. Farmer Producer Organization/ Farmer Producer Company

Through government scheme, farmer producer organization can apply for custom hiring centres/ farm machinery banks. In interactions with the FPOs which availed farm machinery bank status in Uttar Pradesh, the study explored the rental dynamics. Due to the changing labour dynamics, farmers are preferring machines. The ownership of machine is limited, and hence rental services have important role to play. Rental services of FPOs are availed by the members and non-members as well. The reach is higher in terms of the number of villages because of ongoing agricultural business activities. There is no formal training received by the operators of the machines but required machine demonstrations were conducted before allotting the machine to FPO. Skill operators are very important for maintenance and long life of machines. Gear reading, turning point, picking up the hydraulic lever to save fuel cost, adjusting gear depending on the soil type, regular maintenance with oil check and change, water level / coolant requirement, gear oil check, mobile oil is some of the skills which a machine operator or machine care taker should know about. These are technical details which an operator shall know along with general awareness of crop suitability. Also, if tractor is being used, the working of the attachments is also to be understood. For instance, if a spraying attachment is with tractor, then what is the number of weedicides to be used etc. Over the past few years, the number of labourers has been declining and issues have been faced for weeding activities. Farmers have turned to the use of chemical sprays for getting rid of the weeds. Since there is no labour, chemical spraying is done all over the land by hiring one labour. Many times, farmer don't spray over the area which they use for personal consumption. With introduction of small machine, it will become popular quickly if available in the market as these are promising for dealing with labour shortages.

5.3. CIAE: Central Institute of Agriculture Engineering

CIAE is addressing mechanisation related issues, machinery related to crop production, working in renewable energy sources and irrigation water. All India Coordinated Research Project (AICRP) is under ICAR, mainly involved in location specific research, and popularize equipment through KVKs. They build 5-10 equipment and send them to multiple locations. Modifications are done and licences are allotted to farm machinery manufacturers for further productions and selling to customers. Self-propelled and bigger machines are promoted for agriculture operations and manual tools should be used when there are no other option or alternatives or in remote places. Manual tools are preferred in some cases where it is difficult to use machinery like rice puddled field. The semi-structured interview with personnel at CIAE highlighted the fact that adoption of machinery results in time saving and other benefits. Now, 60-70% farmers hire combine harvesters. The operations saves time and has lower cost as compared to manual labour. Availability of labour is becoming an issue day by day and male workers are not available to work in agriculture. States like Punjab and Haryana observed labour shortage at time of rice transplantation and hence they started

adopting rice transplanters. CIAE identifies need for adequate training and skills with respect to the operation of machines. It also advocates training of women in agriculture and their engagement in operations of machines and tools. As women are more involved in labour-intensive/ manual activities while men operate machines their training form machines can increase adoption and hence, efficiency. CIAE is working on to adjust machines so that women can operate with ease. For physiology, ergonomics and safety, it was found out that there are anthropometric differences across gender but haven't been incorporated in the manual tools. So, agencies like CIAE have started developing tools in which women can work comfortably. The tasks are already being performed without these tools, but with these, efficiency will increase. Differences in anthropometric body sizes led to designing of tools with which women could work comfortably.

5.4. Central Institute for Women in Agriculture

ICAR-Central Institute for Women in Agriculture (ICAR-CIWA) exclusively works for gender related research in agriculture. CIWA focuses on participatory action research in different technology-based thematic areas involving farm women to make farm technologies suitable for them. It engages in activities to catalyse and facilitate research and development institutions to incorporate farm women perspective in research and development programmes. CIWA creates database to recognise the issues face by women by defining sectoral role of women. It works for drudgery reduction through agroeconomic aspects for women who are vulnerable by climate change, water shortage etc. During the primary interaction with CIWA, it was emphasised that women involvement in agriculture is directly linked with labour intensity of the operations. It is widespread that land preparation and spraying are totally mechanized and men are seen performing these operations. Labour intensive operations like weeding, harvesting is still carried by the women. There are power weeder etc but the notion that women can't use power intensive tools are limiting factors. CIWA focusses on breaking these taboos by conducting demonstration of various tools which can be used by women.

Extension programs are planned through Panchayat institutions, and they consider farmers for any kind of schemes and interventions. By default, women do not own land and are not categorised as farmers leading to unintentionally by passing of women as only, 13% women are land holders. Other challenge with technical training programs is that they are targeted to men. Time setting of these events (first half of the day where women are majorly engaged in household activity) becomes major hindrance for women participation. So, women focussed training needs to be planned and their time shall be considered. It is important to bring women in training purview as even small simple tools require a certain level of information to be absorbed by women. A twin wheel hoe operates on a push and pull mode. It can't be pushed down in the group. A simple manual tool also requires information dissemination for its adoption. A higher focus is needed to make women informed for power tools and other big machineries. A basic training of maintaining tools to women will also help women to sustain usage of power tools and manual tools. With government efforts, farm power availability is increasing but its implication could be different for women. An increase in number of tractors will not translate into women using machines. Owing to the current taboo of machine usage by women, appropriate technologies need to be deployed for women. Power vs manual tool promotion comes with a cost angle. A woman in agriculture will not be able to afford a power weeder of Rs 25,000 but they can be inclined to buying a cono weeder of Rs 4,000. So, CIWA promotes power tools but also keeps a focus on manual tools. Depending on the region and the level of awareness and willingness among agriculture community, tools are selected for promotion.

5.5. State Agriculture Universities

Navsari agriculture University has three mandates namely research, education and extension. All university have their app. Farmers can download the application and be connected for weather forecasting updates, market price of commodities etc. Extension activities have strong focus with promotion of activities and tools like cono weeder. These are used in Systematic Rice Intensification. With broad spacing between the crop sown, less resources are required and production is high as well. Cono weeder is assumed as a principal in SRI and helps in weeding operations. Interactions also highlighted on that women participation in manual operations is also attributed to their punctuality, honesty and efficiency. For activities like weeding, usually women are involved. With increased labour shortage, a strong movement towards weedicide is increasing. They are proven to be detrimental in health but one can also not ignore their role in agriculture. "crysallof' (name of a herbicide) kill weeds of small leaves and for bigger leaves, manual weeding is required. Small farmers can save on weeding cost if no weedicides are applied. Also, in conditions where weedicide application is not feasible, manual weeding is resorted. The hand tools which are being popular for weeding can be deployed for the mentioned contexts. Also, many schemes are being created for promotion and adoption of these tools.

5.6. Krishi Vigyan Kendras

KVKs have a mandate of training farm men and women, and rural youth. KVKs are also knowledge resource centre in terms of research and information. KVKs conducts Participatory Rural Appraisals to understand needs and demands of farmers. They conduct on Farm Training and Front-Line Demonstration of various technologies such as seed varieties, fertilizers and farm tools. The farmers are engaged by KVKs to test out technology such as growing different varieties of a crop etc for dissemination of information. They decide on an annual plan for the coming year. KVK Staff take down the issues which farmers are facing and then targets the areas accordingly. In KVKs fund allocation is done more specifically by socio-economic categories such as General, SC, STs, etc, under which women are a sub-category. In Ahmedabad area, women are involved in weeding activities and animal husbandry. But with the introduction of mechanization of operations and weedicides, men are taking over the operations. Technology adoption depends on the cost. In Ahmedabad, mostly farmers who have large landholdings, have tractors and rely on motorized operations. KVKs promote the tools but carrying out need assessment (identifying patch with particular crop and recommendations), understanding the local practices and finding technological solution. In order to promote the solution, identifying appropriate demonstration activity (could be awareness - kisan koshti, live demonstration etc) is important. For small tools-demonstration are conducted in batches of 10-15 people. KVKs also promote tools which are not manufactured locally but are developed by other KVKs in the country. For example, the bhindi plucker was ordered from Parbhani, Maharashtra for demonstration. It took around 2 years to get local demand of the tool and then the production of tool was given to the local artisan/blacksmith. Local artisan has a skill to make it but they need the demand and scale. Locally made and locally selling of the tool ensures availability as farmers won't travel long distances for small tools. According to KVK, Bhavnagar, the availability and affordability of

Locally available or developed tools

KVKs play an important role in modifying technologies according to the region-specific requirement. Wheel hoe made by university was demonstrated by KVK. Wheel hoe was modified according to local condition and land type. Modified wheel hoe got huge demand by farmers as compared to university made. The major reason identified was the difference between the angular plough.

the technology/tools/ equipment is a major factor for adoption. Farmer will not adopt costly technology; it shall be economical. The land size also matters for instance a marginal farmer can't opt for tractor mounted reaper. Lack of information about how will technology be useful and lack of skills in particular, the skill required for operating technology. Many times, for a particular technology, farmers need immediate effects i.e., farmers want immediate results which is not possible in many cases like organic fertilisers. Factors for adoption of small tool are mostly dependent on local practice and mindset. For example, of bhindi plucker which uses one hand to pluck bhindi's, the farmer finds using both hands efficient while harvesting bhindi.

> "In case of labourers, they won't carry their bhindi plucker. Even if they bring, the owner won't prefer it. As owners want maximum work irrespective of labour injury, they will prefer labour working with both hands." – Head of a Krishi Vigyan Kendra

Currently, there is no separate focus on women for promotion of all kinds of technology/ machines. There is lack of capacity at the KVK end. Women are focussed for specific things like Animal husbandry (usually only 10-15 % are men farmers, majorly women), tools like: chaff cutter, milking machine (they say, it damages uder of milch animals), drudgery reduction tools, nutrition, health, kitchen gardening, horticulture. Women extension staff manages the activity to be conducted among women. The KVKs with presence of home science position and agriculture engineering positions are doing better in terms of technology dissemination among women and also developing appropriate technologies according to the region. Agriculture engineer enables modification of the technologies with respect to local acceptance i.e., soil type, crop suitability, cultural practices etc. A Krishi Vigyan Kendra in Odisha reported that there are challenges of untrained operators. These challenges comprise of below age operators (license/ age). They lack awareness about maintenance of machines, regular check-up for the routine maintenance, checking of oil etc.

Challenges in mechanization and Skill development gap identified by KVKs:

KVKs are under-staffed to carry out all the mandates. Training and demonstration activities are done by very few people which makes outreach very challenging. Lack of human resources at appropriate positions leads to inefficiency in operations and burden on existing resources. Both the targets of mechanization and extension work are difficult to achieve because of shortage of staff. A lot of the farmers are not certified but have the basic skills of operating mechanized tools. Bringing in a system of having their database will help in identifying who is to be trained at what level. Farmers need to take up mechanization as operations are being disrupted by scarcity of labour caused by migration as well as negative externality of welfare schemes. CHCs, Farm Machinery Banks and rentals are not common in this area and entrepreneurs are not willing to set up CHCs and Machinery Banks. Timely availability of the machines is an issue. Rural youth are not engaged in such initiatives.

5.7. Panchayati Raj Institutions (PRIs)

(i) The State Government and other designated implementing agencies, to the extent possible, ensure active participation of the Panchayati Raj Institutions (PRIs) in the implementation of this Mission. (ii) PRIs may also be involved in publicizing the demonstrations and training of farm equipment and in ensuring participation of farmers from nearby areas for widespread dissemination of technology.

5.8. Local Artisans

Network of local artisans/blacksmiths/lohar are well spread in the villages. Small tools are usually procured from them. Local artisans/ blacksmith is easily approachable by rural men

and women. The 'lohar' mentioned that farmers are willing to pay only if they are ensured with quality of the tools. Also, they will pay if there is regular requirement of that particular tool. The quality is ensured as they are handmade. They also modify tools according to farmers feedback and suggestions. At times, Krishi Vigyan Kendra collaborates their small tool manufacturing with local artisans. After one local artisan created this tool, number of other artisans started to replicate the tool.

Image on the left: Bhindi plucker by Krish Vigyan Kendra, Sanosara, Bhavnagar. Image in middle: The scissors for drumstick made locally using cycle brakes. Image on the right: handmade replica of store available scissor.

Image: 'Sanedo' transformed into mini tractor by attaching various attachments. This is used for land preparation, sowing and weeding.

5.9. The role of Private Players

The private sector not only is responsible for production of agriculture machines but also play

an effective role in promotion and adoption of machines in agriculture. Though their motive also thrives on profit making but their operations and product have been able to deliver success in agri production and increasing farm power availability. From well established brands to the upcoming business with innovative models, interactions and insights have been summarised below:

In discussion with a private manufacturer of machines, it was found that promotion of machines among women is challenging. Women agricultural workers are also engaged to operate machines but this was met with some resistance in the field as men didn't allow women to operate machines but it was overcome through dialogues. Women are no less capable than men in agriculture but the set biases which have been ingrained in women and mindsets of others keep them at bay when it comes to agriculture mechanization. Adoption issues have been faced because of terrain (movement up-down), crop pattern (row gaps, crop height, stem) or soil. The company focusses on power tools because they reduce drudgery by greater amounts as compared to manual tools. Mechanized tools do not involve gender friendly aspect as they are power operated and can be easily used by women as well with proper training. Government subsidises are way to incentivise agriculture machinery adoption. But DBT have found to be more efficient for instance in Telangana. The company observed increased machinery sales with implementation of DBT. CSR fund- education scholarship in agriculture (number of women: men- 80:20) is also been started by the company for training farmers for agriculture machineries.

Insights from new and innovative businesses working to promote mechanization have provided insights on design, awareness, availability and affordability of machines for adoption. A startup rental aggregator focuses on reducing the rental prices as compared to the ongoing market prices for tractors and implements. The major pain points for farmers were identified in context of agriculture machinery. Availability of machine on right time is a challenge. If a farmer purchases a machine by investing his money, he won't be able to purchase if models are upgraded until 5-6 years. Price variation and higher prices of machines makes it unaffordable. With removing the downtime for farmers (the time where the tractor is lying idle), this cost can be decreased further by expanding the renting horizon of tractor owners. Tractor owners who rent face 25-30 % bad debt as farmers default in paying their rental charges. With the aggregation concept, the risk of bad debts reduces. Also, the network of the organization which consists of multiple machine operator are imparted skills on machine operations. The approach to skill development is achieved through seminars which are held before every season and organization's service providers are trained on all the machine and implements required to be used for particular crops.

Toya Agro Solutions

It was started when an educated farmer with large handholding suffered shortage of potato planter machine and tractor in his village. Potato sowing window is very short and even a delay of 24 hours hampers productivity by 10%. This instigated the thought of making machines available on time and hence Toya agro solutions Pvt ltd was found.

Toya has network of 2000 registered service providers which rent their machines through app based of tele calling bookings.

Another startup was established and started to promote hand tools which reduced drudgery in agriculture operations. Currently, they are developing and promoting tools for processing and harvesting. They are oriented to bring solutions that (a) replace skill rather than labour, so casual labour can do the job of skilled labour and (b) crop specific machine based operating solutions. Sickle approaches the development of tools through various steps of firstly, Identification of farmers need and gaps in field through farmer interaction, input are

then shared with design team for new or modified tool solutions, testing of product prototype and finalisation of product for market. There are no gender specific studies or tools but as the company is into skills of selective operations like picking etc, mostly women are involved as manual labour, these tools are handy for them. Design considerations are made with human factor, age, gender, handling distance etc. Purchasers/ customers are mostly men, as farmers. Women are employed as labourers. 35% of labourers comprise of women, therefore use the tools indirectly. Tasks include specialized/skilled activities such as in harvesting, weeding, paddy transplant, post-harvest, manual grading and sorting for particular crops such as cotton, tea, saffron. Thus, women hardly make purchasing decisions even when they comprise 30-40 % of users of purchased equipment. The pricing of the products is based on unit economics. The tool cost is the amount that is saved by the farmer due to use of the tool (due to elimination of wastage). Thus, their idea is that the farmers should be able to break even in one season. The pricing is affordable as these are smaller tools and have pay back of only one season. The company has adopted different marketing channels which varies from state to state but are similar within the state. In Himachal, there is community farming and high penetration of internet among farmers groups and hence information is disseminated accordingly. In Kashmir, Pulvama district, maximum people in community use shared taxis and hence their network is used for leaflet distribution. They target progressive farmers by providing them with demonstration units, consider them as role model and support them. Also, word of mouth works well in this sector. Typically, scaling of adoption takes 2-3 years and the major barriers identified to adoption are as risk aversive nature of farmers, looking for fellow farmer adopters to validate the technology and its result.

Established in 2004 in Gujarat, a machine seller based out of Gujarat, expanded the business in other states like Maharashtra, Himachal Pradesh, Rajasthan through dealer networks. Earlier they were manufacturing large machines and equipment and took dealership for small machines like power tiller, power weeder. In 2007, they manufactured their first small machine, power tiller by incorporating engines of prestigious company. While operating business as regular, their marketing and promotion of products is through network of dealers and they have a great online presence through amazon and Indiamart which garners interest across India. They have also developed a vertical of hand tools which are efficient for drudgery reduction of manual operations. Their designs are ergonomically suited for women as well. With their power tiller/ weeder and other tools, they claim to reduced time for agriculture operations like weeding, tilling, ploughing and delivery of cost-effective operations as it reduces labour drastically. These small machines have proved to useful in areas with labour shortage. There tools have proven useful for small farmers due to price affordability and cost benefit.

A design-oriented startup based out of Uttar Pradesh, develops Hi tech alternatives based on sustainable source of energy for performing agriculture operations such as harvesting of crops. There main product is a manual harvester (a hand tool for harvesting rice, wheat, fodder etc) and provides proposition of cost and labour saving. Harvesting with this hand tool helps farmer save Rs 2500-Rs 3000 per acre compared to a sickle (manual) and Rs 16000

per acre with combine harvester. Where combine harvester has been limited to larger farmers and bigger land size, sickle is used by small farmers on smaller land sizes. It is a tool which can be used easily by small farmers in small pockets of land as well. It reduced drudgery and provides additional cost benefits. The tool has been included under the "smart tool scheme' by government. Its promotion can proof a boon for farmers for harvesting of wheat, paddy and other pulses.

5.10. Private Public Partnerships

- Under PPP, the Government of UP has entered into MoU with a few corporates viz. under PPP Mode for Extension activities.
- The nationwide launch of online based Service - farm equipment rental platform as a CSR initiative of an Indian machine manufacturer. It has been launched in Odisha jointly with the Department of Agriculture and Farmers' Empowerment, Government of Odisha, to facilitate the hiring of tractors and modern farm machinery to farmers.

5.11. The role of Social Organizations:

There are number of trusts, NGOs, section 8 entities working to strengthen agriculture as livelihood of rural households. While working close to the farming community, they have observed the changing pattern of labour and agriculture drudgery. Keeping in mind the concept of labour-saving technologies and labour displacing technologies, these organization have been successful in promoting the appropriate tools in respective regions. An interaction was carried with one such trust which is working in the fields of tribal and rural development. The organization is engaged in training, demonstration and extension activities. They work with artisan clusters to get agriculture tools manufactured. There is a centralised procurement of raw materials and then supplying the required material to the artisans at block levels. This ensures the quality of the tools. They manufacture hand tools - spades, shovels, mattocks, picks, hoes, forks and rakes; axes, bill hooks and similar hewing tools; secateurs and pruners of any kind; scythes, sickles, hay knives, hedge shears, timber wedges and other tools of a kind used in agriculture, horticulture or forestry: spades and shovels. They also supply the tools to the Krishi Vigyan Kendra. Not only they are supporting businesses of small tool makers but also promoting labour saving technology and imparting skills to the local artisans.

A NGO based in Odisha which is also working with the government and over the years have played a major role in developing such programs as Integrated Rural Development Program and the National Rural Livelihood Mission. It is still works for bringing skills and systems that help women, families and communities. The primary interaction with the NGO brought in insights from the field where they are working with farmers and women in agriculture. Women operating machines is a taboo. Machine equipment drawn by hands, go well with women farmers. Accessing manual equipment is easier. There is better access of agriculture machines to large farmers, but civil society/ NGOs are working in for the smaller farmers and women groups. National rural livelihood mission has also developed community lending centre with Self-help group women. The women farmer can have

"8 hours of work were completed in 2 hours without requiring extra labour. The cost of weeding tool worth Rs 800 was recovered only in one day of weeding as while working with the tool, no extra labour was hired" – Beneficiary

access to the equipment either individually or group. During various interventions, it is observed that when women work with technology, they save on time and their participation increases in village level meetings. Majority is developed for large farmers with focus of drudgery reduction for large farms and not for small farms. All technology brings solution for large farms can operate and meet their labour crunch. Small farm technology is scanty and is in developing scale. The technologies available, they are not accepted by farmer due to affordability and availability. The biggest challenge identified is the term "Women as farmers" which restricts rest of the women who are working as labour while enrolling for government schemes and subsidies as this labour don't have any access to land.

A section 8 company working in the field of strengthening farmer's primary livelihood through training and extension has created an intervention for promotion of labour-saving technologies among farming communities. There interventions are through CSR funding of the corporates. In their project area in Gujarat, labour saving technologies were distributed to the beneficiaries both men and women. These tools were focused on weeding in multiple crops and harvesting paddy. Total of 832 weeding tools were given in 27 villages and for harvesting, the paddy harvesting tool was allotted in 17 villages. Both the tools resulted in drudgery less operations by the beneficiaries.

An interview with a field officer, helped the study to understand the village dynamics for machine adoptions. There are village level demonstrations organised for promotion of agriculture machines. Crops like Cotton are highly labour -intensive crop. The level of mechanisation is still low where sowing is mechanised with seed drills, application of fertilisers is done through sprayers but weeding is carried manually and with use of spraying weedicides, harvesting is done manually. In rural areas, the major source of agriculture information is the agriculture service centres also known as 'khad beej dukan'. There is limited penetration of gram Sevak and Krishi Vigyan Kendra. Gram Sevak's reach is restricted to a particular stratum of society. KVKs usually engage with progressive farmers who are well aware and cooperative for activities undertaken by KVKs. District level exhibitions at market centre are also one of the sources of information. These are organised by government agriculture departments. For any kind of information regarding farm machinery, Gram sevak are the first choice as they are updated with new machines, schemes and subsidies. For adoption of any machine, a minimum time of 1 year is required. There are various factors at play for the adoption. Even for women tools, there is lag in adoption period from first watching the tools and adopting it. Factors such as cost, drudgery, efficiency, technical complications, easy maintenance and utility are considered by women for adoption of tools. Women headed household usually don't buy implements as there is issue of machine operators. They prefer renting as operators come along with rented machines. Women from different categories of land holdings engage in different agriculture task. Landless women usually perform labour work. Women of small farmers engage in labour work on their own and other farmer's farms. Women from medium farm household engage in monitoring of labour in their fields and partial labour work. Women from large farmer household usually monitors the work or doesn't visit the farm at all.

While interaction with these private players gave insights into design, marketing and adoption of machines/LSTs, there were few emerging challenges:

- Goods and Service Tax (GST) is high on the products. Example: 18% on saffron dryer (as it is a dryer, comes under the category of industrial tools and hence high taxes) leading to high price. There should be some consumer price classification for farmers/industries/business etc.

- Credit Guarantee Fund Trust for Micro and Small Enterprises (CGTMSE) schemes aren't glitch free as projected.
- Identification of people/ entrepreneurs who want to purchase machines or open CHC so that these private agencies can collaborate maintaining the efficiency and maximise machine reach. Collaborations/ connection with CHC/FMB for their network. This can ensure demand of CHC machines and spread the reach to the farmers.
- Exploring ways to leverage government subsidy mechanism to work parallel and optimise subsidies for machine adoption
- Involving specific startups to become a training agency for the government to share the load of FMTTIs and develop skilled operators for various machines in various districts of the country. This will enable the reach to all pockets of the country and not only limit it to FMTTI reach. The targets can be competitive and deliverables shall be par with the industry standard.
- Agri universities have done well in terms of inputs and agro economy but not in terms of mechanization. Interacted with state universities- less work in machine development, more in seed and practices, bio inputs. They have important role in these avenues but for documenting/creating data sets/specific for machines is not their forte.

Takeaway

Understanding of agriculture stakeholder is important for the spread of mechanization in agriculture. Given constraints of Indian agriculture, synergies of these stakeholder can create larger impacts. The interaction among stakeholders, including farmers, manufacturers, researchers, and policymakers. Also, it can lead to the development and adoption of advanced machines. The linkages between the stakeholders collectively address policy issues and advocate for supportive regulations and incentives. By working together, they can provide policymakers with valuable insights into the benefits and challenges associated with the adoption of agriculture machines. This collaboration can help shape policies that promote technological advancement, facilitate access to finance for farmers, and ensure the sustainable and responsible use of machines.

CHAPTER 6

LABOUR-SAVING TECHNOLOGIES FOR WOMEN

Section 1: Overview of women and LST

Agriculture is the largest employer but share of workforce engaged in the agriculture sector has decreased from 58.2 per cent in 2001 to 54.6 per cent in 2011.[18] There is continuous change in labour supply in agriculture. As the service sector is growing, rural population is moving towards urban areas for better employment. As men are migrating, male labour availability is decreasing. According to the Census of India 2011, the percentage of women in agriculture in India is 24.6%[19]. Gender perspectives come in with availability of women and elders as labour. Women are more involved in drudgery heavy operations and there are attempt to reduce drudgery of women. Women contributes their labour for 70% of the major agricultural work, including sowing, planting, weeding, threshing, cleaning, winnowing, grading (NSWF, 2014)[20]. They contribute 86% of work in intercultural operations (Census of India, 2001). Also, as women in agriculture are increasing, there is a need to shift in thinking towards using women's time optimally/efficiently and reduce their drudgery. However, the adoption of machinery by women has been limited due to prevalent social and cultural norms. Manual tools/equipment can be a useful way to transition for the short run. to tackle the issue immediately. The major factors which influence the adoption of technology varies from social issues, skill of operating, availability of tools. The focus of government in gender mainstreaming is evident from the various schemes and inclusion of women.

Image on left: Sickle on the top and bottom. 'Rapdi' in the middle used for weeding. Image on right: Women using a traditionally modified tool for weeding in a standing posture.

In this study, a number of focused group discussions were cWonducted to explore the adoption of labour-saving technology by women. With the semi structure discussions with Central

[18] Agrarian Land, Ministry of Agriculture and Farmer's Welfare, https://pib.gov.in/PressReleasePage.aspx-?PRID=1601902

[19] Census of India, Ministry of Home Affairs, Government of India. (2011). C-11: Distribution of Workers by Industry and Sex. Retrieved from http://censusindia.gov.in/Census_And_You/economic_activity.aspx

[20] National Seminar on Women Farmer – NSWF February Organized by – Junagadh Agricultural University, Junagadh (Gujarat), Vigyan Parisar, Department of Science and Technology, Noida (UP) and National Council for Climate Change, Sustainable Development and Public Leadership, Ahmedabad (Gujarat), 2014.

Institute for Agricultural Engineering (CIAE), it was seen that it is not about light-weight and small size of the tools but the machine to fit the physiological aspects and their perception towards the use of machinery. It should not be beyond the capabilities of women as it might induce drudgery and will demand more resting gaps. During demonstration process, women preferred the tools they fit with their requirement. However, for purchase decisions, affordability of the tool is considered. We find a huge gap between the reasons of non-adoption between women farmers and manufactures. The manufacturers of the tools stated that there is no demand for the manual tools and women state that tools are not available. This can be attributed to the fact that there are very low margins with manual tools hence there is lack of interest in their production and promotion by retailers. Further, there have been issues in training and demonstrations of these tools as women have time limitations. They have to cater to childcare and other domestic work, which limits their time devoted for trainings. There is lack of effective communication between women farmers and male extension workers which limits the scope of them learning the required capabilities.

Technology aspects of labour-saving technology:

- Experience of social network
- Easier to operate
- Strength required to operate
- Weight of the tools
- Size of the tool
- Efficiency and productivity
- Multi-functionality of the equipment
- Reduced labour requirements
- Appropriateness to crop and soil

Women typically work on their own farms and also as labour on other farms. They are majorly engaged in activities like weeding, harvesting and rice transplanting which are manual in nature. For weeding, farmers have shifted to weedicides especially in horticulture crops. The labour requirements vary according to the crops. Hand tools such as the wheel hoe are suitable to be used for weeding, but they are not appropriate for all agro climatic zones. All of these are performed manually. These manual operations have resulted in various health issues such as back pain, leg pain, joint pain, uneasiness in walking etc (Kishtwaria and Rana, 2012; Pinzke and Lavesson, 2018). Rice transplanting involves most amount of drudgery as it requires bending posture of body.

Literature so far suggests that women are majorly engaged in weeding, other manual operations like transplanting, post-harvest activities due to factors like:

1. Traditional gender roles: In many agricultural societies, weeding and other manual tasks are traditionally seen as women's work, while men perform more physically demanding tasks like ploughing and harvesting.
2. Family labour: Family labour is not paid and hence women at home are expected to contribute in manual operations. This saves on cost from hiring labour and helps in completing the task timely.
3. Availability of women labour: Women often have to share agricultural tasks, especially in rural areas where men may be involved in non-farm employment or migrate to urban areas for work.
4. Precision and attention to detail: Weeding is a task that requires precision and attention to detail, which is possible manually. Women labour is termed to be effective and efficient when it comes to manual tasks.

Insights from in-depth interviews/ focused group discussions with stakeholders:

The aspects covered during the discussions were focussed on women drudgery, use of machines for various operations and perception of LSTs. For LSTs, various technology attributes such as experience of social network, easier to operate, strength required to operate, weight of

the tools, size of the tool, efficiency and productivity, multi-functionality of the equipment, reduced labour requirements and appropriateness to crop and soil were explored.

Image: AERC team showing video of labour-saving tool as part of the survey questionnaire.

During the course of the study, we conducted roughly more than 20 Focus Group Discussions across five states which give very useful insights into how women perceive labour-saving technologies. During the process of group discussion, the participants were shown video of rice transplanters and weeders. For rice transplanter video, women perceived it to be of a great relief for the activity. Another respondent who did not know about transplanter, quoted value of Rs 20,000 for purchasing. Women responded that they will buy LSTs only if they receive good experience by the users of the LST, if it works easily and requires less strength which is appropriate for a woman, and if it these tools are not heavy.

Along with these aspects, willingness to pay was captured for labour saving tools. It was observed that there is a difference in preferences of women from land owning household and women from households undertaking labour work. The responses from women of land-owning households, the chances of purchasing the LSTs increases when cost of equipment is matched with the labour cost incurred for performing the operations. Women weighted LSTs from cost saving perspective. The responses from women from households with no land ownership varied from the above category. They reported that renting is not feasible as it will not bring any value propositions. If wage earned is Rs 400, then can afford to pay Rs 100 in rental for tools. Otherwise, there is no scope for purchasing the tools with Rs 200 per day wage labour. With the numerous group discussions, insights were drawn for challenges in adoption of LSTs:

"If the equipment is able to compensate the productivity of two labour" - A women participant replied on adoption of the labour-saving equipment.

"Income generated from equipment is approx. Rs 25,000 over two months then can invest Rs 5000 for purchase" - Women respondent.

"I don't want to invest in machines/equipment as I don't have any land ownership. This season I might work in rice fields but later I might be in horticulture crop" - Women respondent

- *Decision making*: A general consensus was that decision making is usually rests with men and they might not identify the need of tools for women and their drudgery reduction. If women advocate for LSTs, they might be considered as lazy.
- *Perception of technology*: It will displace labour similar to the harvesters which displaced labourer's role of cutting and bundling of rice and wheat. Also, it might attract other people to join labour force due to ease of operations with equipment.
- *Multi-utility of machines*: LSTs are specific to a particular crop or operation. They are not as versatile as a sickle which can be used for harvesting and weeding as well. LSTs may lay idle once operations are completed.
- *Affordability*: Daily wage earners have limited income which is spent mostly on consumption. Hence, it is difficult to buy LSTs.
- *Payment norms*: If landowners pay according to the work irrespective of time taken then, only machines which reduce time are helpful. Also, from labourer perspective any reduction in pay-outs will drive them away and from family labourer perspective, deployment of labour-saving technology will bring drudgery reduction, time saving and cost savings.
- *Temporarily employment:* Labourers are not sure whether they will get similar work again or not. Hence, investing in LST for particular operation is not feasible.

Section 2: Benefits of adopting LSTs

Women involved in cotton plucking said they can wrap their work early and head back home and complete household chores in extra time. Currently, due to work, women wake up early and work till late. If these tools are deployed, then with time savings, the household work can also be completed easily in day (food, utensils, cleaning, mopping etc). Also, agriculture work will be completed in half the time giving scope for more work more and doubling the income by working. Cost of manual labour for weeding is 3 times more than the cost of weeding incurred using herbicides. Any reduction in cost which is less than hiring the labour or cost of weedicides is most appreciated with adoption of LSTs.

A ranking activity was carried with women groups to understand how they will allocate their time which will be in surplus after usage of labour-saving technologies. The activity was started after the focus group discussion where labour-saving technologies were showed over a digital device. A wheel hoe used for weeding and a manual paddy transplanter was shown to the women. When women understood that there will be time savings from using these tools, they will have enough time to allocate it to other activities. The ranking activity was conducted to identify the priority given to various activity by these women. It is seen that women prioritised household chores over every other work. This indicates that they are currently under work pressure while balancing agricultural role and taking care of the house. The fact that they are overburdened have been voiced over different group discussions with women. Even though these women weren't educated, they wanted to make sure that they provide some time to their children education by giving some attention (by not engaging in teaching the course but supervising that children time is appropriately used). Labour work

in agriculture is prioritised over any other livelihood generating activities. This shows their comfort level in the activity which are undertaken by them. Venturing into different income generating activities would require a nudge and whole eco system to start. Activity like watching television/ using mobile phone is least prioritised.

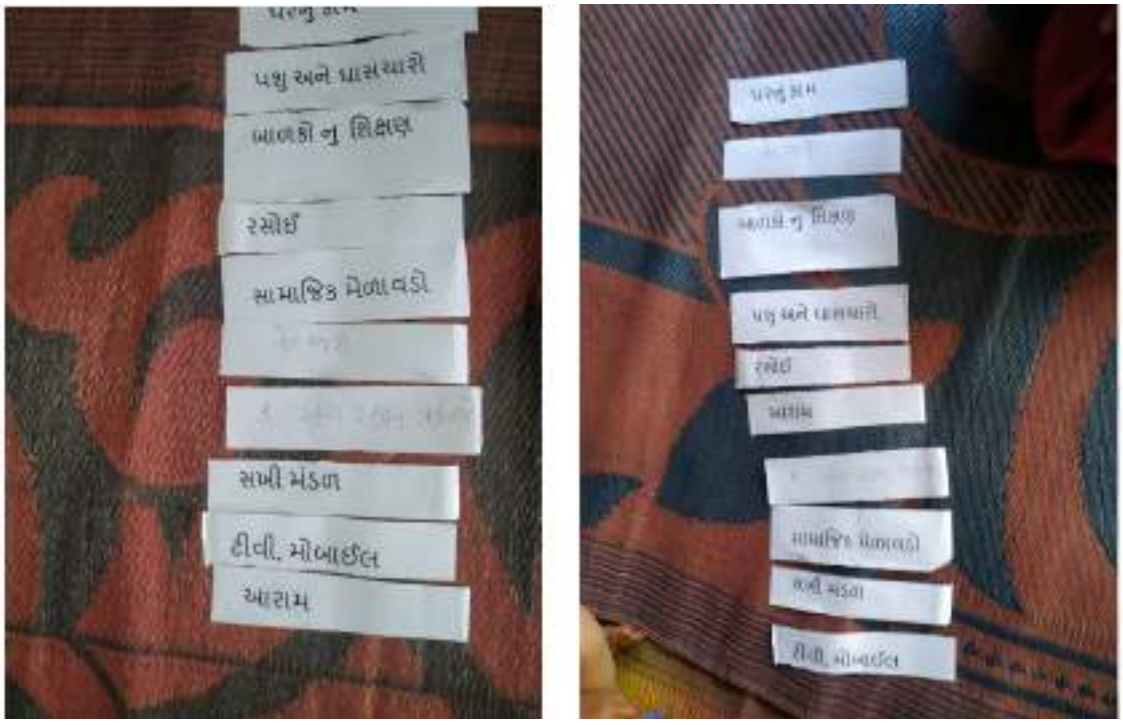


Image: Ranking of activities done by women in Village – Gondaliya (on left) and Mandva (on right). The text is in Gujarati language to make women understand and read.

Table 6.1: Ranking of activity by women group

Rank	Village Gondaliya	Village Mandva
1	Household Chores	Household Chores
2	Livestock and fodder	Agriculture labour work
3	Child's Education	Child's Education
4	Cooking	Livestock and fodder
5	Social gatherings	Cooking
6	Agriculture labour work	Rest
7	Other Income generating activities	Other Income generating activities
8	Self-help groups	Social Gatherings
9	Television/ Mobile	Self-help groups
10	Rest	Television/ Mobile

It can be concluded that the effects of adoption of labour-saving technology will not only reduce drudgery of women, but also have positive impacts on women's health, child's education, nutrition and income of the household.

Section 3: 3 A's of adopting LSTs

In context of labour-saving technology, the study explored the three aspects of adoption of LSTs. An experiment was conducted to capture perception and current status of information

of LSTs among women. The experiment included displaying of videos of LSTs on a digital device followed by set of discussions and questions.

Awareness: Women are not usually aware of the machines or technologies which are new. They know well about the machines which are used in the field operations. Any new information regarding any tools/equipment doesn't reach them appropriately. The major source of information is their social circles, neighbours and shops. Usually, husbands do not tend to share technical farming information with women. With the LST videos, it was observed that majority of women didn't identify the tools. They have never seen the tools anywhere. Only two groups one each in Bhavnagar and Bharuch had witnessed the wheel hoe tool. This was due to the efforts of the Krishi Vigyan Kendra in respective regions. The women who have been demonstrated the tools didn't feel comfortable using the tool due to strength issues. The tools which were distributed by the KVKs seemed to be outdated as compared to the similar kind of tools available with private agriculture tool manufacturers.

Access: While the perception of the tools was captured and is discussed in above section, majority of women who work as family labour showed higher inclination in buying the tool but women who worked only as labour where reluctant in investing a particular amount for the tool. Even with women knowing about the tools, they didn't know about the places from where it can be procured. Also, willing to pay varied from each category of women. Rental of these tools was also preferred by labour women who did not own the land. The major reason of preferring rental was to take the tool on rent when required as their work is seasonal and also, they are not sure which crop they would be working on next season. Family labour is willing to invest in the tools as they are cost saving and time saving and the investment amount depends on the cost benefit of the tools.

Affordability: The perception was captured through discussions, women inclination towards tool which reduce their drudgery, save them same time and cost was highly appreciable. The women who indulged in only labour work showed reluctance due to the labour displacing nature of the tools but have agreed to the drudgery reduction benefits. Given easy access and affordability of the tool, LSTs can be widely popularised.

Takeaways:

The qualitative findings suggest that women involved in agriculture do value their time and concerned about the drudgery involved. Women are engaged in agriculture and household work. Both being time consuming and tedious, it affects the women health and productivity. Deployment of labour-saving technologies by women in agriculture can bring a respite to the ongoing struggle. Given the decision-making ability, and removal of market constraints, they are likely to benefit from the adoption. While the women who are operating their family farm may benefit from ownership, for women labourers, the adoption needs more thinking. LSTs have huge potential to reduce the drudgery of the women in agriculture. They promise high benefits. There popularisation can be done through Krishi Vigyan Kendra networks but with a special focus and an innovative approach. The current model of popularising these tools is not as effective to reach masses and collaboration with private sector and other agencies can be leveraged. Rental of these small tools shall be explored through Agri business and agri clinic centres. Inclusion of these tools into CHC/ FMB can result into promotion and trial of these tools which can translate into sales and adoption. As the smart tool scheme of government is implemented, better awareness of the tools will lead to higher demand and adoption of the tools.

CHAPTER 7

MECHANIZATION STATUS AND ASSESSMENT OF SKILL GAP ACROSS ASSAM

Section 1: State overview

The Indian state of Assam is situated in the nation's northeast. With a land size of 78,438 square kilometres and a population of over 31 million, it is the largest state in the north-eastern region. Dispur, a Guwahati suburb, serves as the administrative centre for the state. At current prices, Assam's GSDP (2019–2020) is 351,318 crores, while at constant prices (2011–2012), it is 248,796 crores. For 2019–2020, GSDP growth at constant prices (2011–2012) is 6.30%. Assam is renowned for its wildlife, unique culture, and natural beauty. The Brahmaputra River, one of the biggest waterways in India, is located in this state and provides water for irrigation and transportation. Assam is also home to many national parks, including as Kaziranga, Manas, and Nameri, which are noted for their endangered species of wildlife, including the one-horned rhinoceros, tigers, elephants, and many more species. States's typical temperatures range from highs of approximately 36 °C in August to lows of about 7 °C in January. The state avoids the typical hot, dry season in India, the southwest monsoon, which starts in June and lasts until September, brings the largest precipitation in the state. This monsoon frequently brings widespread and severe floods. The average annual rainfall in Assam ranges from 1,800 mm in the west to more than 3,000 mm in the east, making it not only the highest in the nation but also among the highest in the globe. The state places a primary focus on agriculture, which employs nearly half of the state's working population and accounts for around one-third of its gross domestic output. More than two thirds of the land is sown with rice. The Brahmaputra valley is a major producer of tea and jute, two major exports that provide significant foreign cash and a significant amount of the nation's tea is grown in Assam. The sericulture industry in Assam is well-established, and is a leading silk producer. The north-eastern section of the state is home to significant natural gas and petroleum deposits. Tourism, handicrafts, and handloom weaving are other industries. The state faces a number of difficulties, like as poverty, poor infrastructure, and unstable politics, despite its natural beauty and cultural legacy.

Table 7.1: Status of farm mechanization in Assam

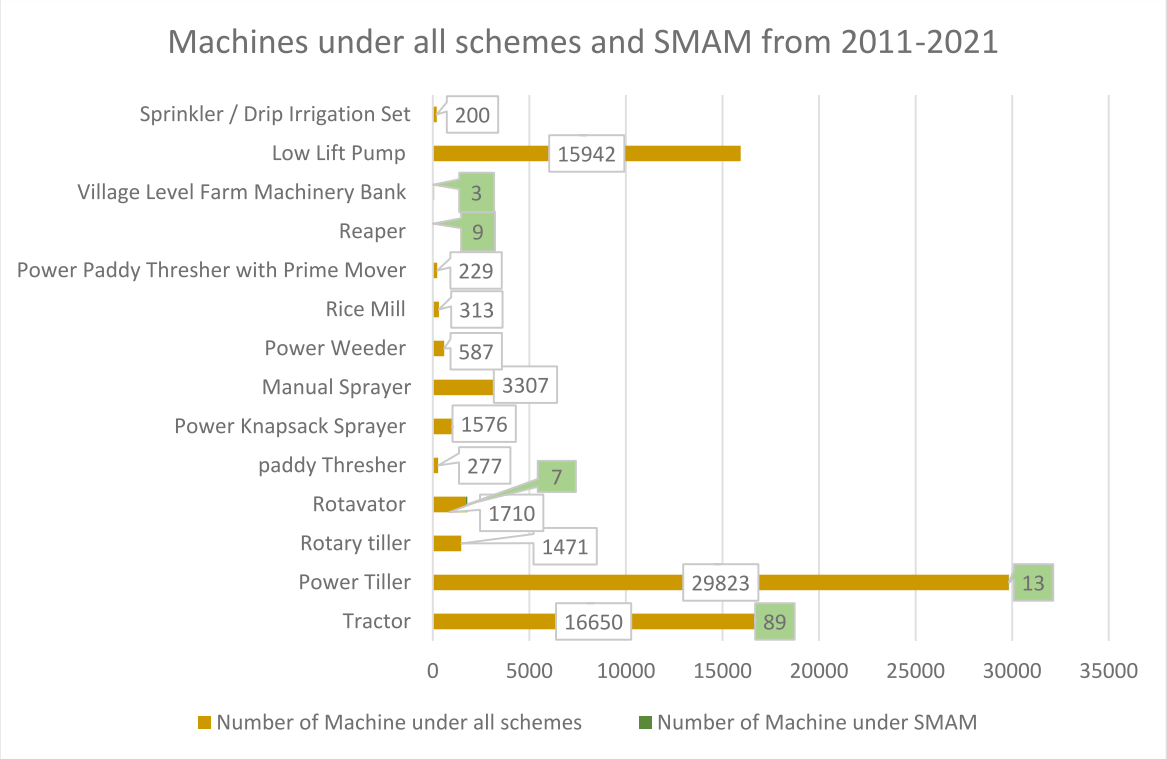
Year	Tractors	Power tillers	Power pumps	Small implements	Rotovators	Farm power availability (Hp/ Ha)
2016-17	0	6321	0	0	14	1.30
2017-18	0	5207	40	0	160	1.21
2018-19	6582	3125	0	5175	0	1.29
2019-20	4296	4598	0	0	50	1.16

Source: *Directorate of Agriculture, Assam*

The growth of farm mechanization in Assam is slow. Farm mechanization is imperative to support the bullock draught power which is inadequate for covering additional areas under cultivation. Assam has implemented the central Govt Scheme – **"Sub-Mission on Agricultural Mechanization (SMAM)"** under the aegis of National Mission on Agricultural Extension & Technology to promote the use of farm machines and increase farm power availability up to 2 kW/ha. Currently, the farm power availability stands at 1.16 Hp/Ha as shown in table 7.1.

The figure 7.1 indicates the total number of machineries over the period of 2011 – 2021 which have been given under subsidy. The numbers of SMAM scheme are only in 2019 indicating late start of the scheme in the state. The scheme has very low numbers but Village level farm machinery banks have been set up under SMAM.

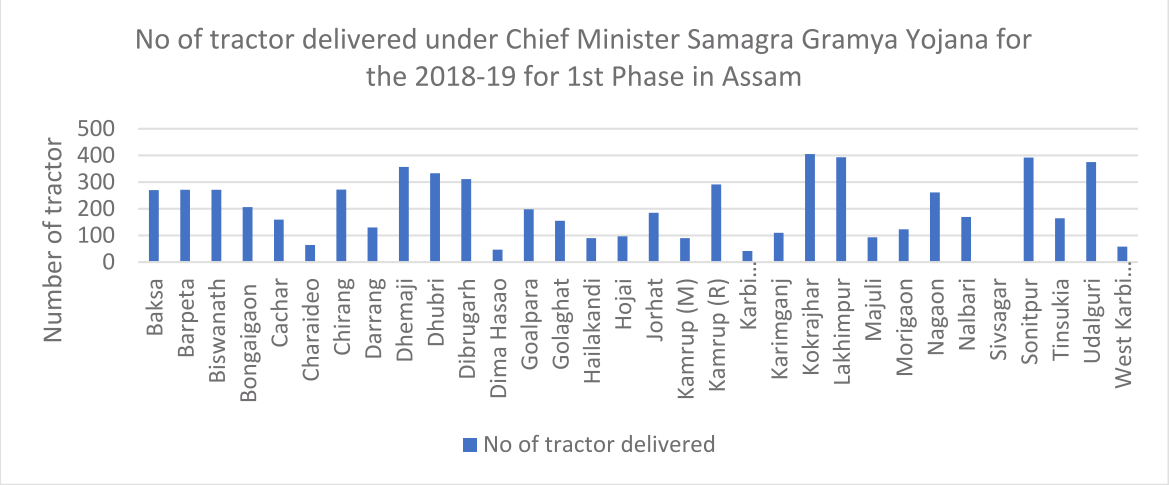
Figure 7.1: Machines under schemes in Assam



Source: *Directorate of Agriculture, Assam*

In addition, the state government of Assam also launched the scheme **"Chief Minister Samagra Gramya Unnayan Yojana (CMSGUY)"** in which one Tractor is provided to each revenue village covering 25 villages. This was done with aim to achieve the desired growth of Mechanization in agriculture.

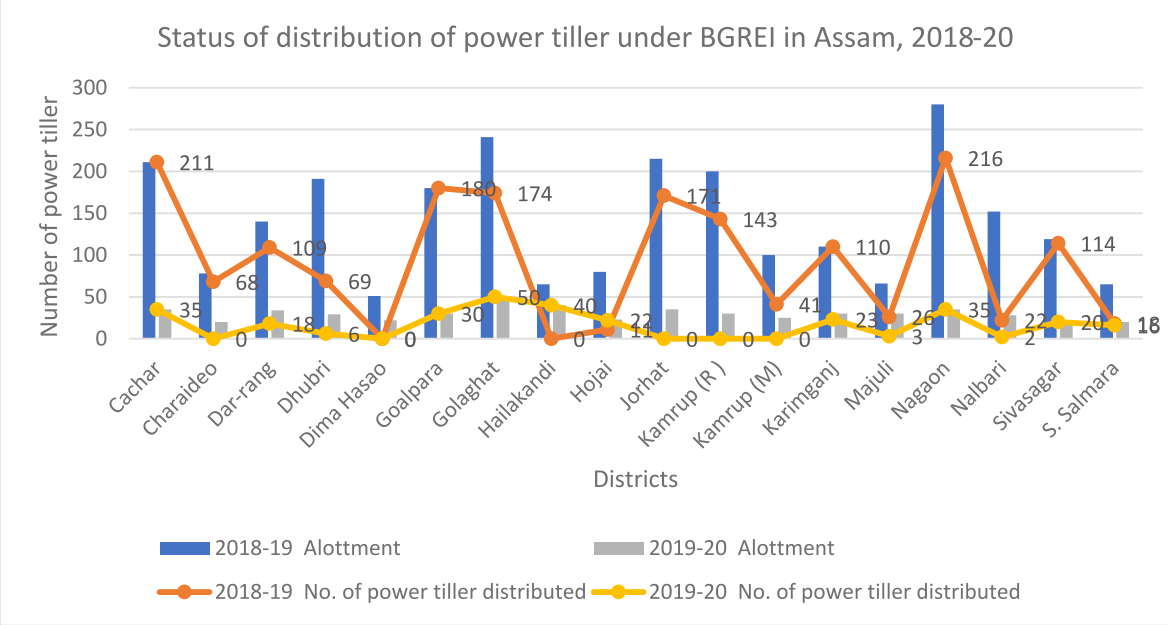
Figure 7.2: Tractors distributed under CM Samagra Gramya Yojna in Assam



Source: *Directorate of Agriculture, Assam*

Assam has also implemented the Bringing Green Revolution to Eastern India (BGREI), a sub scheme of the Rashtriya Krishi Vikas Yojana starting 2010- 11. This was to address the constraints limiting the productivity of "rice based cropping systems". It is being implanted on 90:10 sharing basis with government. Under this scheme, assets were built across Assam. In 2019-20, 2629 bore wells were installed, 778 self-propelled paddy transplanters, 9439 pump sets, 5582 cono weeders, 24876 manual sprayers, 3355 power knapsack sprayers, 1253 paddy threshers, 784 multi crop threshers, 3835 rotavators, 2456 power tillers and 5.12 lakh meter of water carrying pipes were distributed.

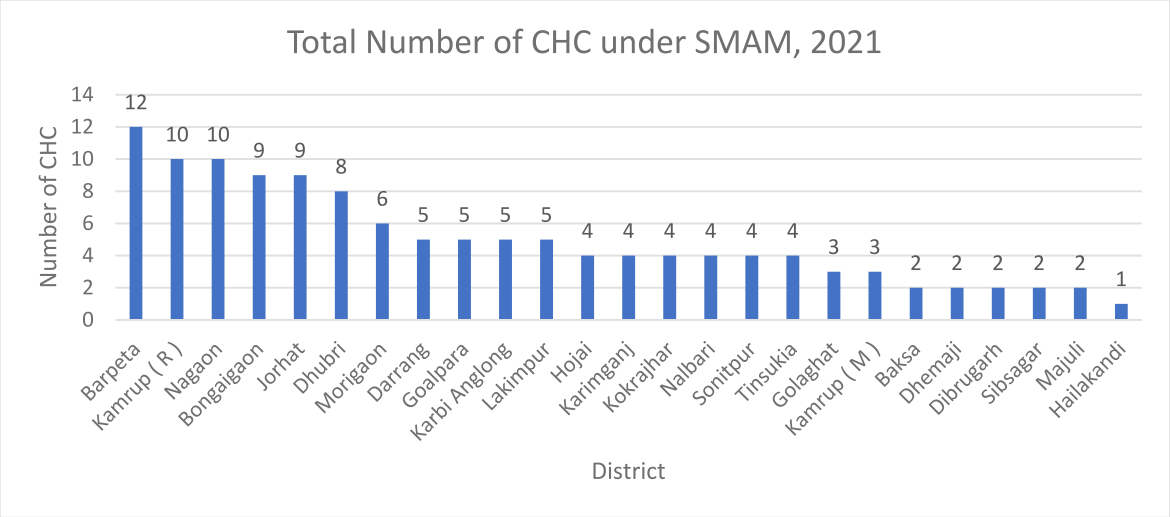
Figure 7.3: Status of distribution of power tiller under BGREI in Assam, 2018-20



Source: *Directorate of Agriculture, Assam*

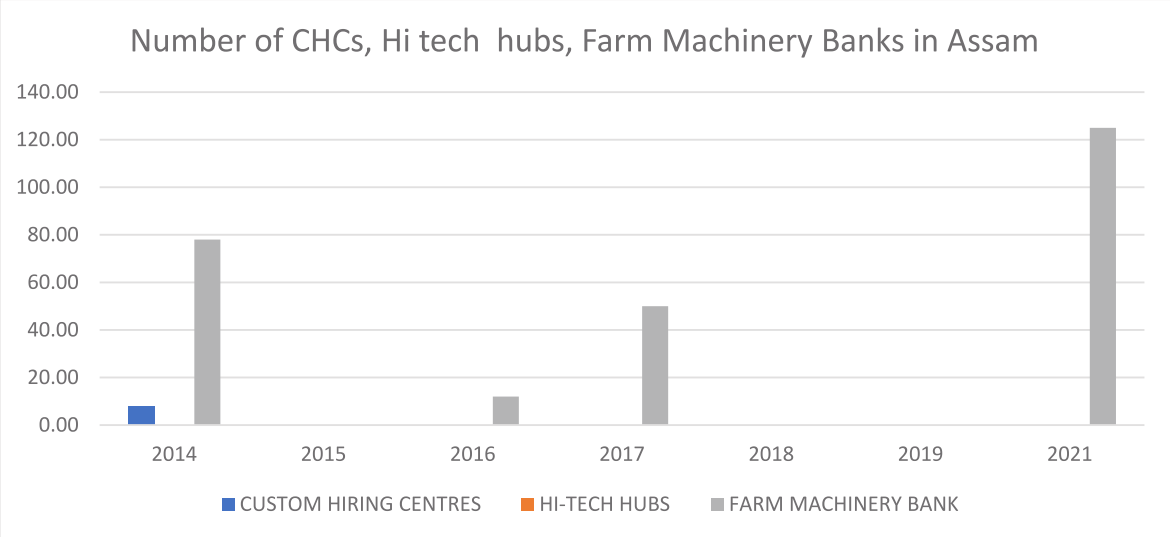
Under National Food security Mission, 2601 power tillers were allotted in 2018-19 and 2238 power tillers were distributed across the state. In 2019-20, 3182 power tillers were allotted and 1732 were distributed. A large proportion of power tillers remain undistributed. Under the Rashtriya Krishi Vikas Yojna, 1704 power tillers were allotted in 2018-19 and 1442 power tillers were distributed across the state. In 2019-20, 625 power tillers were allotted and 448 were distributed.

Figure 7.4: Total number of CHC under SMAM, 2021



Source: *Directorate of Agriculture, Assam*

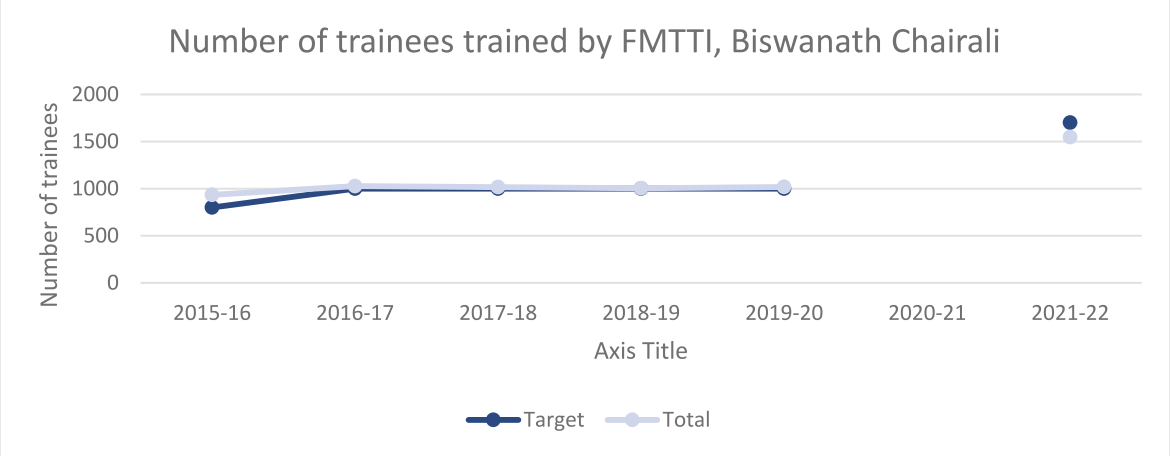
Figure 7.5: Number of CHCs, Hi tech hubs, Farm Machinery Banks in Assam



Source: *Sub Mission on Agricultural mechanization*

A FMTTI (North Eastern Region Farm Machinery Training and Testing Institute) has been established at Biswanath Chariali in the Sonitpur district of Assam, to cater to the needs of human resource development in the field of agricultural mechanization and also to assess the quality and performance characteristics of different agricultural implements and machines in the region.

Figure 7.6: Number of trainees trained by FMTTI, Biswanath Chairali



Source: *Monthly Progress report, North Eastern Region Farm Machinery Training and Testing Institute*

Section 2: Village and household profiling from primary data

This section describes the socio-economic background of the households surveyed across four blocks in Assam. Socio-economic profile indicates information on the average age, education qualification, ownership of APL/BPL (above poverty line/below poverty line) card, caste, gender, occupation, family size, members involved in agriculture and non-agriculture work.

Socio-economic characteristics of sampled households

Table 7.2: Villages for Assam under the study

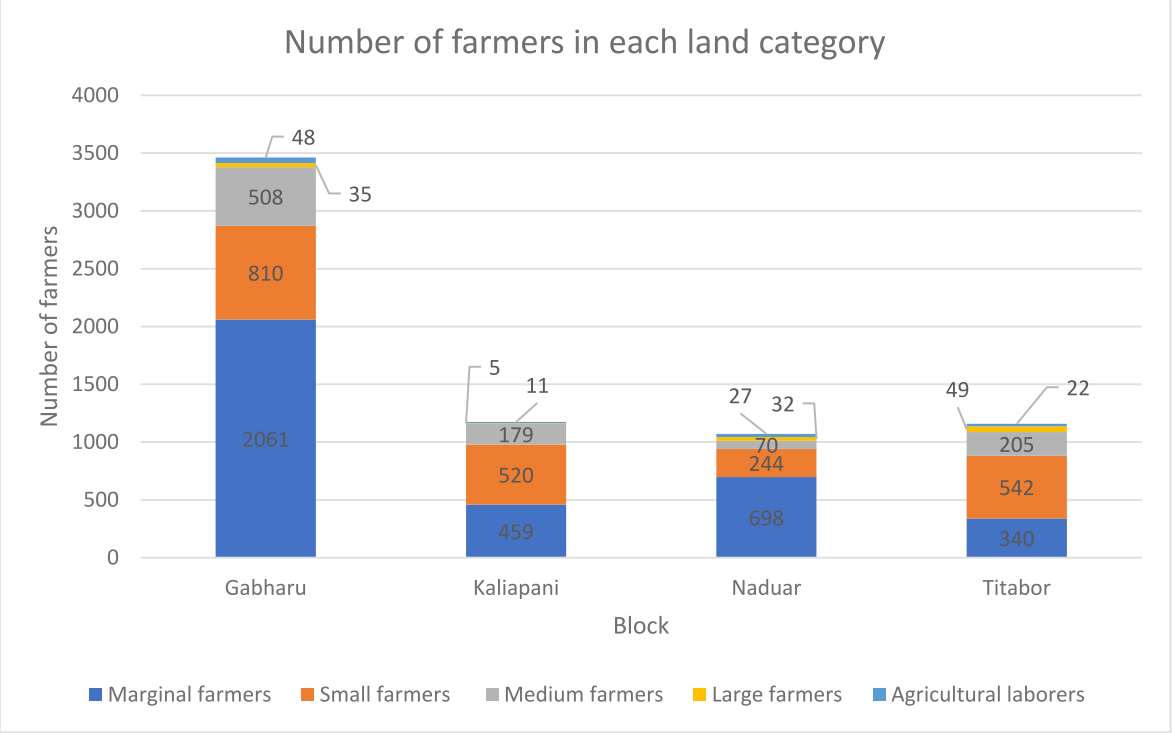
District	**Jorhat**		**Sonitpur**	
Block	**Kaliapani**	**Titabor**	**Gabharu**	**Naduar**
Village	Khatuwal Pathar Gaon	Khatuwal Gaon	Jorgarh	Niz-Chilabndha
	Bohotiya Gaon	Khamjongia Gaon	Tengabasti	Major Chuk
	Dulia Gaon	Ekorni Gaon	Urium Guri	Ghanibez
	Sagunpara Gaon	Bandarchaliha Gaon	Boikhowa	Bhoroli Chapori
	Dewhai Gaon	Phulbari Gaon	Bhomoraguri	Nandikeswar

Table 7.2 shows the list of the all the villages in which the survey was conducted in different blocks of Assam and table 7.3 shows the block wise split of the households covered under each land category for the survey purpose. The marginal farmers constitute of the large proportion of the sample size followed by small and semi medium farmers. Medium farmers have a very less proportion and there was no large farmer. In the sample, marginal farmers consist of 22% of the population across all the blocks followed by 31% of small farmers, 14% of medium farmers, 2% by agricultural labour and 2% of large farmers (figure 7.7).

Table 7.3: Category of households covered under the survey

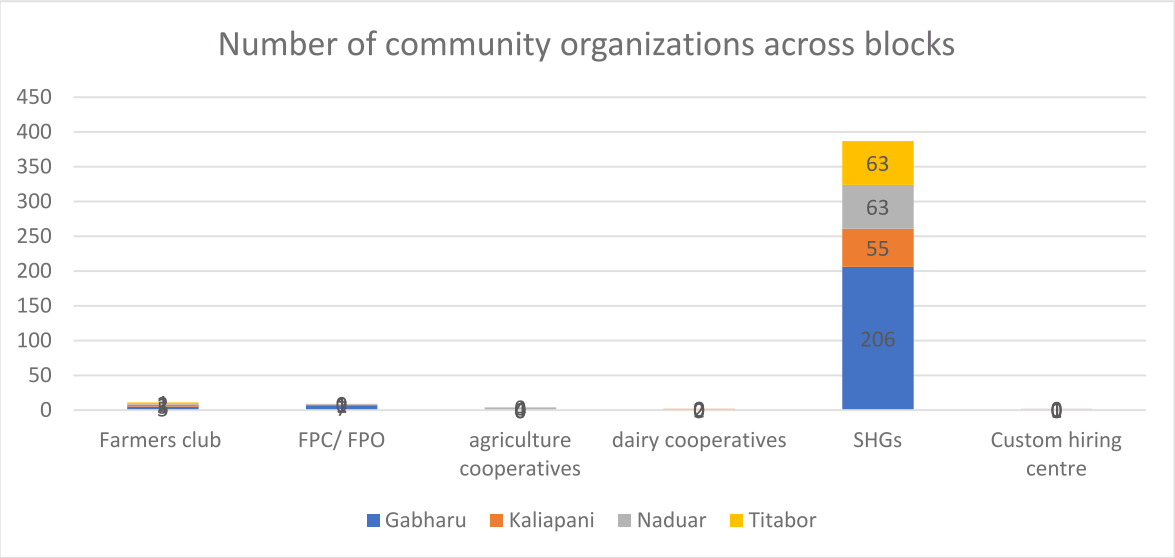
		Sonitpur		Jorhat			
	Row Labels	**Gabharu**	**Naduar**	**Kaliapani**	**Titabor**	**Household covered for each category in the state**	**% Household covered for each category in the state**
Marginal	Less than 2.5 Acres	67	78	47	71	263	44.05%
Small	2.5 -5 Acres	54	48	92	47	241	40.37%
Semi Medium	5 - 10 Acres	22	17	10	29	78	13.07%
Medium	10 - 25 Acres	7	6	0	2	15	2.51%
Large	25 Acre and above						0.00%
	Total	150	149	149	149	597	100.00%

Figure 7.7: Number of farmers in each land category



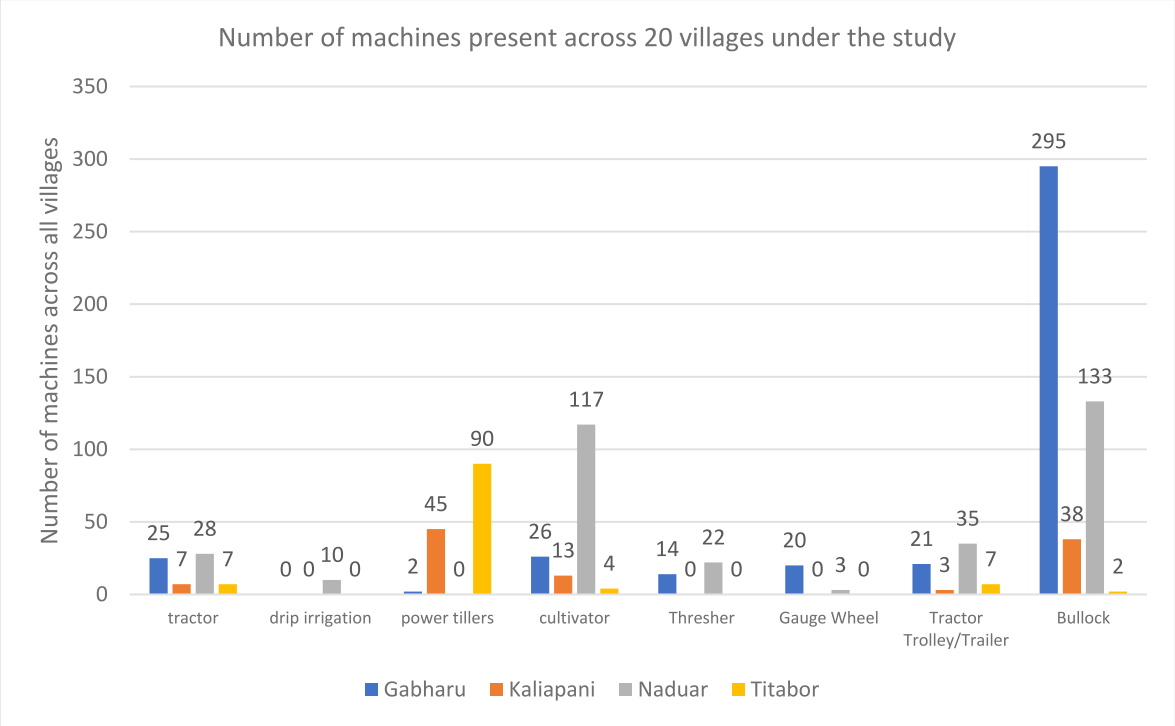
All blocks have presence of Self-help groups. Presence of only one CHC each is Kaliapani and Naduar block. There is presence of arm club in all 4 blocks. There are Farmer producer organization are present in 3 blocks but not in Titabor. Agriculture cooperatives are present in only in Naduar block. The presence of various organisations/entities in the blocks can be seen in the figure 7.8.

Figure 7.8: Number of community organizations across blocks



There is high prevalence of SHG across the blocks. All other community organizations are low in numbers. Around 415 originations/groups are present in these 20 villages but SHGs comprise of 93%. Highest number of SHGs being present in Gabharu block (53%) followed by Naduar (14%), Titabor (16%) and Kaliapani (14%).

Figure 7.9: Number of machines present across 20 villages under the study



The number of farm power are compared in the figure 7.9. Across all the villages, there are number of machines available with some ranging from single digit (combines harvesters etc) to some ranging in high numbers (sprayers and electric diesel pumps). The machines/ equipment/animal farm power are namely (number available): Tractor (67), power weeder (2), combine harvester (2), transplanter (1), harvesters (2), winnower (1), chaff cutter (2), drip

irrigation (10), sprinkler (2), super seeder (4), diesel pump (435), electric pump set (791), power tiller (127), sprayers (1030), cultivator (9160), thresher (36), gauge wheel (23), tractor trolley (66), bullocks (468). The data collected indicates that there is no requirement of arranging machines from outside of the village.

A village level analysis showed that the only a small proportion of tractor operators and machine mechanics are certified. But the proportion of certificate holders are high for multi-machine operators. This certification indicates that the operators have undertaken a formal training process. Owing to the complexities of machines, a proper training is required to efficiently operate them. For mechanic, it requires a higher level of knowledge for repair of different machines. It is imperative to have training for these complexities. The machine wise split of certified operator and non-certified operator can be seen in the figure 7.10.

Figure 7.10: Number of operators in Assam (certified vs non certified) operator

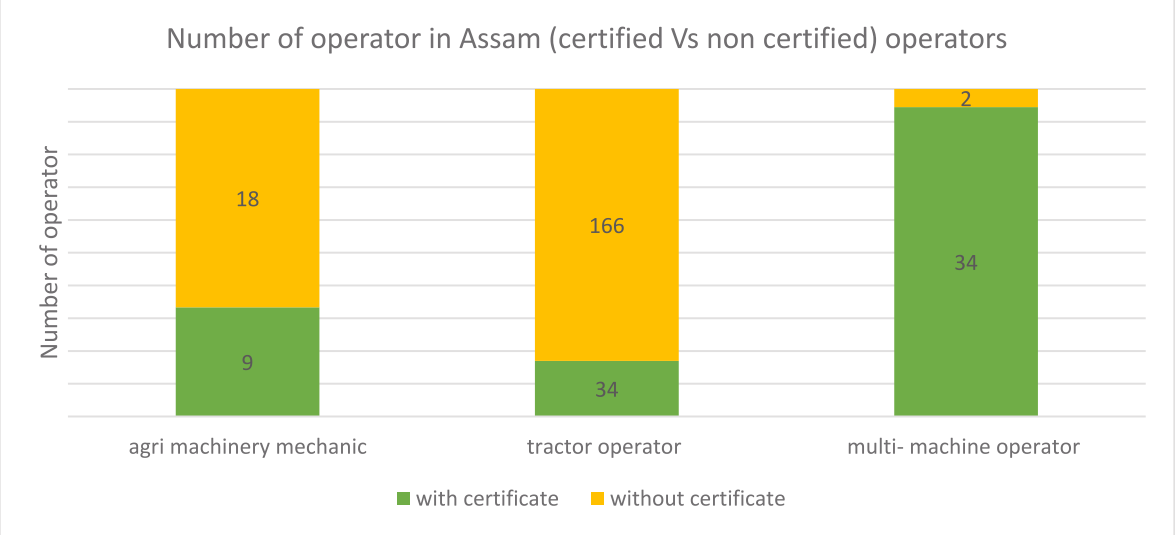


Figure 7.11: Occupation of households

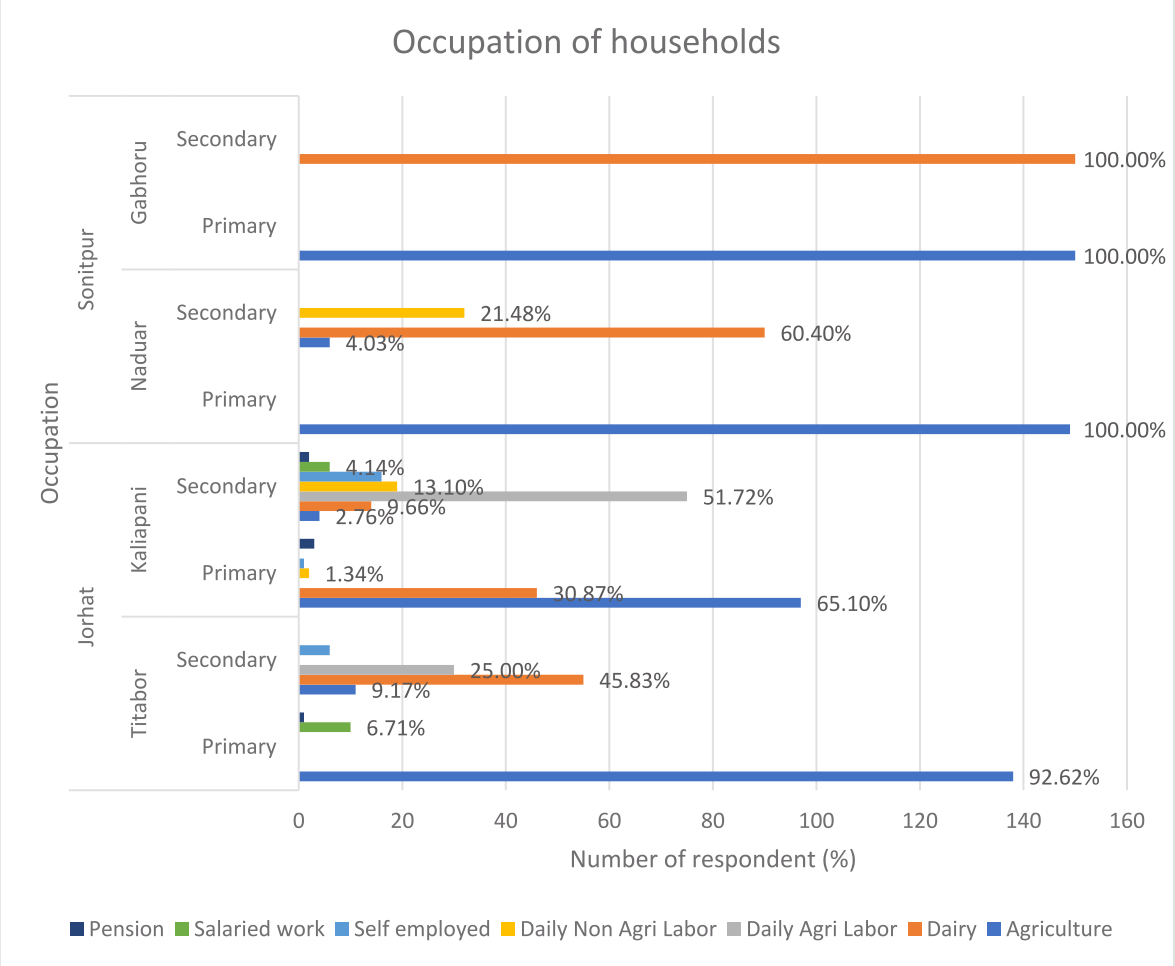


Figure 7.11. highlights the primary and secondary source of income of the household. Table 7.4 gives a sense of the proportion of households having agriculture and non-agriculture sources of income as primary and secondary occupation. As per results, the highest percentage of respondent have agriculture as their primary occupation (92.62% respondent in Titabor, 65.10% in Kaliapani, 100% in Naduar and Gabharu) whereas dairy/animal husbandry is second most opted primary occupation engaging 30.87% respondents in Kaliapani. Out of 597 respondents in all 4 blocks, only 4.26% respondents don't have any secondary occupation. For secondary option, the highest number of respondents have dairy as secondary occupation followed by daily agriculture labour. The table 7.4 below can be referred to find the proportions of all the primary and secondary occupations of the respondent.

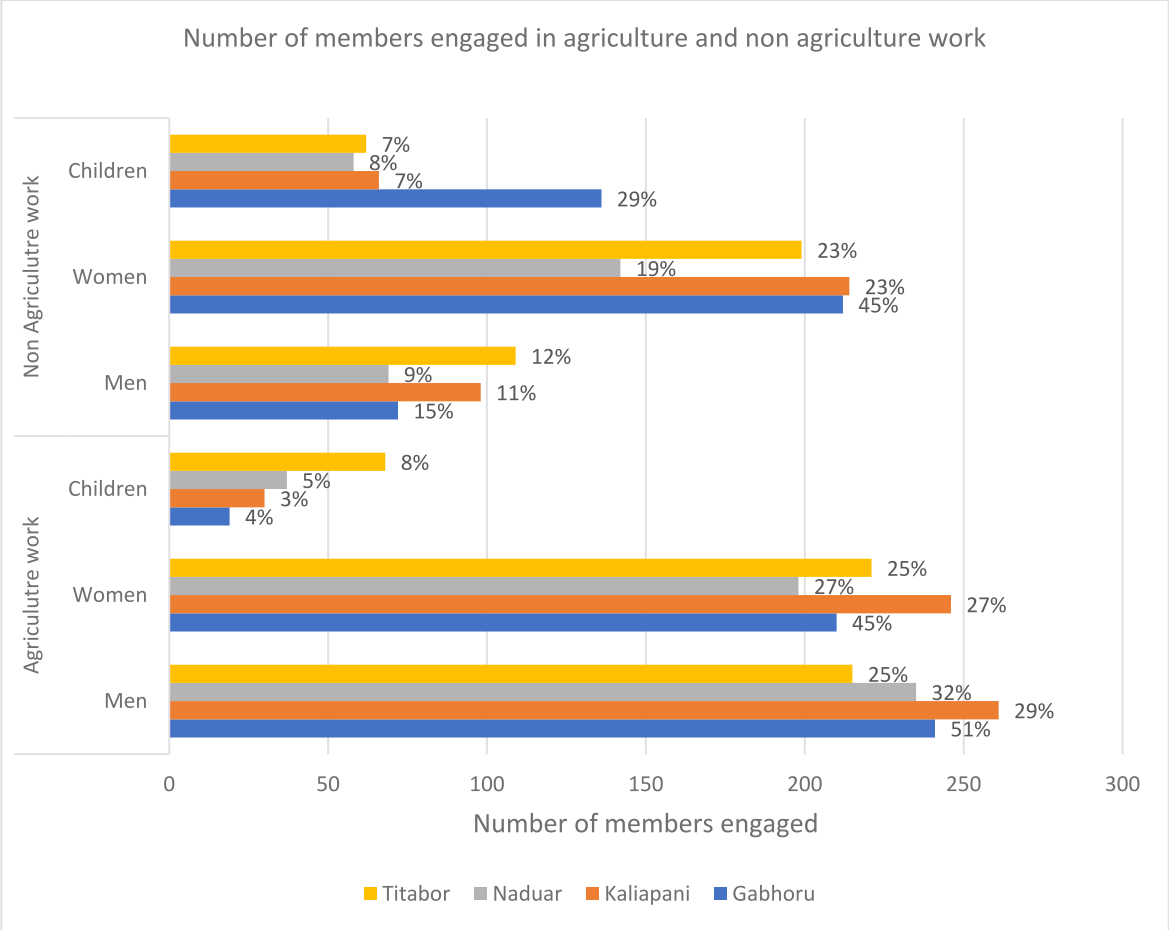
Table 7. 4: Proportion of households having agriculture and non-agriculture sources of income as primary and secondary occupation

District	Jorhat				Sonitpur			
Block	Titabor		Kaliapani		NADUAR		Gabharu	
Occupation	Primary	Secondary	Primary	Secondary	Primary	Secondary	Primary	Secondary
Agriculture	92.62%	9.17%	65.10%	2.76%	100.00%	4.03%	100.00%	0.00%
Dairy	0.00%	45.83%	30.87%	9.66%	0.00%	60.40%	0.00%	100.00%
Daily Agri Labour	0.00%	25.00%	0.00%	51.72%	0.00%	0.00%	0.00%	0.00%

District	Jorhat				Sonitpur			
Block	**Titabor**		**Kaliapani**		**NADUAR**		**Gabharu**	
Occupation	**Primary**	**Secondary**	**Primary**	**Secondary**	**Primary**	**Secondary**	**Primary**	**Secondary**
Daily Non Agri Labour	0.00%	0.00%	1.34%	13.10%	0.00%	21.48%	0.00%	0.00%
Self employed	0.00%	5.00%	0.67%	11.03%	0.00%	0.00%	0.00%	0.00%
Salaried work	6.71%	0.00%	0.00%	4.14%	0.00%	0.00%	0.00%	0.00%
Pension	0.67%	0.00%	2.01%	1.38%	0.00%	0.00%	0.00%	0.00%
No secondary occupation	0.00%	15.00%	0.00%	4.83%	0.00%	0.00%	0.00%	0.00%
Others	0.00%	0.00%	0.00%	1.38%	0.00%	0.00%	0.00%	0.00%

Women involvement in agriculture is similar to men with 48% men and 44% women engaged. But in non-agriculture activities, women are highly engaged with 53% engagement and only 24% men are engaged. Children have higher proportion of 22% in non-agriculture work as compared to 8% in agriculture work. Figure 7.12 shows that proportion of family member (men, women, children) engaged in agriculture and non-agriculture work across the four blocks.

Figure 7.12: Number of members engaged in agriculture and non-agriculture work

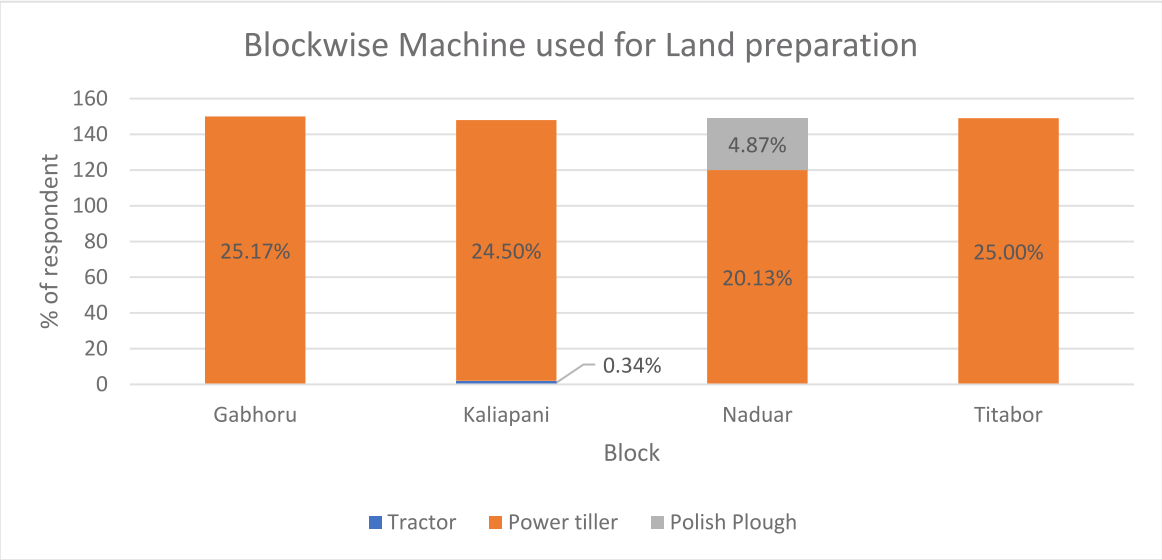


Section 3: Machine usage, skill gap and labour dynamics in state

Machine Usage for Agriculture Operations

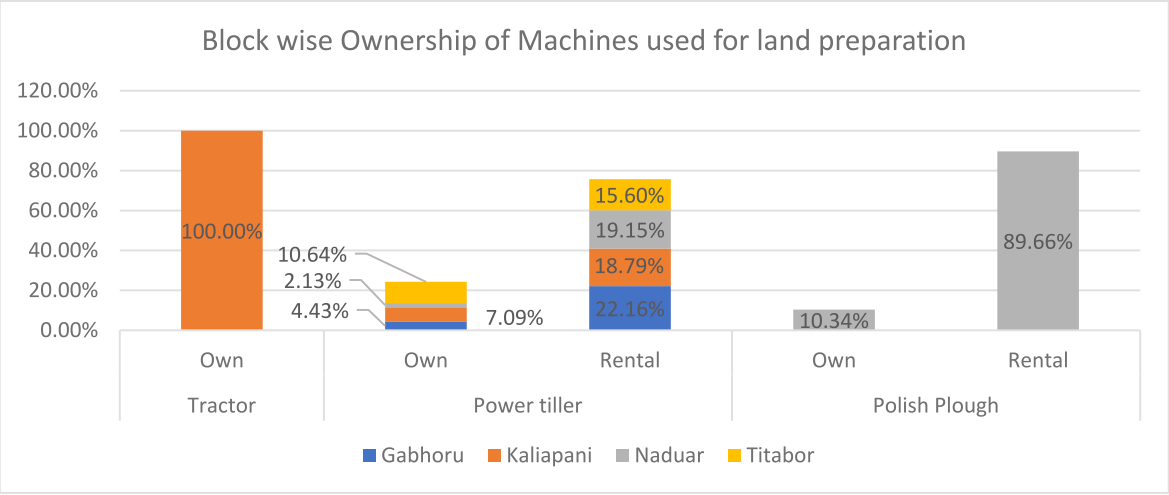
Out of 597 respondents across all the blocks in Assam, only 0.34% used tractors and the users are only present in Kaliapani block. Power tiller has largest user base for land operation and it is spread across all the block with 25.17%, 24.50%, 20.13% and 25% respondents using it for land preparation in Gabharu, Kaliapani, Naduar and Titabor block. Polish plough is only used in Naduar block and only 4.87% respondent use it. These ploughs are operated using Animal power.

Figure 7.13: Block wise machine used for land preparation



Ownership of machines is limited in the state and majority of machines are rented. For power tillers, only 24.29% respondent own it and 75.71% take it on rentals. None of the respondents covered under the survey rented a tractor. Majority of respondents, 89.66% rented the polish plough and only 10.34% respondent owned it. The rentals are generally taken from other farmers.

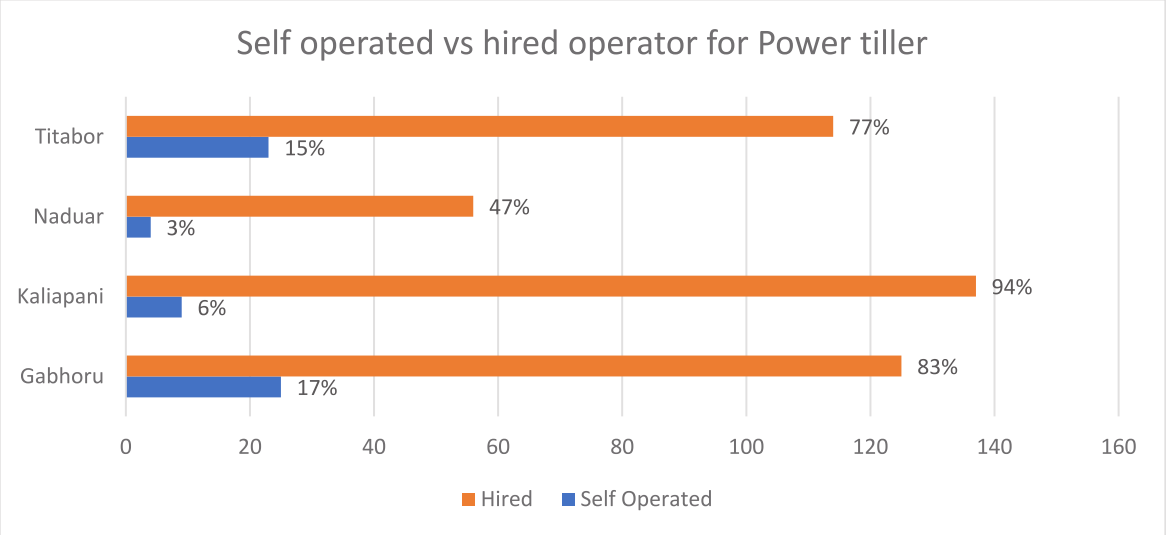
Figure 7.14: Block wise ownership of machines used for land preparation



Out of 427 respondents who rent the power tiller, 95% rented it from other farmers. All the respondent who rented polish plough, rent it from other farmers. There were no responses captured for renting from FPC/FPO/cooperative/CHC/FMB/Agri/Centre/KVKS/other institutes. The rental charges were found to be affordable by all the respondents who rented the machines. Also, the response captured for availability of the machines confirmed that the machines were available when required for the operations.

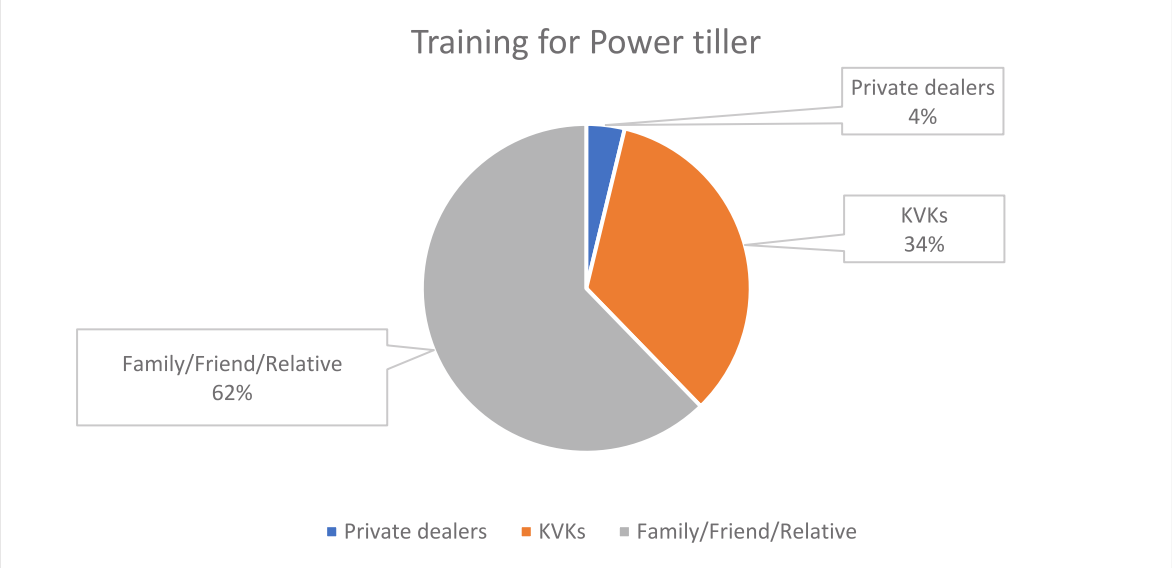
It's been 7 years for the usage of power tiller among the sample. Major proportion of farmers i.e., 22% have established their ownership of power tiller for 2 years and 12% respondent for 3 years. The 9 hp power tillers are most popular with 44% respondent ownership followed by 50 HP with 20% ownership and 15.4 hp with 10% ownership. The range of power tiller varies from 9 Hp to 50. There is huge variation in power of power tillers used across the blocks of both the Sonitpur and Jorhat Districts. The average power of power tiller is 44.61 hp and 47.63 hp in Gabharu and Naduar block of Sonitpur. The average power of power tiller is 16.13 hp and 13.17 hp in Kaliapani and Titabor block of Jorhat. The average cost of rental for per bigha operation with power tiller are Rs 968, Rs 935, Rs 545 and Rs 600 in Gabharu, Naduar, Kaliapani and Titabor respectively.

Figure 7.15: Self operated vs hired operator for power tiller



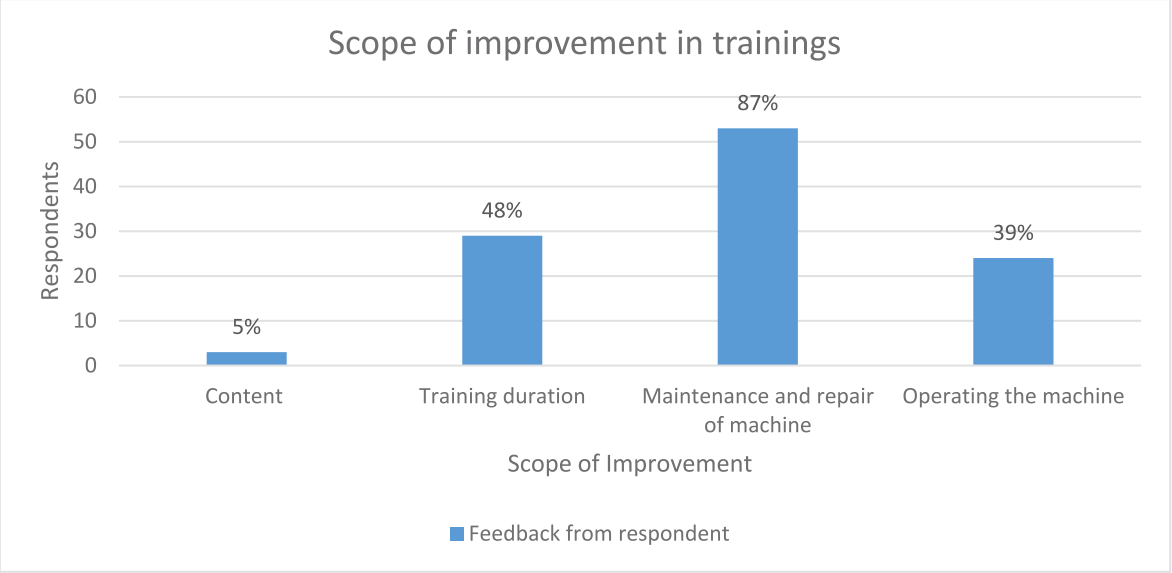
Out of 564 household using power tillers for land preparation operations, only 11% operate the power tillers by their own and 76% hire operators. Only in Gabharu block, all the owners were operating the power tiller by self. In rest blocks, even the owners of power tiller were hiring operators.

Figure 7.16: Training for power tiller



In Gabharu block which has highest operators, all have learnt power tiller operations from family/friend / relatives. They haven't undertaken any formal training. Similar is the case with Naduar block. In Titabor, KVKs have trained a significant proportion of operators (75% of the operator's Titabor). It indicates a strong intervention from KVKs which has enhanced the operator number in the blocks. The survey captured the scope of improvement in any kind of training by the operators and the responses are depicted in the figure 7.12. Major proportion (87% of the respondents wanted a focus on training for maintenance and repair of machine, 48% respondent wanted shorter duration of trainings, 39% respondent required a focus of training on operating the machines and only 5% indicated change in content of training.

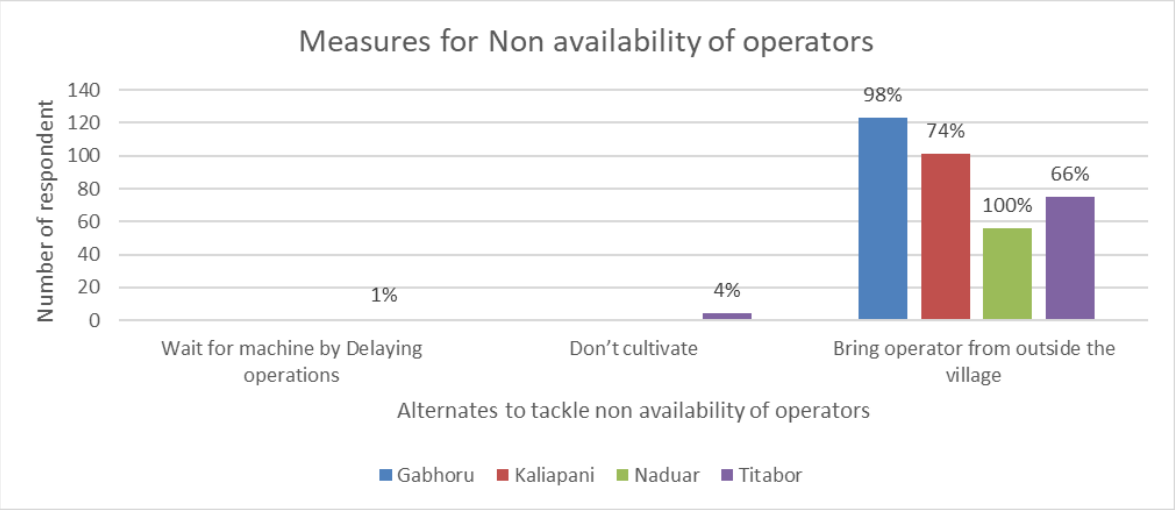
Figure 7.17: Scope of improvement in trainings



Power tiller operators are hired by 432 respondents and only 12.5% respondents have confirmed easy availability of the operators. Rest 82.18% have indicated that due to non-availability of the operators, they bring the operator from outside the village, 0.93% responded that their cultivation operations are hindered and there is slight possibility of not cultivation

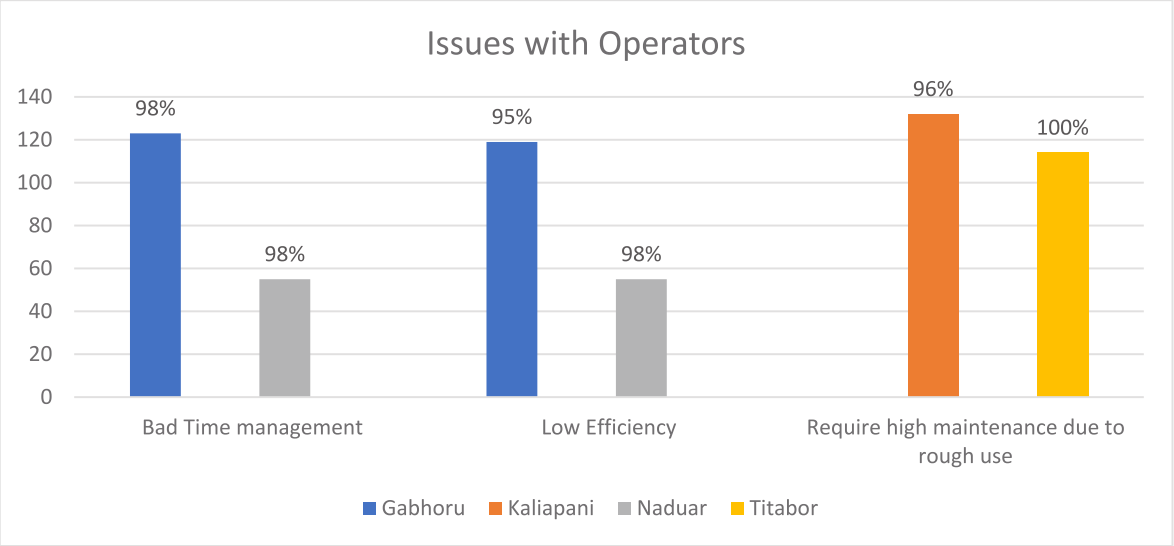
and 0.23% reported that their agriculture operations get delayed as they wait for operators. This is a challenge where machines are available but shortage of operators becomes an issue. A collaborative effort with KVKs can be deployed in the blocks which have been facing these issues. This gap was found highest in Gabharu block with 98% respondent stating that the operators are to be called from other villages followed by Kaliapani, Titabor and Naduar. The wages for men operator are in range of Rs 300 to Rs 600 with average of Rs 456 per day. The average wage in Naduar and Gabharu block is Rs 500 and Rs 439 and Rs 405 in Kaliapania and Titabor block respectively.

Figure 7.18: Alternates adopted by households to tackle non availability of operators



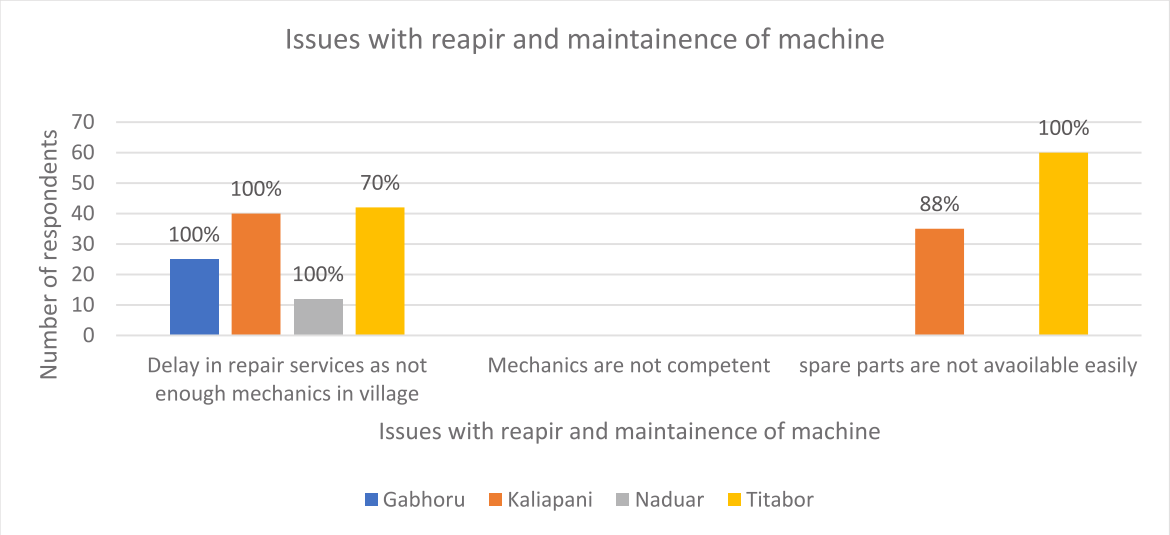
Out of total responses from 432 respondents who hire operators, 57% across all blocks have faced issues about incurring high maintenance cost as operators use the power tillers roughly, 40% indicated low efficiency of operators and 41% indicated their lack of time management. In Titabor block, 100% respondent faced high maintenance cost due to rough usage, followed by 98% in Kaliapani block. Gabharu block had 95% respondents facing low efficiency and 98% facing lack of time management among the hired operators. In Naduar bloc, 98% respondents face low efficiency and lack of time management issues.

Figure 7.19: Issues with operators



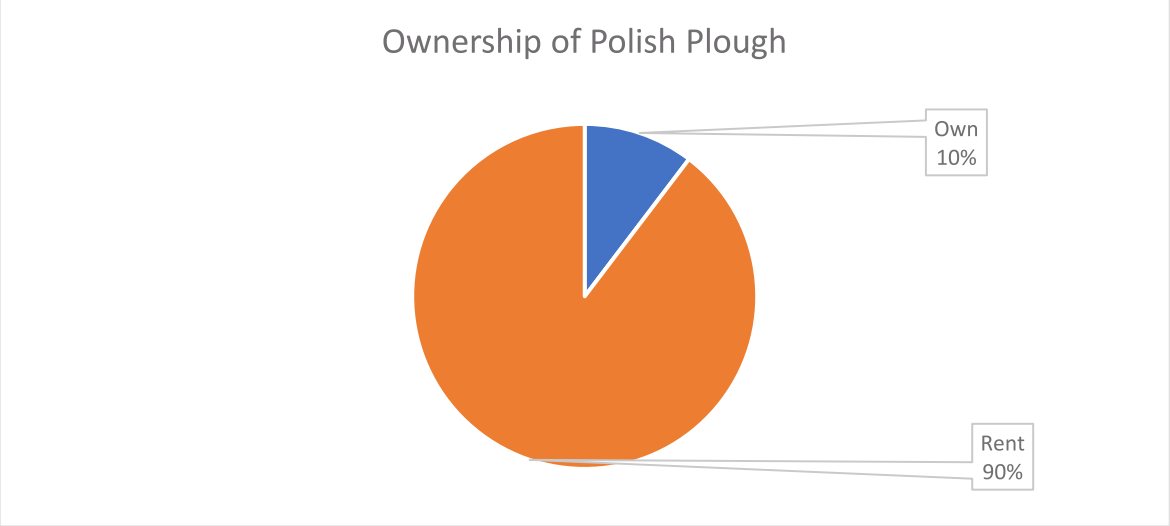
Out of 137, 97% of the respondent found the manual useful. Only 14% of the respondent undertook regular maintenance on fixed intervals and 82% got repair and maintenance when there is breakdown in power tiller. All the respondents state shortage of spare parts of the power tillers. On an average, power tiller breakdown occurs 1-2 times in 6 months. The proportion of respondents who visit mechanic at block and district level is 85%. Only 13% of the respondent get it repaired at the village mechanic. only 1% of the respondent get it repaired by their neighbour or relative and for another 1% there is no option for mechanic available. The respondent has found the mechanics competent but 87% respondent faced delay in repair services as enough mechanics are not present in the villages.

Figure 7.20: Issues with repair and maintenance of machine



Polish plough is animal driven. Their prevalence is found only in Naduar block with only 10% respondent owning the plough and 90% renting it out. All the owners of the polish plough bought it from the dealer in the city. Kamco and Sonalika brand of Polish plough brands are prevalent. All the respondent rented the polish plough from other farmers with rental charges of Rs 1200 per bhigha which is considered affordable. The cost of operations using the polish plough sums up to Rs 1800 per bhigha. The owners operate the plough by themselves and have received the training from Krishi Vigyan Kendra. They stated that the duration of the training can be shortened. Also, they found the manual which came along with the equipment useful. They carry regular maintenance on fixed intervals which is a positive indication for life of the equipment and efficiency. There are fewer breakdowns in the equipment i.e., once in 6 months. For any kind of repair and maintenance service, mechanic at the village level can be approached. Usually, the problem is faced in the availability of the spare parts. Owners of plough are willing to adapt to any suggestive innovative methods of improving the efficiency performances and life span of machine.

Figure 7.21: Ownership of polish plough



All the owners of the tractors hire operators and their availability becomes tricky. They have to arrange operators from outside the village as well and per day charges are Rs 460. Though work of operators is satisfactorily but due to their rough use of machines, it requires higher maintenance. The manual with the tractor was found useful by all owners. They undertake miniatous only when there is breakdown in the machine. Undertaking regular maintenance on fixed intervals can increase the life of the tractor and its efficiency. They have faced breakdowns for 1-2 times in last 6 months. The repair of the tractors is done at block level and if required at district level. Major challenges faced during the repair is the availability of the spare parts and delay in repair services as not enough mechanics in village. Owners of tractors are willing to adapt to any suggestive innovative methods of improving the efficiency performances and life span of machine.

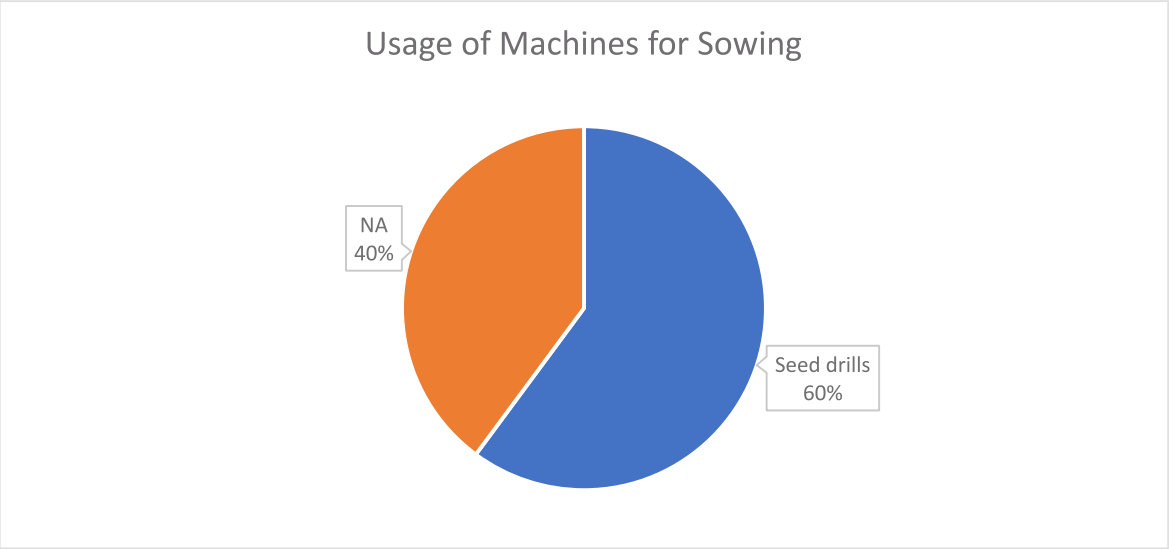
Tractor owners in the Kaliapani block hired the operators. In case of non-availability of the operators in the village, they preferred to get the operators from other villages. This would ensure that their operations are not delayed and avoids hiring of manual labour. Even though the tractor users and owners are negligible in the sample collected, their experience with hire operators have been same as they report that there is rough usage and hence tractor high maintenance. The operator charges for tractors are Rs 460 per day. The owners have read the manual which came along with the tractor. Also, the owners et their tractors repaired only when there is a break down. This gives a scope to provide information to them about benefits of regular maintenance of their tractors at fixed intervals. This will increase the life of tractor and improves its efficiency. Also, all the owners are willing to adopt suggestive innovative methods of improving efficiency performances and life span of their tractors. Usually, the breakdown occurs 1 or twice in 6 months. For getting the tractors repaired, there is no access to mechanics at village level resulting in delay in repair services. Owners have to resort to mechanics in block level or strict level. Also, spare parts are not easily available. There is a gap in availability of mechanics and providing training to self-repair the tractors would be highly feasible. As the spread of tractors is very limited ad hence this small number can be catered through specialised training to the owners themselves.

Sowing:

In Assam, 60% of the respondents used seed drills for sowing. Among the non-users of any machines, 50% of them reported that unavailability of repair facilities has been one of the

reasons of non-usage. From the users, 75% respondent owned the seed drills and 6% rented it from other farmers. There was no other source of renting identified as it was case in other states. The rental charges for seed drill are Rs 750 per bhigha and is considered to be affordable by all the respondents. The machine is mostly available when required. In case of non-availability, machine is arranged from outside the village. Interestingly, all the users of seed drill hired operators for its operations. The operator worked was found satisfactorily but then there were issues about their lack of time management. Shortage of mechanics and delay in services were often faced by the owners of the seed drills. All the respondent were interested in taking training for adopting innovative methods to increase the efficiency and performance of the machine.

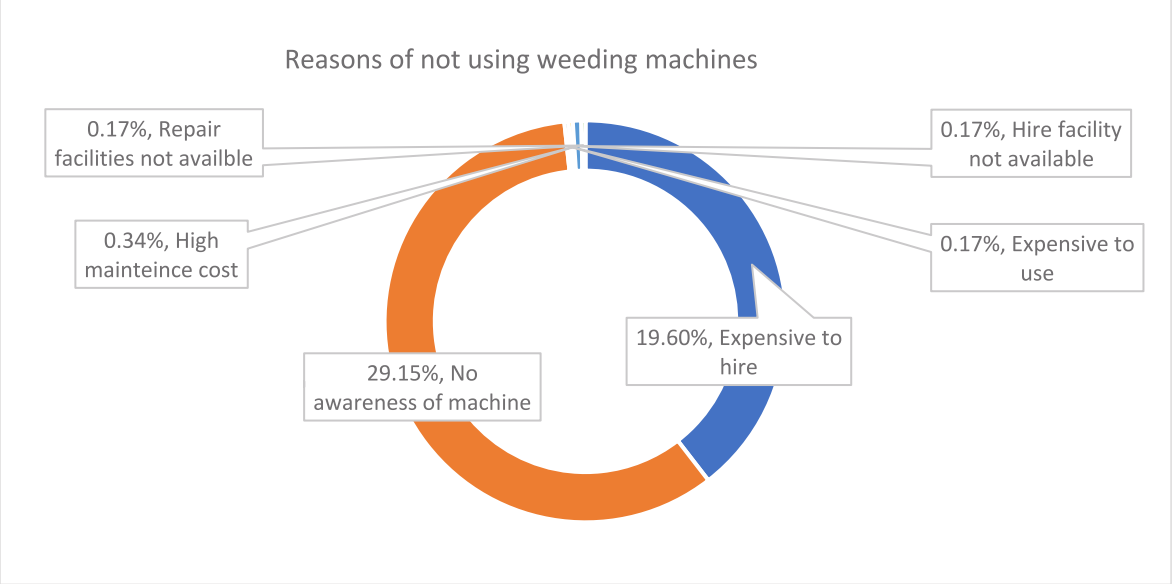
Figure 7.22: Usage of machines for sowing



Weeding:

No machine/tools/ equipment were used for weeding operations. Major reasons were found to be related to affordability and awareness. 29.15% respondent said that there was no awareness about such machines, 19.06% mentioned that hiring machines is expensive. Other reasons where machines are expensive to use, repair facilities are not available, high maintenance cost is involved and hiring facilities are also absent.

Figure 7.23: Reasons of not using weeding machines



The major reasons of not using any machine/equipment for weeding is given in figure 7.19. Majority of respondent, 29.15% stated lack of awareness of weeding machines as a reason of not using machines. The second ranked reason being expensive to hire (19.60%). High maintenance cost was reported by 0.34% respondent and 0.17% respondent reported absence of repair and hire facilities and affordability issues.

Spraying, Irrigation, Harvesting and Threshing have found no usage of machines in the given sample which is surveyed.

Section 4: Access to extension services

From 597 respondent, 99.7% own bank account and only 0.8 % did not own it. For Kisan credit card, only 21 % respondent own it and 78 % did not. Out of the total 597 respondents, 54% had visited government departments for information or subsidy, 1% respondent stated no and 45% didn't response for the question. From the responses, only 52% responded for their frequency of meeting with the extension officers. A high proportion of 50% respondent met the extension agents 12 time a year, which indicates meeting every month. Rest 20% respondent met extension officers only once. only 54% responses were captured from the total households or capturing the visit of Krishi Vigyan Kendra or another related institute. A large proportion of 88%have visited KVK and only 12% didn't. This indicates a close linkage with KVK.

Table 7.5: Impacts of using machines in agriculture operations

Impacts of using machines in agriculture operations	Impacts reported by respondent (%)		
	Increase	No change	Decrease
Time use	0%	56%	44%
Cost of cultivation	20%	60%	20%
Productivity	40%	60%	0%
Income diversification	35%	65%	0%

Impacts of using machines in agriculture operations	Impacts reported by respondent (%)		
	Increase	No change	Decrease
Education level	58%	42%	0%
Health status	45%	55%	0%
Food expenditure	20%	80%	0%
Demand of agriculture labour	20%	52%	28%
Demand of non – agriculture labour	29%	55%	15%
Overall Income	35%	65%	0%
Agriculture wages	35%	65%	0%
Migration from rural to urban places	30%	65%	5%
Youth in agriculture	50%	50%	0%

With 597 households engaged in agriculture operations, responses were captured for households' perception on the impact of machines on various aspects. The impacts considered for analysis are: time use, cost of cultivation, productivity, income diversification, education level, health status, food expenditures, demand of agriculture labour, demand of non-agriculture labour, overall income, agricultural wages, migration from rural to urban places, youth in agriculture. About 99.4 % household have given their responses for the impact observed with the use of machines. Table 7.5 indicates the percentage of respondent who observed any increase/ decrease/ no change in the given impacts. Highest increase has been reported under educational level followed by youth in agriculture with 58% and 50% respondents. Rest of the impacts have witnessed increment by less than half of the respondents. The percentages are indicated in the table 7.5. Interestingly, high number of reported impacts haven't seen any changes by majority of the respondent (>50%). The percentages are coloured in green where there are >50% of respondents.

Section 5: Women adoption of machinery and labour-saving technology

Engagement of women in agricultural operations was captured and it was found that 94.47% household have at least one women member participating in the operations. Out of these, 68.26% household have engagement of 1 women member, 22.7% household have engagement of 2 women members, whereas only 4.08% household engages no women member at all.

This section examines the women's access to agriculture information and extension services. Age split of the women respondent is as given in the table 7.6. majority of women are in the age group of 46-50 years, followed by 41-45 years.

Table 7.6: Proportion of women engaged in agriculture in a household

Number of women engaged in households	% of households with given engagement of women in agriculture
0	4.08%
1	68.26%
2	22.70%
3	2.66%
4	1.60%

Number of women engaged in households	% of households with given engagement of women in agriculture
5	0.71%

Table 7.7: Age wise proportion of women

Age	% of women respondent
20-25	1%
26-30	7%
31-35	6%
36-40	11%
41-45	14%
46-50	38%
51-55	12%
56-60	10%

Assam has less coverage of machineries and it is more limited for women. All these operations by women respondents were performed without any usage of machines/tools. They perform all the options manually. Under the study, various reasons were explored for women not using the machines for performing various agriculture operations. Majority of women respondents, 95% reported that they don't use the machine as there are safety issues while using the machines and 89 % respondent pointed out that women might not be able to operate. Out of the total women respondent, 89% women didn't know how to operate the machines and 84% women avoided the machine use to avoid any damage as machines are expensive. The table 7.8 summarizes all the reasons for non-usage of machines by women.

Table 7.8: Reasons for not using any machines for agriculture operations

Reasons for not using any machines for agriculture operations	% of women respondent
Safety issues and risk	95%
Women might not be able to operate	89%
Do not know how to operate	89%
Machines being expensive	84%

Majority of the women don't use machines and no women in the respondent participated in the decision to buy machines. This keeps women out of any discussion regarding machines and their utility. Also, they are restricted to raise opinion about their preferences of machines or operations where they might require technical help. Also, operating machines is trickier for women and hence trainings are important. While exploring women preferences for training, it was found that out of the responses recorded for whether women would like to receive training for how to use the machine at ease, how to operate it for full efficiency, basic repair, maintenance etc, 89% women wanted to receive any related training and 11% did not respond to the question. This shows a higher inclination of women in Assam for receiving training. A large proportion of women, 84% were willing to devote 2 hours for a training program and 5% were willing to give 1 hour. A high proportion ow women, 89% are willing to travel outside the village to attend such programs. The above figures indicate a very high inclination of women to learn new technology and receive information. Time scarcity of women and

mobility is not hindering their opportunities to learn and get trained. Women do acknowledge the benefits of using the machines. They are aware of the changes which have been observed with machine usage.

Table 7.9: Changes observed by women due to machine usage in agriculture

Changes due to machine usage	Increase	No change	Decrease
Amount of time spent on a task	-	1%	99%
Task easier to perform	78%	22%	0%
Change in Yield of produce	61%	39%	
Change in area under cultivated land	16%	81%	2%
Change in efficiency of work	56%	42%	2%

The table 7.9 shows 78 % women responded that machine use increases the ease of performing task. With 99% women respondent reported decrease in the amount of time spent on the tasks, 56% said increased efficiency in work. Around 61% women found that using the machine increases the yield of produce, 39% said no change in the production yields. For change in area under cultivation, 16% women reported increase in the area but 81% also reported no change in the area with machine usage. With much awareness about use of machines and its impact, women are still lagging in its usage and adoption.

Table 7.10: Sources of Information of women respondent

Sources of Information	% women respondent receiving information from these sources
Gram Sevak	89%
Government outlet	84%
KVK	78%
Social media	78%
Kisan mitra	73%
Government agency	68%
Family member	6%
Community members	1%

Women in Assam have higher access to sources of information. Their access was captured from the given list of sources: community members, family member, KVK, government agency, Media (Radio/TV/newspaper), Kisan Mitra, Gram Sevak, government outlets, social media, NGO and Private shops. Also, from table 7.10, where women are active in agriculture in the state, they also have access to extension agents. There is no barrier observed with male or female extension agents for dissemination of information among women. With 94% of women confirming their meet with extension agents, they have also visited KVK and are willing to attend any training programs which are organised in village. A small percentage (6%) women are not willing for these trainings sue to their non- interest.

Section 6: Labour saving technology

The interview captured women perception of labour-saving technology by showing digital videos to women who were involved in agriculture operations on their own or others farm.

Total of 541 households had at least one woman engaged in agriculture operations. Two tools were presented: 1) Wheel hoe for weeding and 2) Rice transplanter.

Out of these women respondent, 59% women have seen the wheel hoe earlier and 39% didn't. The ones who have seen the tool, saw it at shop outside village (79%), video on mobile (67%) and shop in village (19%). The state engages high number of women in agriculture and hence, the tediousness of these operations was captured. Only 13% women found the agriculture activities as tedious and 68% didn't. Even then, 72% women were willing to adopt the labour-saving wheel hoe shown to them on the digital device. Only 7% were not sure of whether to adopt or not and 18% didn't wanted to adopt the tools.

Figure 7.24: Perceived benefits of labour-saving technology

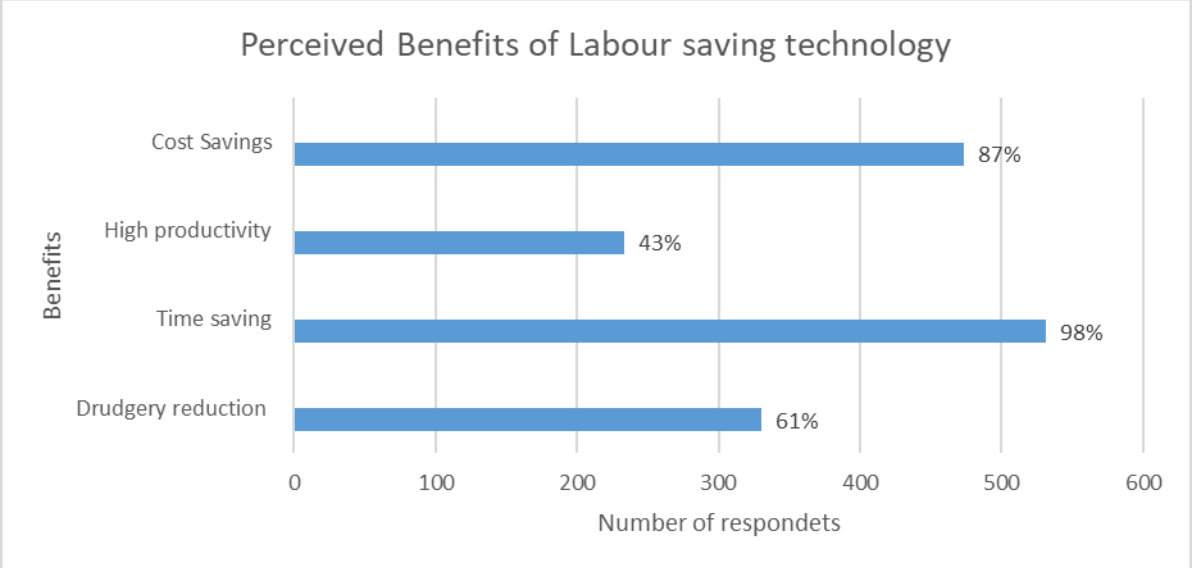


Figure 7.24 indicates the proportion of women who perceived the stated benefits of the labour-saving technology. Time saving was voted by highest number of women (98%) as one of the perceived benefits of the tool, followed by cost savings (87%), drudgery reductions (61%) and high productivity (43%). With so many perceived benefits, all women were willing to purchase both the tools from village and block level markets. It is found that 98% women were willing to by the tool if available at the village level and only 54% were willing to buy it when available at block level. This clearly indicates the access to the tool and inclination to buy. Availability of these tools at village level can create a positive adoption impact. As the availability got varied response, so is the affordability. The willingness to pay for the tool varied with 20% women willing to pay up to Rs 5000 but 78% women were willing to pay in price range of Rs500- Rs 2500. A lower pricing of the tool will help in widespread adoption. But pricing should not compromise on the quality as this may affect the efficiency of the tool.

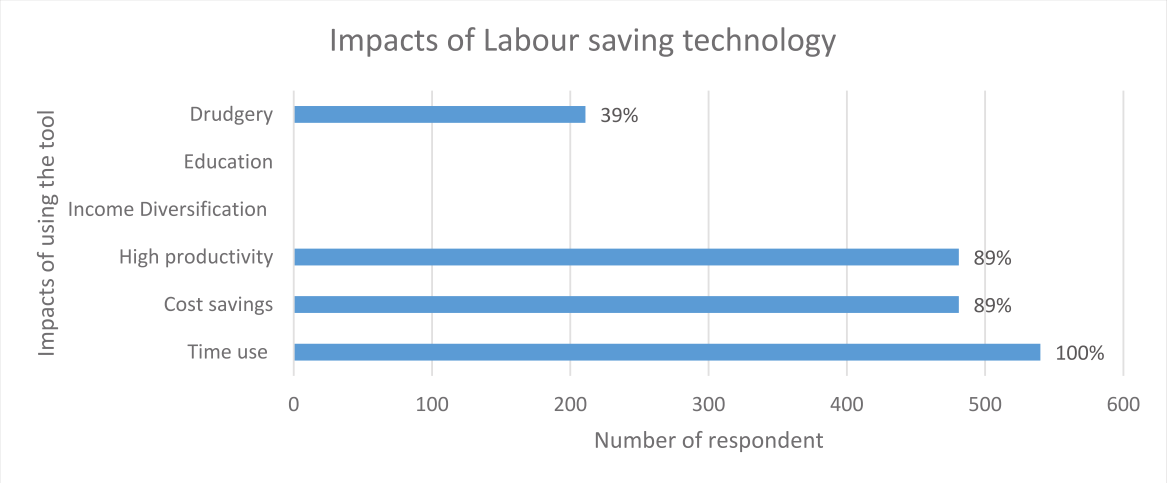
Image: Focus group discussion with women in Jorhat district, Assam

For perceived price of wheel hoe, women opted for multiple funding options like subsidy and own savings with 78% women opted for subsidy on the tool and only 21% relied their own savings for purchase. Tool ownership was preferred among the respondents with 78% denying to rent the tool. Only 22% respondents were comfortable taking the wheel on rent. Even though women showed a high inclination for labour saving technology, the decision to buy still is held by men of the household. Only 6% women had a decision to buy the tool, rest 94% were dependent on the men's decision. In case of denial of purchase from the men, only 25 women would buy it from their savings, 58% will try to convince the men head and 39% won't buy the tool at all.

Focus Group Discussion

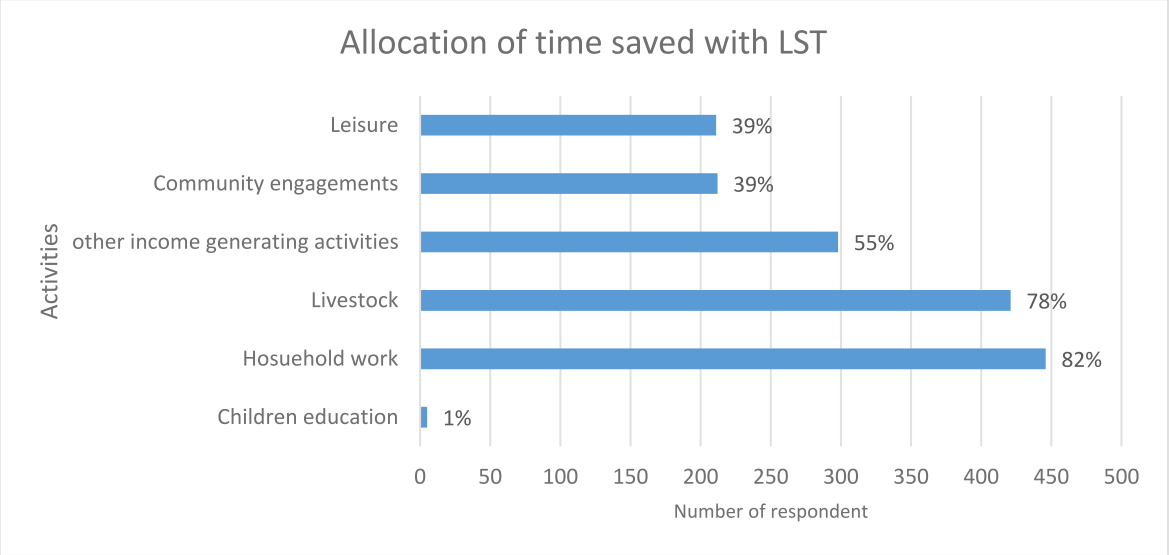
Women of Upper Deori village talked about their experience of drudgery in manual operations. They were curious of knowing about labour saving tools. The video of LSTs captured positive response. Women perceived that using the machines would result in quick completion of their task. They mentioned that this will help them save time where they can complete their household chores easily without rushing through. They were willing to purchase these tools but in consultation with their husbands.

Figure 7.25: Impacts of labour-saving technology



The women responses were captured for the perceived impacts of using the labour-saving technology. It was found that all the women agreed on the decrease in time use with these technologies and 89% women responses were indicating impacts on increase productivity and cost savings. Though, education and income diversification didn't capture any attention but 39% women responses indicated towards drudgery reduction with use of these tools.

Figure 7.26: Allocation of time in other activities with time savings from labour-saving technology



Dwelling deeper into time use patterns of women and how would they use the surplus time available after adoption of these labour-saving tool: Household work and livestock had major time allocations with 82% and 78% women splitting the saved time in these activities. Followed by other income generating activities, community engagement, leisure and children education opted by 55%, 39%, 39% and 1% women respectively.

Takeaways:

Major proportion (87% of the respondents wanted a focus on training for maintenance and repair of machine, 48% respondent wanted shorter duration of trainings, 39% respondent required a focus of training on operating the machines and only 5% indicated change in content of training. Power tiller operators are hired by 432 respondents and only 12.5% respondents have confirmed easy availability of the operators. Rest 82.18% have indicated that due to non-availability of the operators, they bring the operator from outside the village. Respondent stated that that their cultivation operations are hindered and there is slight possibility of not cultivating the land and some reported that their agriculture operations get delayed as they wait for operators. This is a challenge where machines are available but shortage of operators becomes an issue. A collaborative effort with KVKs can be deployed in the blocks which have been facing these issues. This gap was found highest in Gabharu block with 98% respondent stating that the operators are to be called from other villages followed by Kaliapani, Titabor and Naduar.

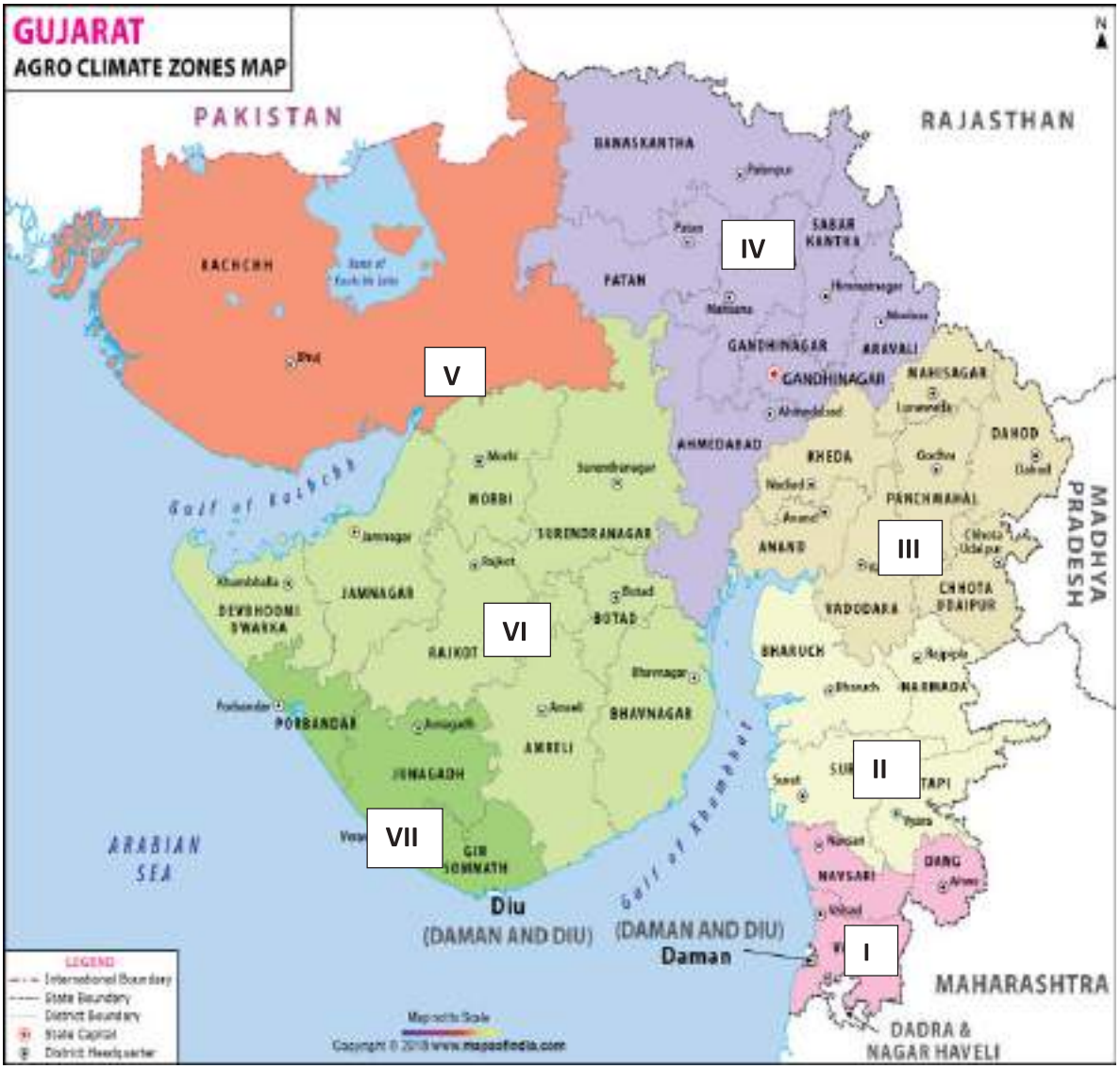
CHAPTER 8

MECHANIZATION STATUS AND ASSESSMENT OF SKILL GAP ACROSS GUJARAT

Section 1: State overview

Gujarat, which is on India's western coast, has the nation's longest coastline at 1,600 kilometres. With a population of 6.03 billion (4.9 percent of all Indians), the state now includes 33 districts, which spans 196,024 km2, is the fifth-largest Indian state in terms of area (75,685 sq mi) Gujarat's literacy rate has been increasing and now stands at 79.31%. Gujarat had the third-highest GDP in India in 2021–2022, valued at 18.9 lakh crore at current prices and the Gross State Value Added (GSVA) on crop sector alone at current prices stood at 16025419 lakh (2020-2021). With exports of US$126.8 billion in FY22, Gujarat was India's top exporting state. It also has the most installed renewable energy capacity (44.44 GW). Gujarat leads the nation's agriculture growth rankings with a CAGR of 10.7% during the previous ten years. In Gujarat, there are 196 lakh hectares of land that are cultivated, or around 65% of the total area. The state contains a large variety of soil types and seven different agroclimatic zones. With 10.1 MMT produced in 2010–11 compared to 5.6 MMT in 2009–10, the production of all food grains saw a significant increase. The state contributes 31% of the nation's cotton production, which is another major industry. 9.8 million bales of cotton were produced in 2010–11 compared to 7.4 million in 2009–10. By introducing various plans and training programmes, governments are attempting to increase the agriculture sector's dependability and profitability for farmers. For efficient planning of agricultural development Gujarat is divided into seven sub agro climatic zones- I. Southern Hills (Dangs, Valsad), II. Southern Gujarat, III. Middle Gujarat, IV. North Gujarat, V. North-West Arid, VI. North Saurashtra, and VII. South Saurashtra- based on different climatic factors. Gujarat is largely classified as megathermic, with a mean soil temperature of more than 28°C. The most important climatic factor is rainfall.

Gujarat is a leading producer of several crops such as cotton, groundnut, castor, cumin, and tobacco. The state is also a major producer of fruits and vegetables, such as mangoes, bananas, and onions. In recent years, the state has seen a significant increase in the production of horticulture crops, which have higher value and demand in the market The state has made significant progress in improving irrigation facilities in the state. Around 52% of the total cultivable area in the state is irrigated, with the government investing in building dams, canals, and other irrigation infrastructure. The state has also implemented the Sujalam Sufalam Jal Sanchay Abhiyan, which aims to conserve and recharge groundwater resources. It has also made progress in promoting organic farming in the state. The government has implemented several schemes to promote organic farming, such as the Paramparagat Krishi Vikas Yojana, which provides financial assistance to farmers for the adoption of organic farming practices. Like other states in India, Gujarat is also vulnerable to the effects of climate change, such as droughts, floods, and extreme weather events. The state government has implemented several measures to address the impacts of climate change, such as promoting water conservation, promoting drought-resistant crops, and improving the efficiency of irrigation systems. The state government has implemented several schemes to promote farm mechanization and modernization, as discussed in the previous question. These schemes have helped farmers to adopt modern agricultural practices and increase their productivity.



Farm Power availability in Gujarat

In 2018, Ministry of Agriculture & Farmers Welfare (Department of Agriculture, Cooperation & Farmers Welfare, Mechanization and Technology division published a report 'Monitoring, Concurrent Evaluation and Impact Assessment of Sub-Mission on Agricultural Mechanization' which states that the average farm power availability in the state increased from 2.252 kW/ha (2014) to 2.565 kW/ha by 2016-17. It registered a 13.9 % increase in three years due to the result of implementation of SMAM. The farm power availability in the state is 27 % more than the national average i.e., 2.025 kW/ha (2016-17). The district-wise farm power availability (2016-17) in the state is graded as given below:

Table 8.1: Farm Power Availability in Gujarat

Name of the District	Farm Power Availability (kW/ha)	Legend
Ahmedabad	3.230	
Amreli	1.530	
Anand	0.727	
Banas Kantha	2.950	
Bharuch	1.668	
Bhavnagar	2.608	
Dohad	2.016	
Gandhinagar	1.646	
Jamnagar	2.005	
Junagadh	3.252	FPA more than 2.03 kW/ha
Kachchh	1.518	FPA between 1.00 to 2.03 kW/ha
Kheda	7.405	FPA less than 1.00 kW/ha
Mahesna	5.423	
Navasari	1.478	
Patan	0.552	
Porbandar	1.448	
Rajkot	2.304	
Sabar Katha	4.599	
Surat	2.487	
Surendranagar	1.736	
Vadodara	2.188	
Valsad	3.597	
Average	2.565	

Source: *Mechanization & Technology Division, Ministry of Agriculture & Farmers Welfare*

There are 111 government Agricultural schemes in Gujarat where the major schemes focusing on farm mechanization are as follows:

AGR-50 Assistance to Farmers purchasing heavy farm equipment

Farm Mechanization AGR-2

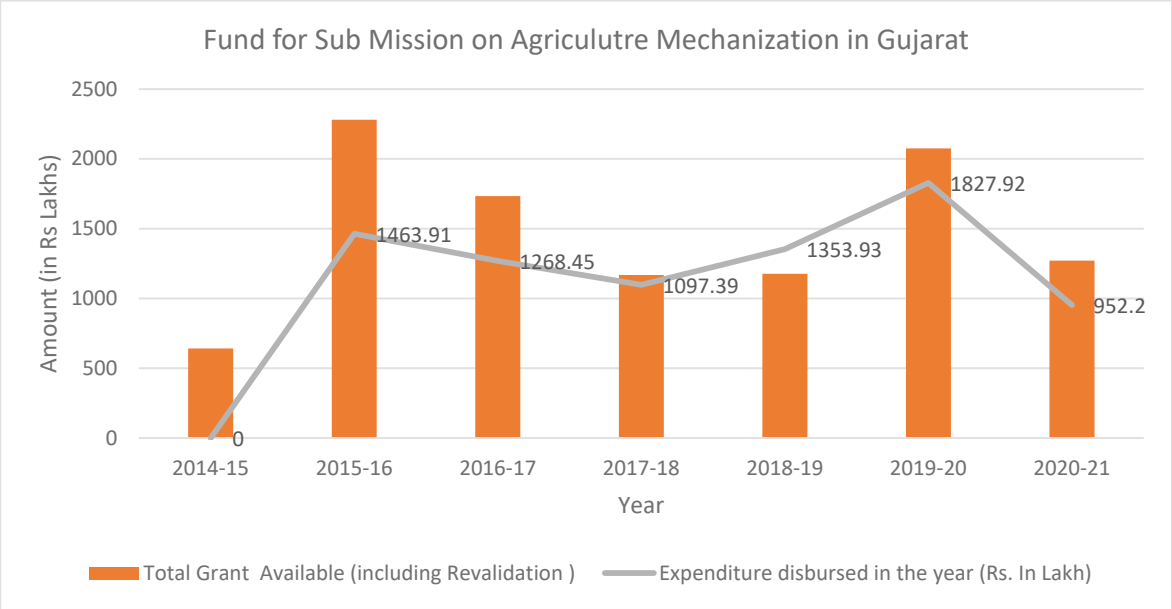
Farm Mechanization AGR-3

Farm Mechanization AGR-4

Increase agriculture profit through use of farm mechanization by establish agro service provider unit

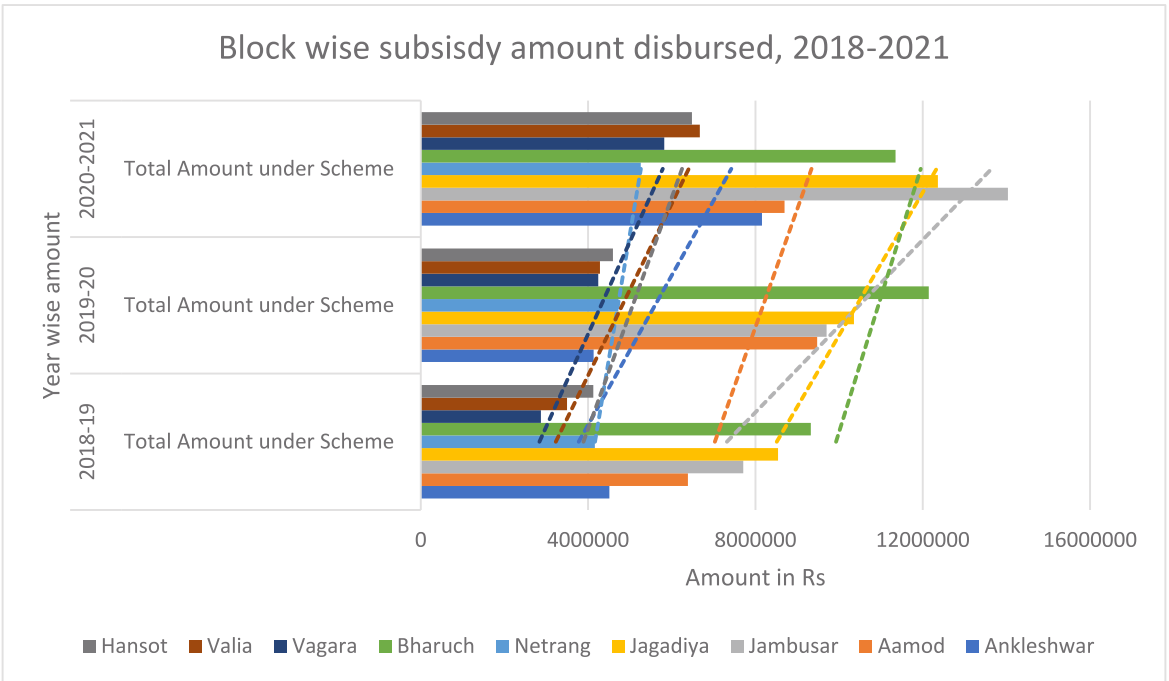
Sub Mission on Agriculture Mechanization SMAM

Figure 8.1: Funds for Sub Mission on Agriculture Mechanization in Gujarat



Source: *Directorate of Agriculture, Gujarat*

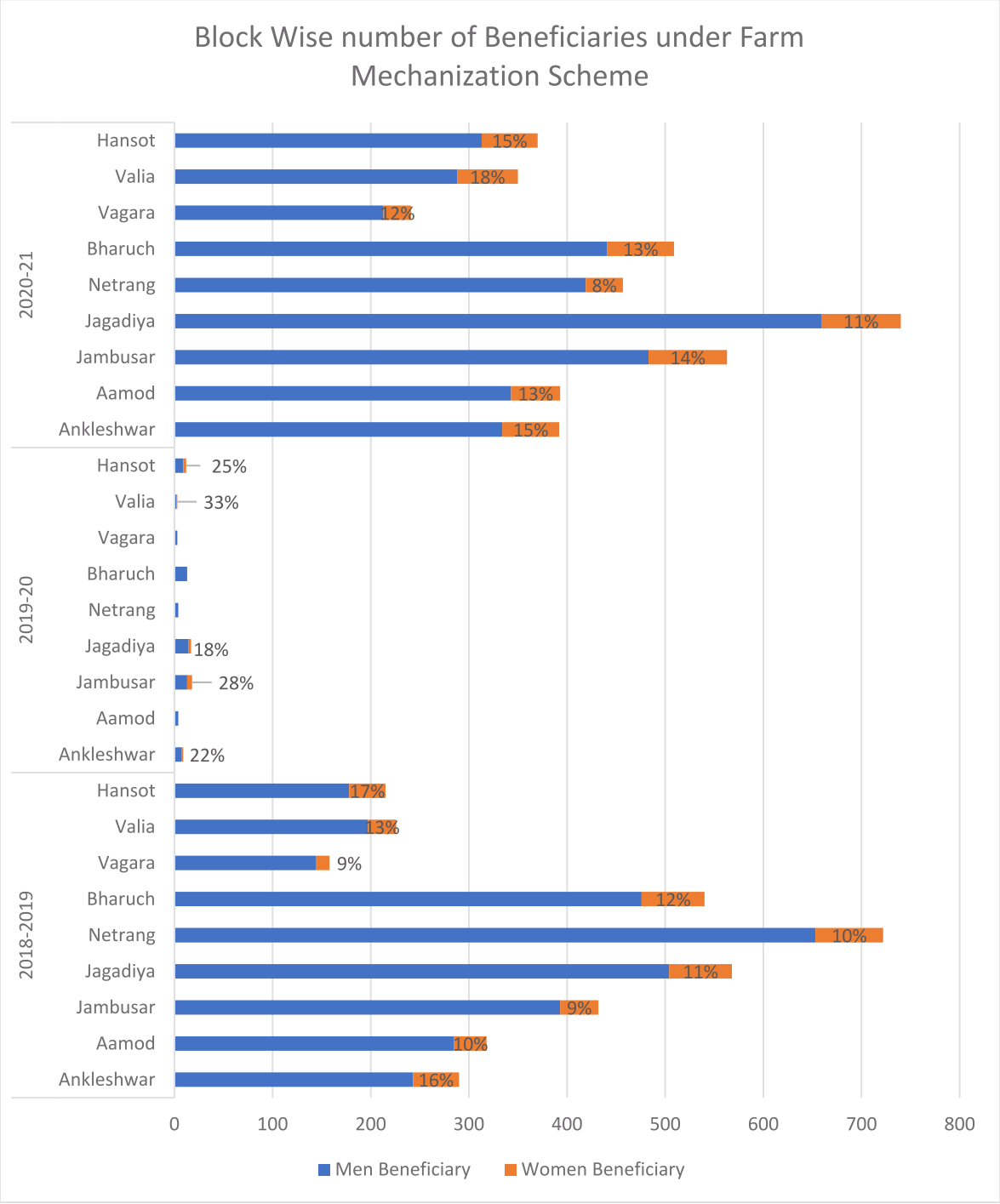
Figure 8.2: Block wise subsidy amount disbursed in Bharuch district, 2018-2021



Source: *District Development office, Bharuch*

The above graph shows that amount of subsidy disbursed across various blocks of Bharuch district. It is observed that the number of beneficiaries in year 2019-2020 is less than in year 2018-19 and 2020-21. But the amount of subsidy disbursed is higher than the previous year.

Figure 8.3: Block wise number of beneficiaries under farm mechanization scheme in Bharuch District



Source: *District Development office, Bharuch*

The above graph gives a split of men and women beneficiaries across the block of Bharuch district from year 2018-21. The data is received from District development office and comprises of the number of subsidies disbursed over the year in all the blocks of Bharuch district. It also gives number of men and women beneficiaries. It is observed that in year 2018-19 and 2020-21, the percent of women beneficiary is less than 20%. Only are some blocks, in year 2019-20, percent of women is higher than 20%.

Section 2: Village and household profiling from primary data

This chapter describes the socio-economic background of the households surveyed across four blocks in Gujarat. Socio-economic profile indicates information on the average age, education qualification, caste, gender, occupation, family size, members involved in agriculture and non-agriculture work.

Socio-economic characteristics of sampled households

Table 8.2: List of the all the villages in which the survey was conducted in different blocks of Gujarat.

District	Bharuch		Sabarkantha	
Block	Bharuch	Valia	Himmatnagar	Talod
Village	Amleshwar	Gundia	Berna	Faujiwada
	Dabhali	Haripar	Hansalpur	Gulabpura
	Haldar	Kara	Jambudi	Modhuka
	Nikora	Mela	Kadoli	Ranasan
	Tralsi	Pathar	Rupal	Sagpur

Table 8.2 shows the list of the all the villages in which the survey was conducted in different blocks of Gujarat.

Table 8.3: Category of households covered under the survey

District		Bharuch		Sabarkantha		Total	
Category	Land size	Bharuch	Valia	Himmatnagar	Talod	Household covered for each category in the state	% Household covered for each category in the state
Landless	0	20	9	0	4	33	6%
Marginal	Less than 2.5 Acres	10	11	10	24	55	9%
Small	2.5 -5 Acres	18	20	28	27	93	16%
Semi Medium	5 - 10 Acres	27	35	38	30	130	22%
Medium	10 - 25 Acres	48	53	66	48	215	36%
Large	25 Acre and above	27	22	8	17	74	12%

The households have been classified into six categories i.e., landless, marginal (less than 2.5 acre), small (2.5-5 acres), semi medium (5-10 acres), medium (10-25 acre) and large (25 acre and above). The details of the household related to the categories have been provided in the table 8.3. The number of the household surveyed in each block is 150 including all the six categories. Majority of the respondents in lies in the age group range of 40 to 49 and 50 to 59. Together this groups constitutes 50.60% of the total respondents followed by age group 60 to 69 and 30 to 39.

Figure 8.4: District wise age of the respondent

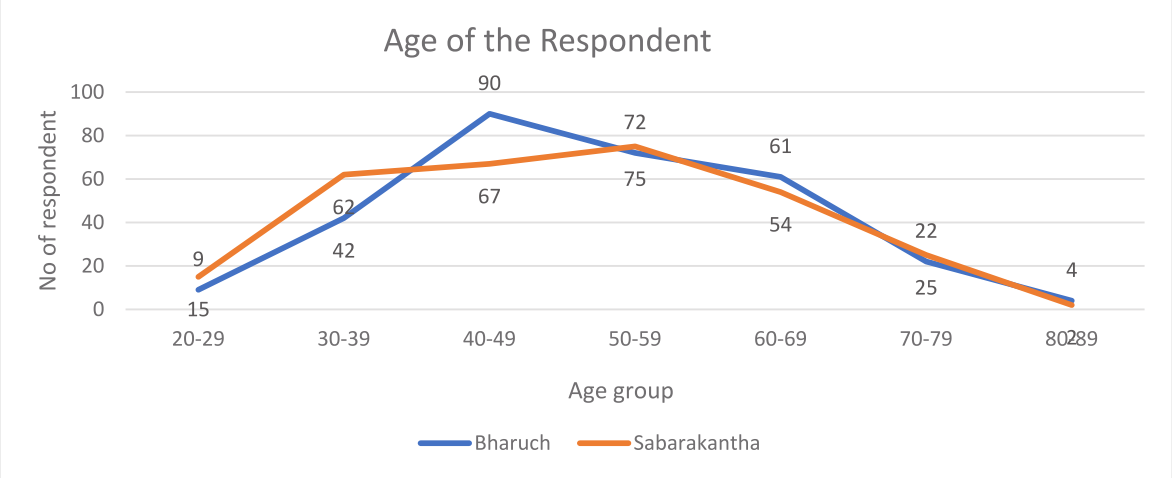


Table 8.4: Family demography and engagement in work in Gujarat

	Landless	Marginal Landowner (up to 2.5 Acre)	Small Landowner (2.5-5 Acre)	Semi Medium Landowner (5-10 Acre)	Medium Landowner (10-25 Acre)	Large Landowner (above 25 Acre)
Average Age of respondent	46.69	48.75	48.47	49.96	52.55	51.8
Average no of total family members	5	5.33	4.97	5.23	5.68	5.9
Average no of children (0-5 years)	0.53	0.47	0.48	0.38	0.42	0.34
Average no of children (6-14 years)	0.35	0.76	0.53	0.62	0.66	0.74
Average no of Adult Male	2.12	2.16	1.95	2.16	2.38	2.34
Average no of adult females	2.18	1.93	2.01	2.1	2.23	2.48
Average no of Male in agriculture	1.36	1.55	1.36	1.5	1.41	1.32
Average no of females in agriculture	0.85	1	0.88	0.67	0.52	0.19
Average no of Children in agriculture	0	0.04	0	0.007	0	0
Average no of Male in non-agriculture	0.85	0.38	0.36	0.36	0.31	0.48
Average no of females in non-agriculture	0.58	0.13	0.18	0.19	0.7	0.08

	Landless	Marginal Landowner (up to 2.5 Acre)	Small Landowner (2.5-5 Acre)	Semi Medium Landowner (5-10 Acre)	Medium Landowner (10-25 Acre)	Large Landowner (above 25 Acre)
Average no of children in non-agriculture	0	0	0	0	0	0

Table 8.4 indicates the family profile of the households. We can infer that the average age of all the respondent in six group of land ownership classification range from 46.69 to 52.55. Households with larger land holdings also have higher average age indicating that older people stay back home and continue to engage in agriculture activities. The average family size was highest in large landowners followed by medium landowner, marginal landowner, semi medium landowner and landless respectively. The lowest average family size is of small landowner households. Female participation in agriculture declines with increase in land size and the gap between average number of male and female in agriculture increases with land size.

Table 8.5: Demography detailed of family members in each category of household

		Bharuch		Sabarkantha	
		Bharuch	Valia	Himmatnagar	Talod
Landless	Average Age	44.25	54	0	42.5
	Average number of total family members	4.65	5.67	0	5.25
	Average number of children (0-5 years)	0.4	0.78	0	0.25
	Average number of children (6-14 years)	0.55	0.56	0	0.75
	Average number of Adult Male	2.15	2	0	2.25
	Average number of adult females	1.6	2.33	0	2.75
	Average number of Male in agriculture	1.55	1.11	0	1
	Average number of females in agriculture	0.9	0.89	0	0.5
	Average number of Children in agriculture	0	0	0	0
	Average number of Male in non-agriculture	0.9	1.11	0	0
	Average number of females in non-agriculture	0.55	0.89	0	0
	Average number of children in non-agriculture	0	0	0	0

		Bharuch		Sabarkantha	
		Bharuch	**Valia**	**Himmatnagar**	**Talod**
Marginal Landowner (up to 2.5)	Average Age	49.4	43.91	55.6	47.83
	Average number of total family members	5.7	4.64	5.2	5.54
	Average number of children (0-5 years)	0.5	0.09	0.7	0.54
	Average number of children (6-14 years)	0.9	0.82	0.5	0.79
	Average number of Adult Male	2.5	1.73	2.1	2.25
	Average number of adult females	1.8	2	1.9	1.96
	Average number of Male in agriculture	1.7	1.36	1.4	1.625
	Average number of females in agriculture	1.2	1.1	1	0.88
	Average number of Children in agriculture	0	0.18	0	0
	Average number of Male in non-agriculture	0.4	0.45	0.3	0.38
	Average number of females in non-agriculture	0.1	0.27	0	0.12
	Average number of children in non-agriculture	0	0	0	0
Small Landowner (2.5-5 Acre)	Average Age	51.33	50.95	49.78	43.37
	Average number of total family members	5.44	4.6	4.07	5.85
	Average number of children (0-5 years)	0.44	0.5	0.14	0.85
	Average number of children (6-14 years)	0.67	0.2	0.54	0.67
	Average number of Adult Male	2	2.15	1.64	2.07
	Average number of adult females	2.33	1.75	1.75	2.26
	Average number of Male in agriculture	1.39	1.6	1.18	1.37
	Average number of females in agriculture	0.67	0.95	0.54	1.33
	Average number of Children in agriculture	0	0	0	0
	Average number of Male in non-agriculture	0.39	0.5	0.25	0.37
	Average number of females in non-agriculture	0.33	0.35	0.11	0.04
	Average number of children in non-agriculture	0	0	0	0

		Bharuch		Sabarkantha	
		Bharuch	**Valia**	**Himmatnagar**	**Talod**
Semi Medium Landowner (5-10 Acre)	Average Age	55.52	48.48	49.86	46.8
	Average number of total family members	4.81	5.4	4.71	6.06
	Average number of children (0-5 years)	0.07	0.48	0.29	0.63
	Average number of children (6-14 years)	0.55	0.74	0.42	0.8
	Average number of Adult Male	2.07	2.03	2.16	2.4
	Average number of adult females	2.11	2.26	1.84	2.23
	Average number of Male in agriculture	1.37	1.57	1.29	1.83
	Average number of females in agriculture	0.52	0.63	0.5	1.06
	Average number of Children in agriculture	0	0	0.02	0
	Average number of Male in non-agriculture	0.37	0.63	0.18	0.26
	Average number of females in non-agriculture	0.18	0.37	0.02	0.2
	Average number of children in non-agriculture	0	0	0	0
Medium Landowner (10-25 Acre)	Average Age	53.75	50.49	52.36	49.85
	Average number of total family members	4.73	6.22	5.74	5.79
	Average number of children (0-5 years)	0.29	0.42	0.41	0.5
	Average number of children (6-14 years)	0.29	1.07	0.71	0.71
	Average number of Adult Male	2.23	2.51	2.39	2.23
	Average number of adult females	1.96	2.28	2.22	2.35
	Average number of Male in agriculture	1.33	1.64	1.38	1.39
	Average number of females in agriculture	0.48	0.74	0.47	0.66
	Average number of Children in agriculture	0	0	0	0
	Average number of Male in non-agriculture	0.35	0.42	0.28	0.23
	Average number of females in non-agriculture	0.06	0.22	0.06	0.1
	Average number of children in non-agriculture	0	0	0	0

		Bharuch		Sabarkantha	
		Bharuch	Valia	Himmatnagar	Talod
Large Landowner (25 Acre & above)	Average Age	49.55	50.91	59.62	52.88
	Average number of total family members	5.44	5.68	6.62	6.59
	Average number of children (0-5 years)	0.37	0.27	0.12	0.47
	Average number of children (6-14 years)	0.59	1	0.62	0.7
	Average number of Adult Male	2.26	2.04	2.62	2.7
	Average number of adult females	2.22	2.36	3.25	2.7
	Average number of Male in agriculture	1.41	1.18	1.5	1.29
	Average number of females in agriculture	0.11	0.23	0.5	0.12
	Average number of Children in agriculture	0	0	0	0
	Average number of Male in non-agriculture	0.3	0.45	0.75	0.7
	Average number of females in non-agriculture	0.07	0	0.38	0.06
	Average number of children in non-agriculture	0	0	0	0

All the respondents owned the house that they are living in. Major source of lighting at home is electricity whereas it is diesel/petrol pump set for agriculture land LPG is used as the major cooking fuel. Himmatnagar block has the highest number of respondents using smart phone followed by Bharuch, Talod and Valia with 86%, 80%, 75% and 69% respectively.

Figure 8.5: Block wise main source of energy

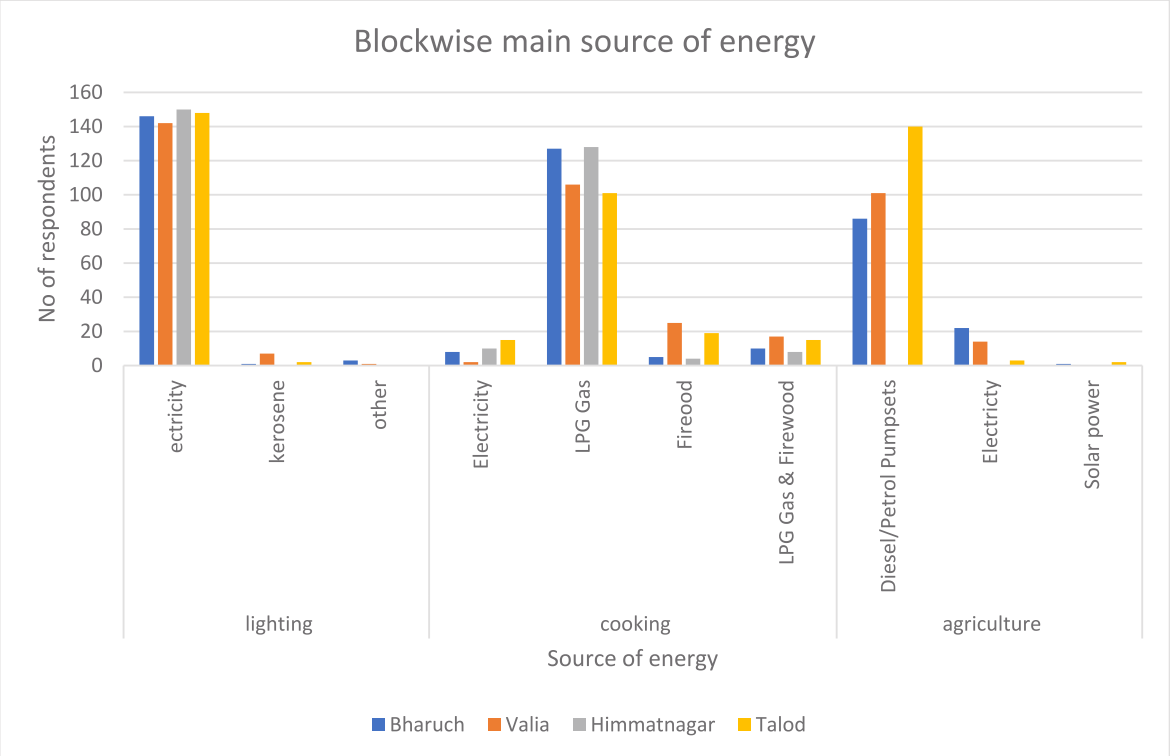


Figure 8.6: Block wise usage of smart phone

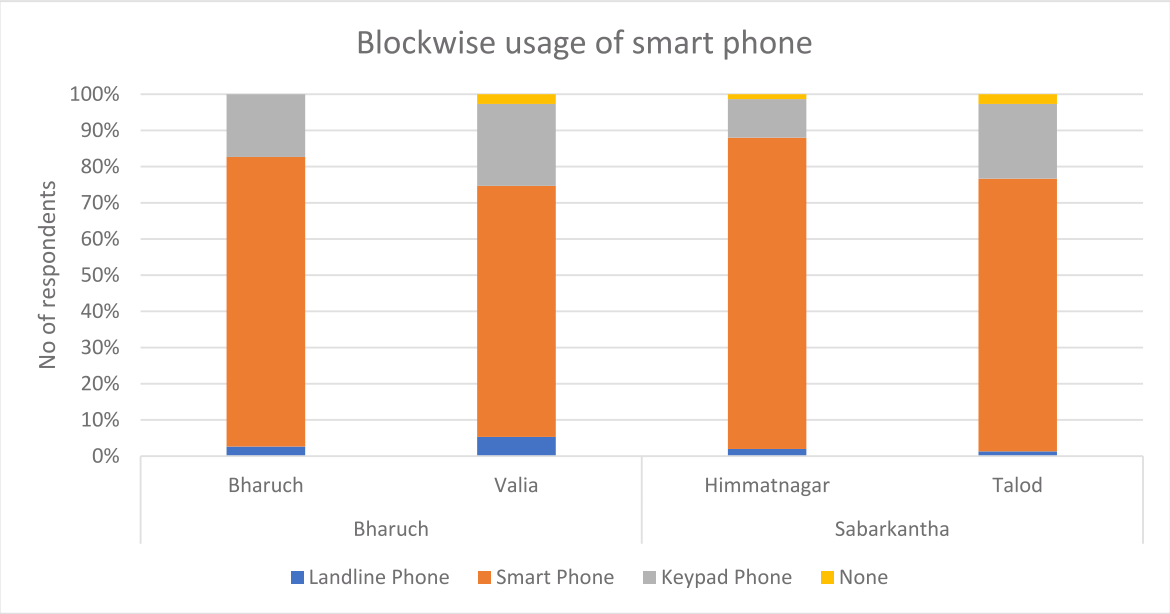


Figure 8.7: Block wise occupation of households

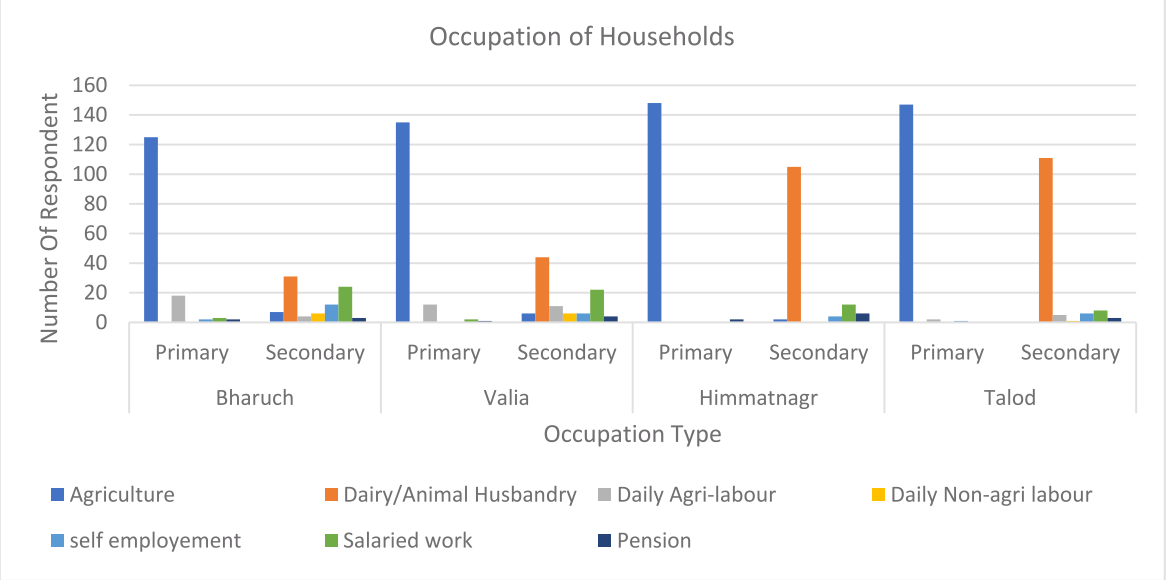


Figure 8.7 gives a sense of the proportion of households having agriculture and non-agriculture sources of income as primary and secondary occupation. As per results it seems that the highest percentage of respondent have agriculture as their primary occupation (99% of respondent in Himmatnagar, 98% in Talod, 90% in Valia and 83% in Bharuch) whereas daily agriculture labour is second most opted primary occupation engaging 12%, 8% and 1% respondents in Bharuch, Valia and Talod respectively. Out of all respondents 25.16% have no secondary occupation. Dairy/ animal husbandry is the most opted secondary occupation in all four blocks with 74%, 70%, 29% and 21% of respondents from Talod, Himmatnagar, Valia and Bharuch opted it followed by Salaried work. The table 8.6 below can be referred to find the proportions of all the primary and secondary occupations of the respondent.

Table 8.6: Primary and secondary occupation

	Bharuch		Valia		Himmatnagar		Talod	
Occupation	**Primary**	**Secondary**	**Primary**	**Secondary**	**Primary**	**Secondary**	**Primary**	**Secondary**
Agriculture	83%	5%	90%	4%	99%	1%	98%	0%
Dairy/Animal Husbandry	0%	21%	0%	29%	0%	70%	0%	74%
Daily Agri-labour	12%	3%	8%	7%	0%	0%	1%	3%
Daily Non-agri labour	0%	4%	0%	4%	0%	0%	0%	1%
Self-employment	1%	8%	0%	4%	0%	3%	1%	4%
Salaried work	2%	16%	1%	15%	0%	8%	0%	5%
Pension	1%	2%	1%	3%	1%	4%	0%	2%
No occupation	0%	42%	0%	34%	0%	14%	0%	11%

Figure 8.8: Engagement in agricultural operations

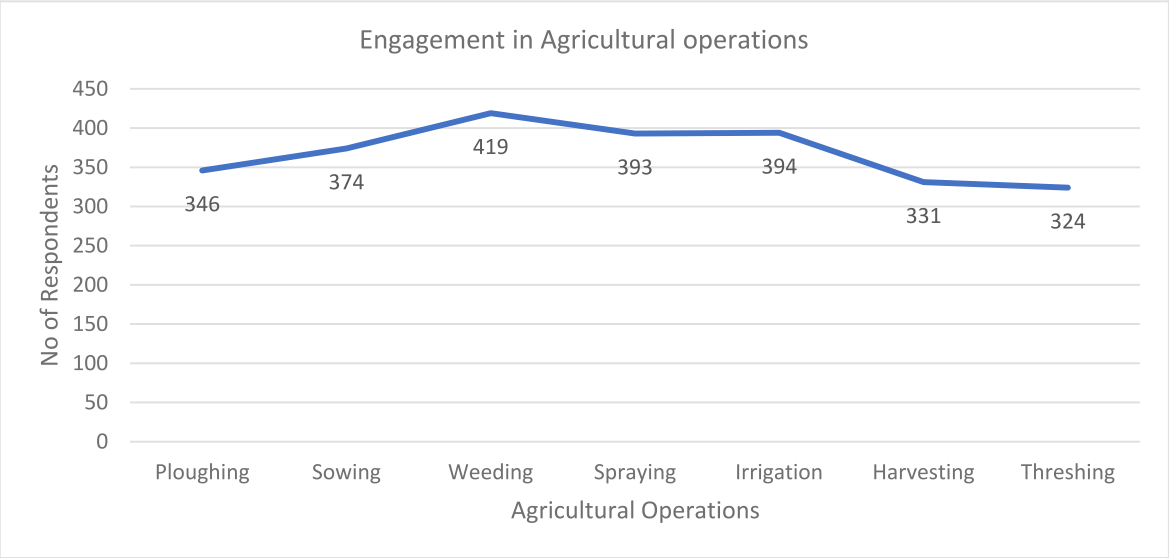
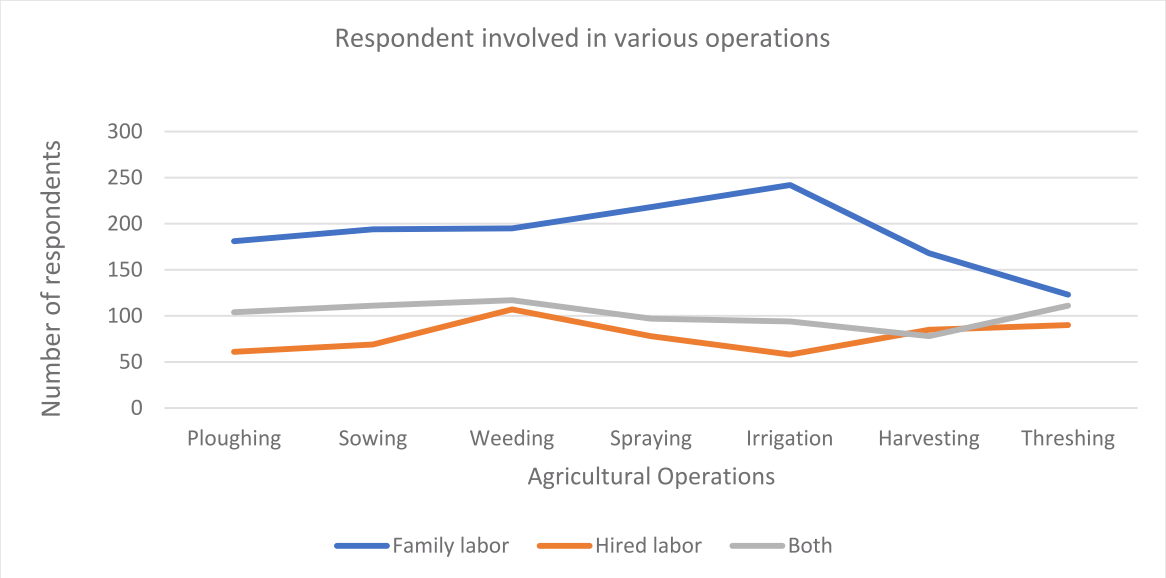


Figure 8.9: Respondent involved in various operations



The figure 8.8 shows number of people engaged in various agriculture operations: 70% of the respondents are engaged in weeding, 66% are involved spraying and irrigation 58% are in ploughing 55% of them in harvesting and 54% of them in threshing. It is evident from the figure 8.9 that majority of the respondents are working in their own land in all seven agricultural operations surveyed and it is highest in irrigation with 61% of the respondents prefer to irrigate their own fields themselves.

Table 8.7: Engagement of family and hired labour in agriculture operations

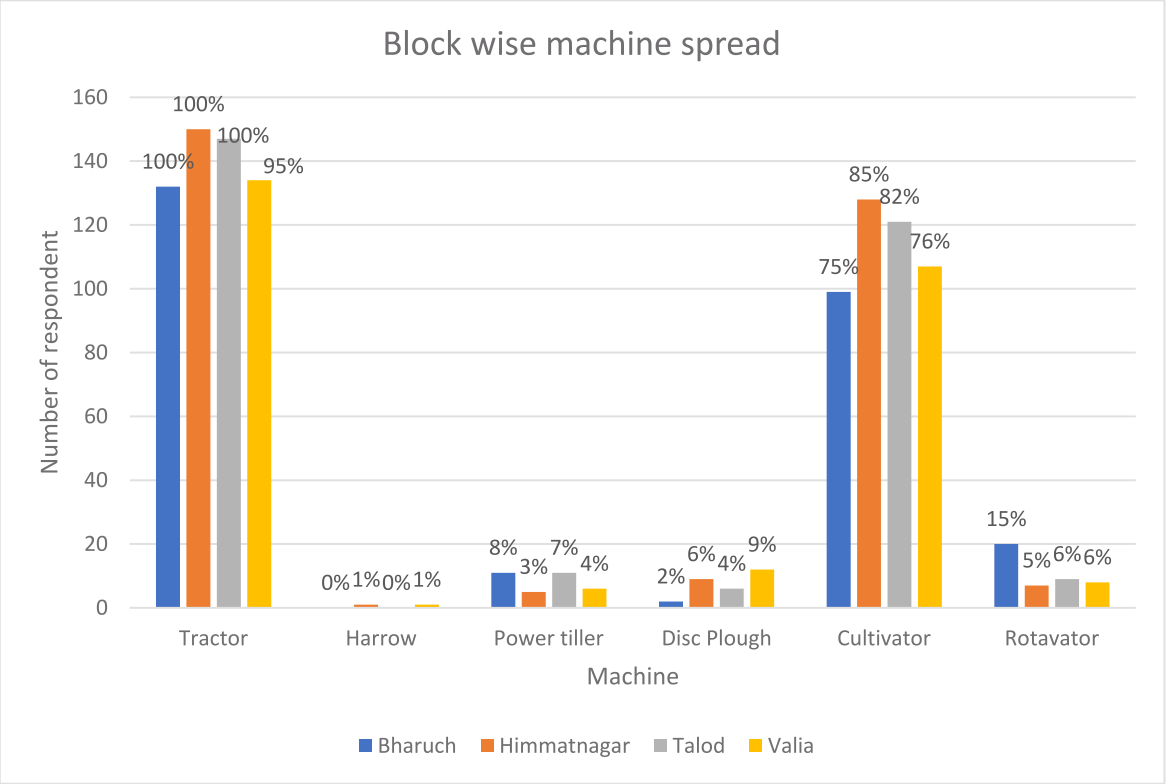
	Family labour	Hired labour	Both	Grand Total
Ploughing	181	61	104	346
	52%	18%	30%	
Sowing	194	69	111	374
	52%	18%	30%	
Weeding	195	107	117	419
	47%	26%	28%	
Spraying	218	78	97	393
	55%	20%	25%	
Irrigation	242	58	94	394
	61%	15%	24%	
Harvesting	168	85	78	331
	51%	26%	24%	
Threshing	123	90	111	324
	38%	28%	34%	

The table 8.7 shows the proportion of respondent involved in various agricultural activities as family labour, hired labour or as both. Hired labour is higher in threshing, harvesting and weeding with 28%, 26% and 26% respectively. Compare to other agricultural activities threshing has highest hired labour (28%) and higher both family labour and hired labour involvement. Weeding is another hired labour-intensive operation along with harvesting. This can be mostly due to the nature of agricultural operations. Weeding, harvesting and threshing are labour intensive if mechanisation is not practiced and these has to be done in particular day after sowing. Doing late weeding affect the productivity, late or early harvesting affect the quality of the product. Thus, this leads to hire the labour to complete the operations within the particular time.

Section 3: Machine and labour dynamics in state

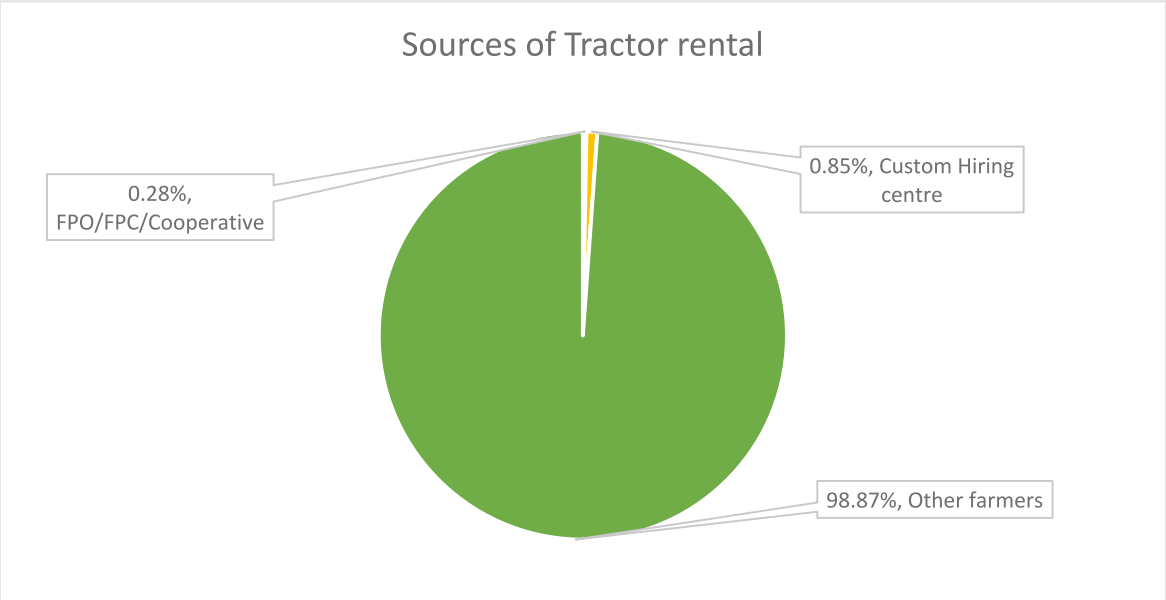
Machine Usage for Agriculture operations

Figure 8.10: Block wise machine spread for land preparation



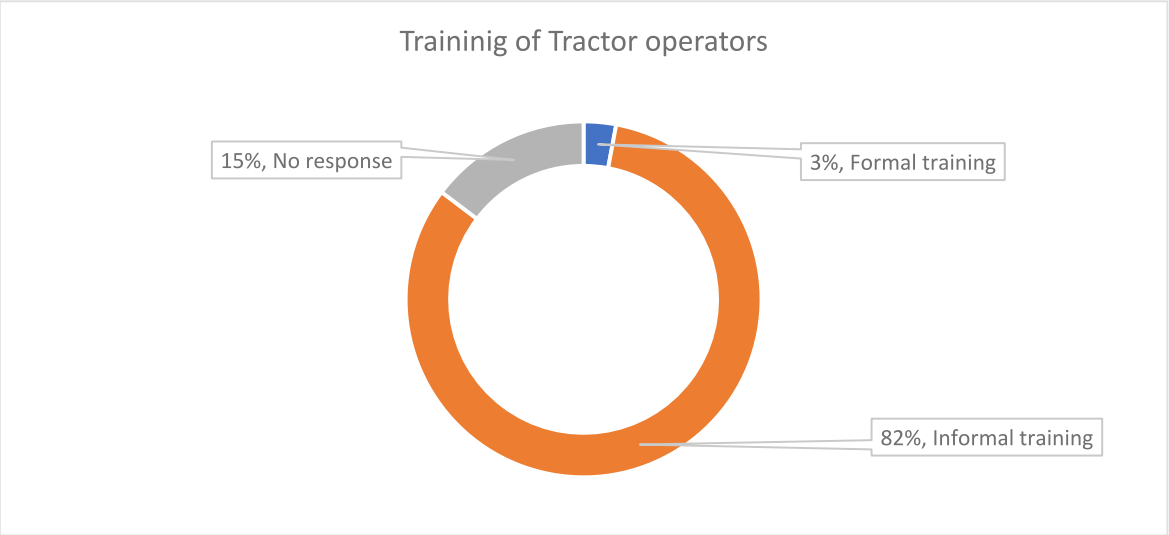
In Gujarat, widely used machine for land preapartion are tractor followed by Cultivator, roratavator, power tiller, disc plough and harrow (figure 8.10). Out of all the land owners, 99% respondent use tractors, followed by 80% respondents using cultivator. Power tiller, Disc plough, Rtavator are being used by only 6% 5% and 8% respondent respectively. Only in Valia block of Bharuch district, 95% land holder reposndet use tractors and 5% don't use tractors as they have sufficeinet manual labour s and own bullocks for the operations. Out of all the users of tractors, 37.30% respondent owned the tractors and 62.70% rented it. Intrestingly, Gujarat witnesses respondents with joint ownership with friends and realtives. This hasn't been observed in Uttar Pradesh and Assam. The owners of the tractor have bought it from the nearby city (45%), block level (41%), nearby village (9%) and own village (5%).

Figure 8.11: Sources of tractor rental



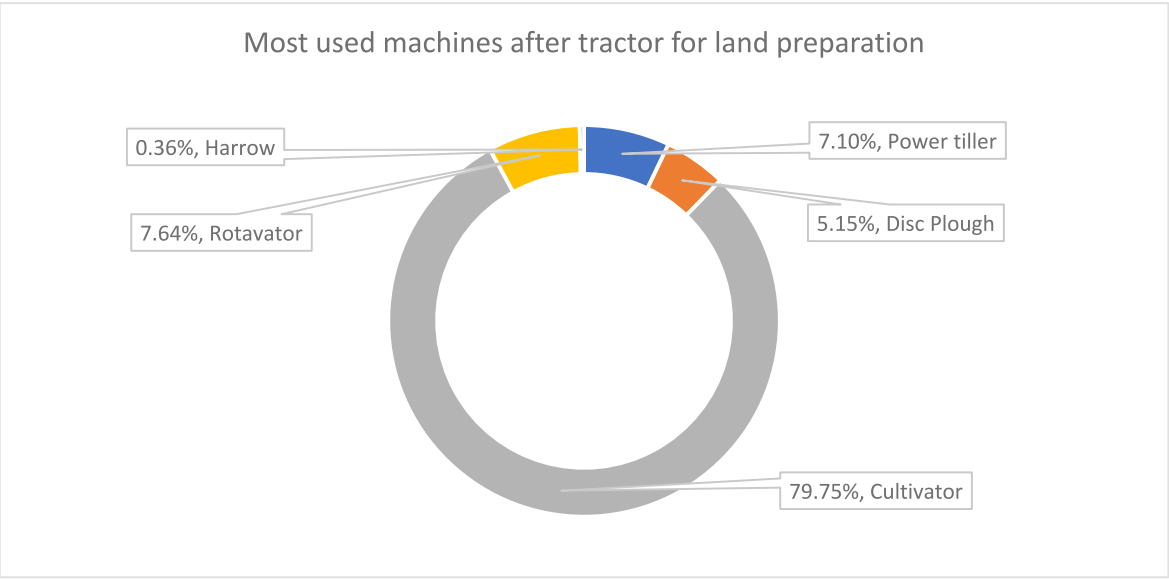
Majority of renting which is 98.7 % of the total respondent who rent tractors is done through other farmers (figure 8.11). CHCs presence was found in Bharuch and Himmatnagar. FPO was present in Himmatnagar Block. Valia and Talod block didn't have any source of CHC and FPO for renting. Out of 563 tractor users, 70% hire operators and 26 % operate by self. Only 4% of respondent either operate or hire depending on availability. Moreover, the response captured from where the operators are trained for from, only 3% have been trained through private dealers and 82% receive training from their friends/relatives. There is large gap in the formal training of the tractor operators. The average cost of operations per acre of tractor is Rs 2460 with self-ownership. Rental charges of tractor are ranging from Rs 600 to Rs 1100 per hour with average of Rs 838 per hour in the state. The average cost of operation comes up to Rs 1676 per acre with tractor. With 353 respondents renting the tractors, 26% have found the rentals to be affordable. Rest, 74% respondents have reported the rental charges to be non-affordable. The machine availability has been able to meet the demand with only 8% responding the non-availability when required. The reason of non-availability of the machine is the high demand of the machine during the peak agriculture time. In case of no availability, 96% respondent wait for the machine by delaying their operations. Only 4% reported crop loss due to delay in machines and 21% reported productivity loss. Out of 563 tractor owners, 70% hire operators and 26 % operate by self. Only 4% of respondent either operate or hire depending on various availability. 82% respondent learn tractors from family and friends.

Figure 8.12: Training of tractor operators



Only 3% respondent received formal training from private dealers. Only 40% of the respondent who received training said it was satisfactorily. About 60% indicated towards shortening the duration of the training and 40% wanted training to be conducted at appropriate times where there are no peak agriculture seasonal activities. Out of 152 responses, 61% weren't willing to devote any time for formal training about machine operations. Rest was willing to undergo training with average of 3.4 days to be devoted to trainings. As many respondents hired operators, 20% respondent had issues with finding operators on time. This leads to various measures adopted by them with 77% responded non cultivation, 73% waited for operators, 30% hired manual labour and 6% arranged operators from nearby villages. The work of the hired operators was found satisfactorily by 99% of the respondents who hired. The small proportion found issues with their efficiency, inappropriate way of handling machines and higher fuel consumption. These can be tackled with proper training for the machine operators. Not only these issues, but the life of machine also increase with appropriate usage.

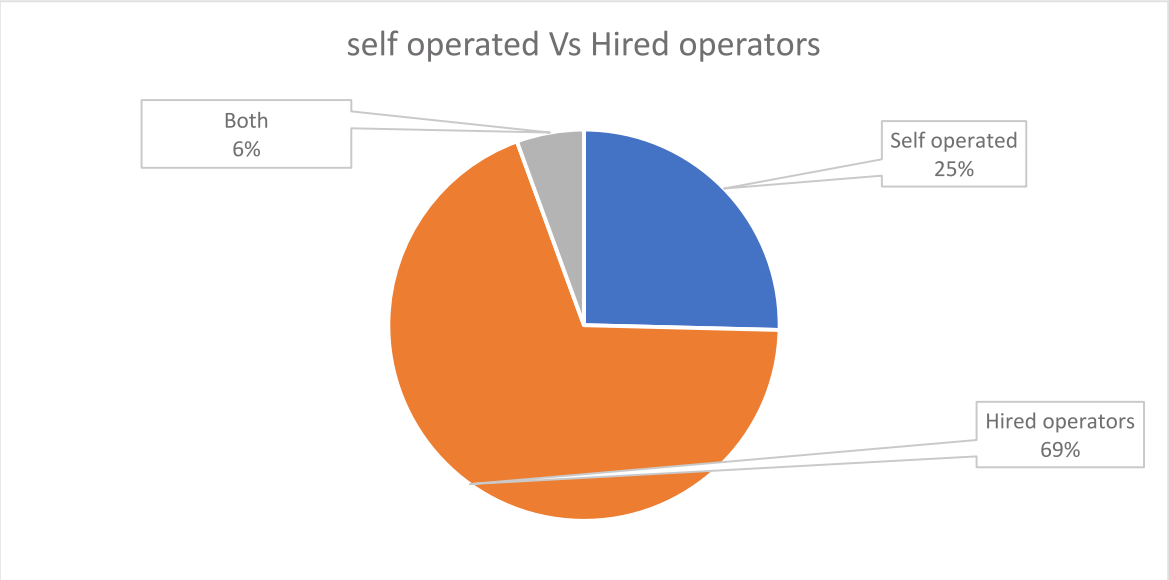
Figure 8.13: Most used machines after tractor for land preparation



For land preparation, all respondent who are using tractors also used secondary machines

and equipment. The split is given in the figure 8.13. As shown in figure 8.13, cultivators have been widely used for secondary tillage in Gujarat, followed by rotavator (7.64%), power tillers (7.10%), disc plough (5.15%) and harrow (0.36%). Though usage of power tiller in Gujarat is more than Uttar Pradesh but significantly less than in Assam. Usage of power tiller has proved a success in Assam and similar operations can be mapped across marginal and small land holders. The ownership of cultivator (figure 8.15) is with 37% of the users and rest 63% rent it from sources like CHC (3.16%), FPO/FPC (0.35%) and other farmers (96.49%). The 92% of the renters of cultivator stated that it is available whenever it is required. Out of the respondent who did not find the timely availability reported the reasons to be High demand due to high number of users during a particular crop (96%) and lack of operators (4%). All the respondent mentioned that when the equipment is not available, they have to delay the operations and wait for its availability. With the non-availability of machine, 38% respondent mentioned crop loss and 4% reported delay in operations affecting crop productivity.

Figure 8.14: Operators for cultivator operations



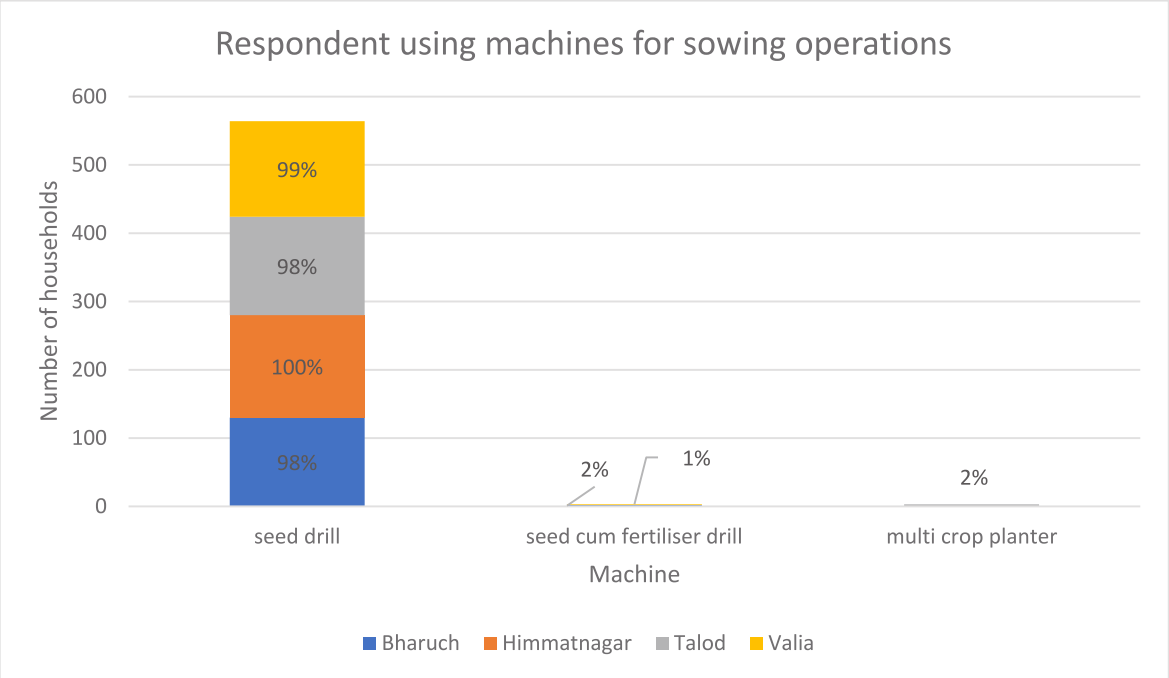
Usually, the tractor operator can use the cultivator as well as it comes as an attachment to the tractor. The formal training number are low where only 4% of respondent who operated themselves have been trained by private suppliers/dealers. Rest all been trained informally by family/relatives. Though the operations of cultivator are not complicated but having formal training helps in increasing the life of the equipment and focusses on regular maintenance. Respondent who has been trained formally have given the feedback to shorten the training duration and to conduct training on appropriate times which do no clash with their sowing and harvesting period. Many times, farmers are not able to attend training as they have to be present for their field operations. With non-availability of operators, respondent cited various measures as waiting for the operators by delaying their operations and hiring labour who can perform operations manually. Also, few respondents reported that at times they had to leave the land uncultivable. Even though percentage of respondent reporting unsatisfactory work of the operators is not high, but it highlights the important aspects of training. All of these respondents stated that the equipment efficiency is low with the operators, 76% reported Inappropriateness in operating the equipment by the operators and 10 % reported higher fuel consumption when equipment was operated by operators. From the respondents owning the cultivator, 86% of them undertook regular maintenance on fixed intervals and only 6% undertook maintenance at the time of break down. This indicates a higher awareness for

upkeep of machines and equipment's as when done appropriately results in better efficiency and life span. The various problem identified in a cultivator which needs attentions were belt breakdown, gear break down, hydraulic issues, oil change issues, Sharpness of the blade. In case of cultivator break down frequency is significantly low. It is interesting to know that 39% of the respondent have to visit mechanic at block level and 12% respondent travel to district level for the mechanic. Only 4% of the respondent get their work done with village mechanic. Though only 1% of the respondent get the work done through black smiths, it gives opportunity to explore the role of black smith and village level mechanics to be trained for tackling issues occurring in all the machines at village level. There has been delay in repair services of 34% respondent as there are not enough mechanics present at village level, 8% reported that spare parts are not easily available. Giving the constraints in the repair of machines, 35% respondent conveyed their willingness to adopt suggestive innovative methods of improving efficiency performances and life span of machine.

Sowing Operations:

With majority of respondent using either one of the machine/equipment for sowing operations, 98.9 % used seed drill and only 0.5 % used seed drill cum fertiliser and multi crop planter. Penetration of multi crop planter was found in Talod block. Out of the total respondents in all the blocks, 100%,98% 99%, 98% respondent use seed drill in Himmatnagar, Talod, Valia and Bharuch (figure 8.15).

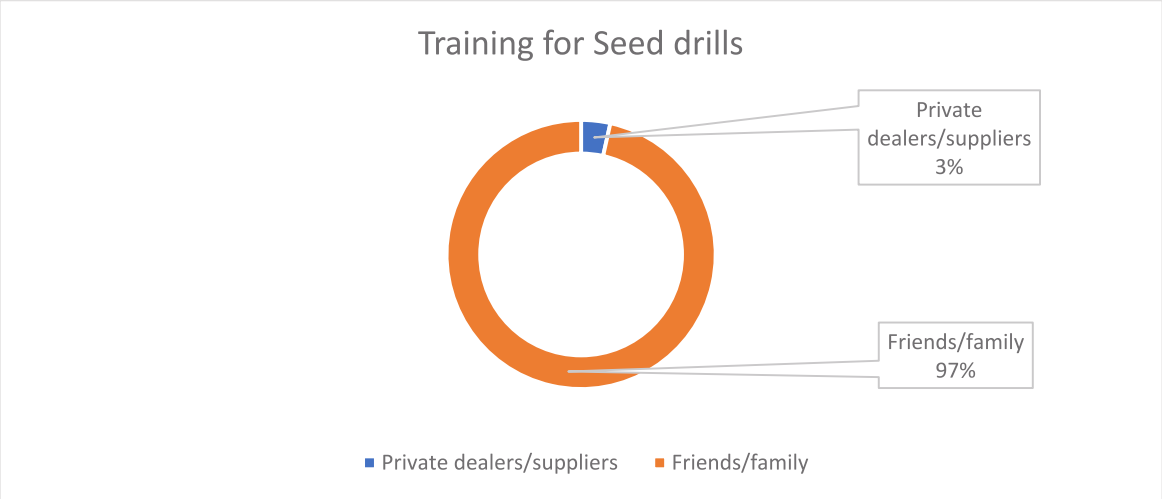
Figure 8.15: Use of machines for sowing operation



Out of the 564 users, the ownership of the seed drill was limited to 36% of the respondents with 98% having sole ownership and 2 % with joint ownership of seed drills. For purchasing of seed drills, 73% respondent bought it from the block level and 22% from the city level. There are only 4% respondent who bought form villages. For renting purposes, 99% of all renters, rented the seed drill from other farmers. Only 1% rented from custom hiring centres. These have been observed in Himmatnagar block in Himmatnagar district and Valia block in Bharuch district. The cost of operation varies across the block and in the range of Rs 200 per acre to Rs 300 per acre. The average cost of operation when the seed drill is owned comes out

to be Rs 300 per acre. The cost of rental ranges from Rs 150 to Rs 350 per hour in Bharuch block, Rs 100 to Rs 400 per hour in Himmatnagar and Talod block, and Rs 100 to Rs 500 in Valia block. The average cost of rental across all four districts is Rs 250 per hour. This is also equivalent to the operational cost for sowing as well. The difference between the cost of sowing using own machine and rented machine does exists. Even though the cost of sowing operations with rental seed drill is less than the owned seed drill, 93% renters still find it non affordable. With 97% of the respondent who rented the seed drill or had it under joint ownership where able to avail the seed drill when required. Only 3% of the respondent mentioned unavailability of seed drill when required. The major reason for this unavailability is due to the higher demand of the seed drills during sowing season. The unavailability has been observed during the crops Tur, Paddy, Cotton, groundnut, cotton, castor, wheat, potato. All the respondent facing unavailability of the machine, wait and delay their operations till the machine is available for use. out of the respondents who have found issues with availability of seed drills, the impacts have been captured. The delay in operations due to timely unavailability of seed drill was reported by 20%, crop loss by another 20%, lower quality crop by 40% and only 20% reported no affects.

Figure 8.16: Training for seed drill



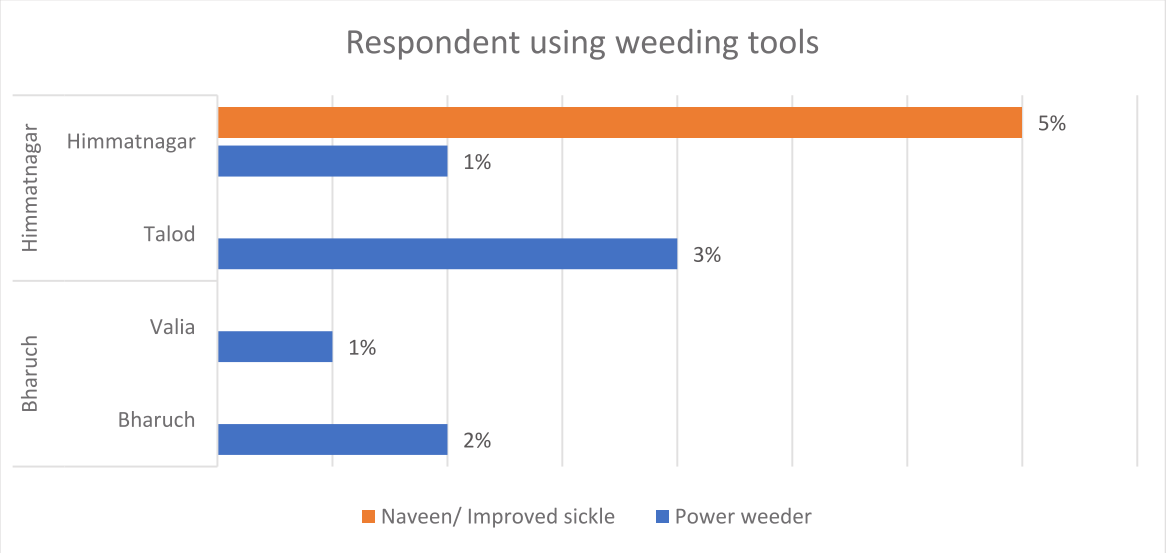
With 564 household using seed drills for sowing operations, 25 % operate the power tillers by their own, 4% either operate themselves or hire operators as well, and 68 % hire operators. From the respondents who were self-operating, only 3.5% had received formal training through private suppliers, and 96.5% have learnt operation by friends/ family (figure 8.16). Formal trainings have been observed in Himmatnagar, Valia and Bharuch blocks. They stated that the duration of the training can be shortened, also to be held at appropriate timing different from their agricultural season. From the people who operate seed drill, 41% showed their willingness to attend the training. Average 3.67 days can be given by respondents for attending any related training. There have been issues with availability of operators, so respondents opt for various measures. Some of them (19%) said that they wait for the operator by delaying their operations, 20% they don't cultivate, 1% said they hire operators form outside the village, and 7% said they hire manual operators. With 5% of the respondent found the operators work unsatisfactory, all of them felt that they have low efficiency. Also, 76% of them felt that operators use the machine inappropriately and 10% felt that their operations results in higher fuel consumption. In case of seed drill break down, frequency is significantly low. It is interesting to know that 24% of the respondent have to visit mechanic at block level and 10% respondent travel to district level for the mechanic. Only 3% of the respondent get their work

done with village mechanic. Though only 1% of the respondent self-repair and 0.49% get the work done through black smiths, these two options can be focussed for training for repairs. Respondent who manages repairs through mechanics have found issues in delayed operations due to lack of mechanics at village level, unavailability of spare parts and incompetencies of mechanics. A small percentage of respondent (29%) showed willingness to adopt suggestive innovative methods of improving efficiency performances and life span of seed drills.

Weeding Operations:

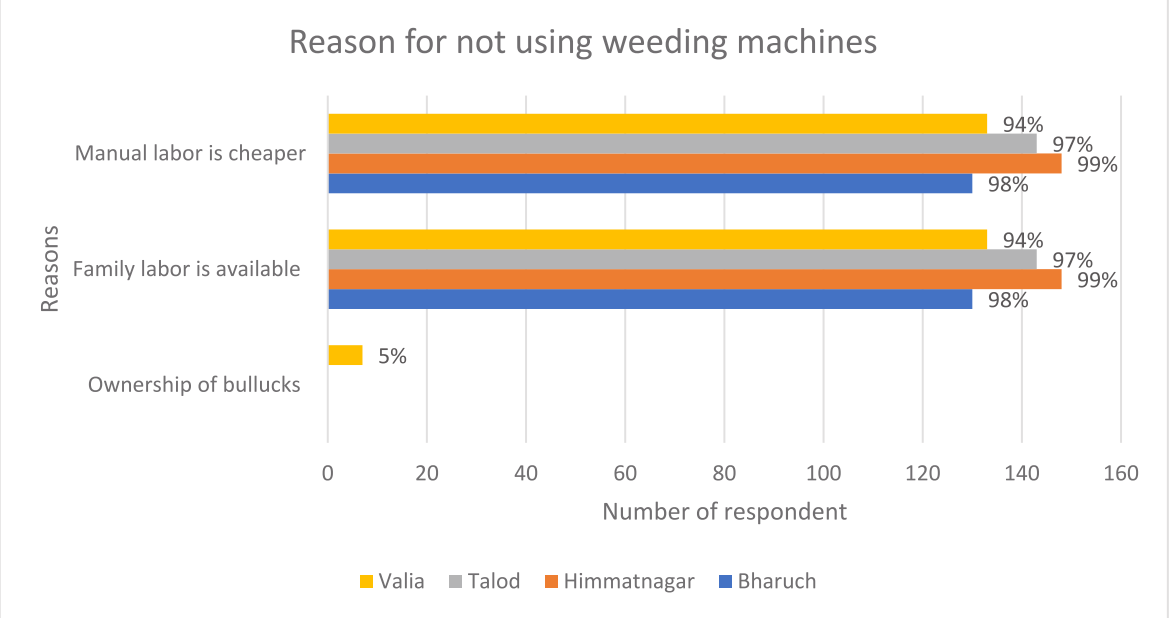
A large proportion of 98% perform manual operations for weeding. The major reason of not using any machine (figure 8.18) was availability of family labour (94%) and cheaper manual labour (94%). Only 1% respondent used bullock for weeding operations. The weeding operations lack involvement of any machines and is predominantly manual. Out of total 600 respondent, only 2% use power weeder for weeding operations and 1% use Naveen sickle (figure 8.17). All these power weeders are operated by fuel.

Figure 8.17: Usage of weeding tools



All of the power weeder were rented from other farmers. The cost of rental is Rs 300 per hour and cost of weeding operation with power weeder comes to be Rs 600 per hour. These rental costs are not very affordable to the all the respondents. All of the users of power tiller hired the operators who are usually men.

Figure 8.18: Reason for not using weeding machines



Irrigation:

The study captured status of few irrigations' technology in Gujarat. The technologies are namely Drip, Sprinkler and rain gun. Out of the 570 land holders, only 10% used these technologies. Majority of 90% didn't opt for any as their land was either unirrigated or under flood irrigation. The inclination towards drip was found higher with 9% of the total respondent in Gujarat opted for drip and only 1% opted for sprinklers. Majority of the drip adopters have been seen in Himmatnagar district which is relatively dry and lack access to water. Bharuch has been blessed with Narmada waters hence leading to less of drip. Again, in Bharuch, Valia block observed more penetration of drip then Bharuch block.

Figure 8.19: Use of irrigation technology

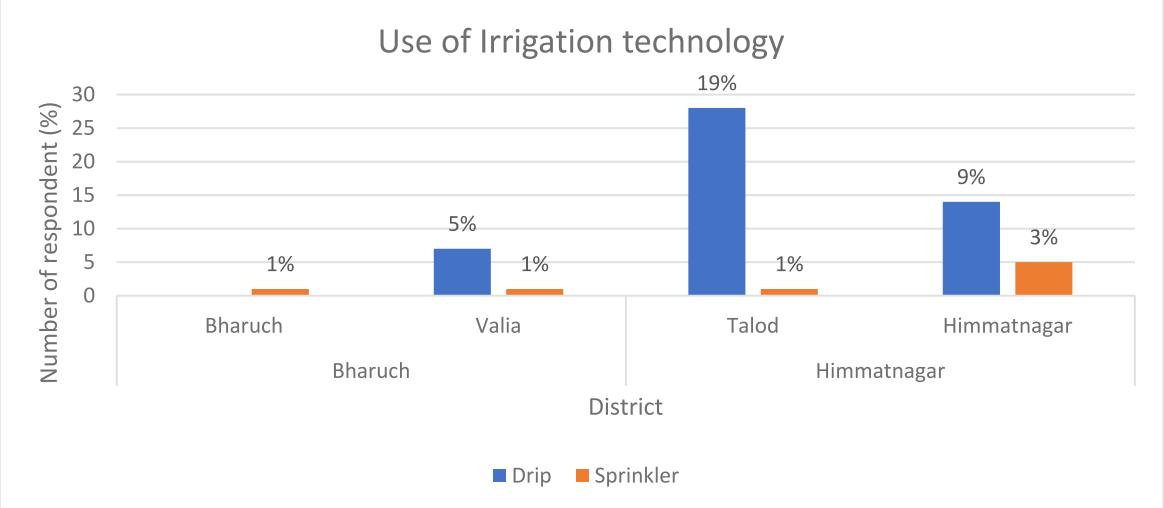
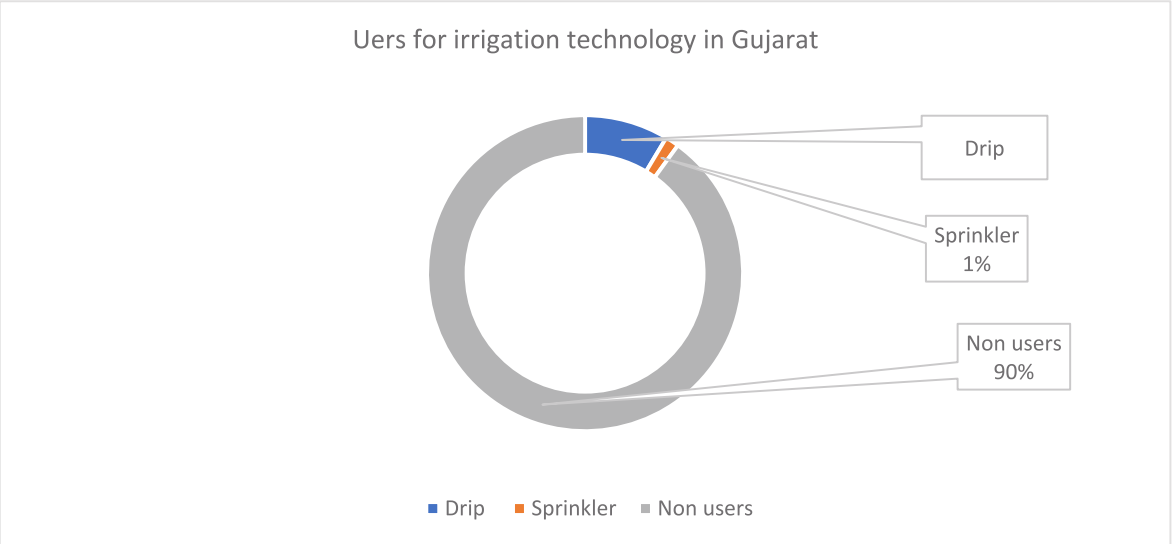


Figure 8.20: Percentage of users for irrigation technology in Gujarat

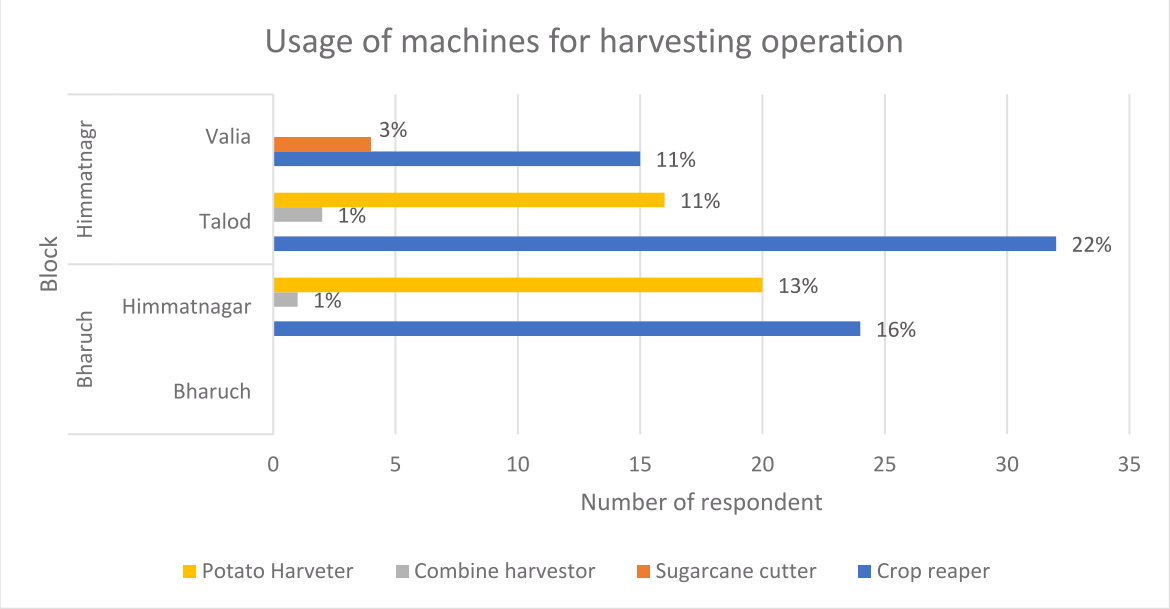


With 57 users of drip and sprinkler, the technology setup was owned by self. For purchasing of drip, 12% respondent that they bought it from the village level, 27% from block level and 61% from the city level. For sprinklers, 13% respondent bought it from nearby village and block level, 75% bought it from dealer in the city. With 49 household using drip for irrigation operations, 22 % operate the drip by their own, 8% operate by hire operators. From the respondents who were self-operating, only 2% had received formal training through private suppliers, 2% from FMTTIs and 14% have learnt operation by friends/ family. Formal trainings have been observed in Talod block. They stated that the duration of the training can be shortened, also to be held at appropriate timing different from their agricultural season. From the people who operate drip, 10% showed their willingness to attend the training. Average 3.2 days can be given by respondents for attending any related training. Around 22% of the respondent found the information in the manual useful. From the responses captured, 18% undertake regular maintenance of the technology setup and 2% get repair done in case of breakdown. Usually, blockage and chokes up have been observed. Out of the total drip users, 2% of the respondent have to visit mechanic at block level and 10% respondent travel to district level for the mechanic. Interestingly, 8% of the respondent self-repair Respondent which have to manage repairs through mechanics have found issues in delayed operations due to lack of mechanics at village level. A small percentage of respondent (16%) showed willingness to adopt suggestive innovative methods of improving efficiency performances and life span of seed drills.

Harvesting Operations:

For harvesting, 34% respondents in Talod, 30% in Himmatnagar, 13% in Valia and 0% in Bharuch block use machines. Only 20% of households in the sample have been using harvesting machine, out of the total cultivators and rest 80% didn't use any machine for harvesting operations. In Bharuch block, there is no machine used for harvesting as major crops are Arhar, Moong, Cotton which are manually harvested. Rest of the block, the respondents stated that the main reasons for not using machines is availability of family member to work on farm and cheap availability of labour.

Figure 8.21: Use of machines for harvesting operation



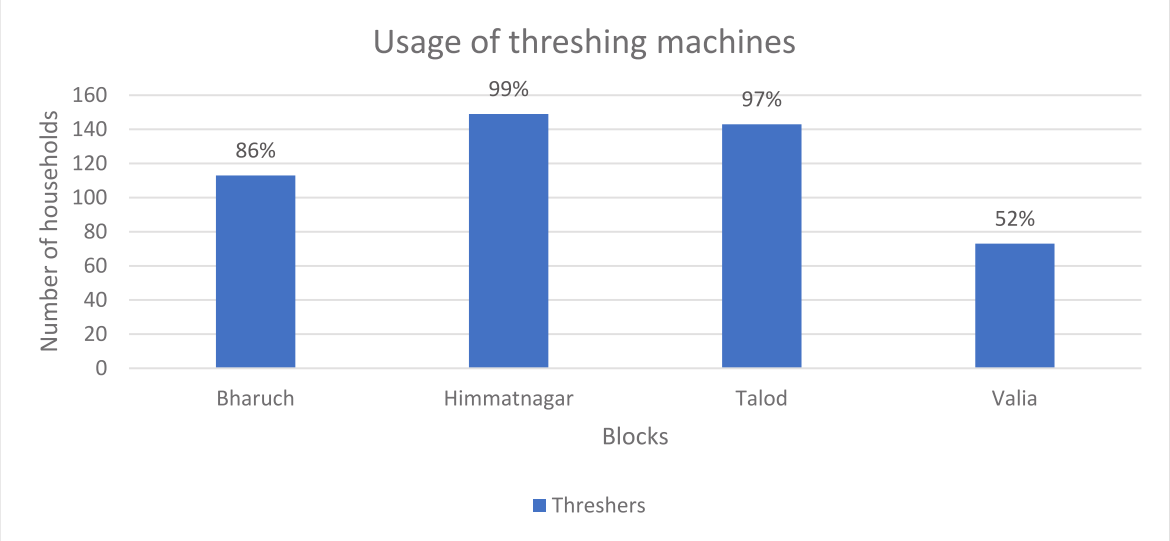
The average labour rates for men are Rs 271 per day and for women it is Rs 266 per day in the state for harvesting operations. Valia block showed highest labour rate of Rs 500 per day for men. Average ownership of crop reaper is of 6 years with the first reaper ownership of 15 years back. The price range of crop reaper starts from Rs 85,000 to Rs 325000. These were purchase from various locations with 86% buying it from the city level, 10% respondents from block level and only 5% from village. All of the respondent who rent the crop reaper, rent it from other farmers. The average rental cost of the crop reapers is Rs 918 per hour across 4 blocks. It is highest in Himmatnagar with Rs 954 per hour and lowest in Valia with Rs 860 per hour. These rental charges are found unaffordable by 58% of the respondents who rent the machine. Also, the 6% of the respondent stated that crop reaper are not available when required die to the high demand of the machine at the time of harvest of potato and groundnut crop. The non-availability of machines has led to delay in operations leading to productivity loss or crop loss as well. With the household using the harvesting machine, not necessary they operate by themselves. There are also operators who are hired for operating the machines. In the sample, 24% operated the machines themselves and 76% respondent hired operators for the operations. The self-operators are operating the machine 6 year on an average. Operators are available easily and are working satisfactorily. All of the respondent found the manual useful. Also, they are willing to devote time for training which covers suggestive innovative methods to improve efficiency performances and life span of machine.

Around 83% of the households rented the machine and only 17% owned the machine. The average cost of operation with an owned potato harvester is Rs 1600 per acre in the state. Even though the ownership of potato harvester is 25 years old but the average ownership year is only 7 years. The price range of potato harvester is from RS 53000 to Rs 125000. The purchase locations were city and block level. Half of the owners bought the machine from block and another 50% bought from city. All of the respondent who rent the potato harvester, rent it from other farmers. The average rental cost of the potato harvester is Rs 978 per hour across the blocks. These rental charges are found unaffordable by 97% of the respondents who rent the machine. Also, the 7% of the respondent stated that the machine is not available when required during potato crop harvest. Due to the delay in arranging for machines, the quality of

crop suffers. In the sample, only 14% operated the machines themselves and 86% respondent hired operators for the operations. The respondents who operate themselves are operating on an average of 1.5 years. Operators are available easily and are working satisfactorily. All of the respondent found the manual useful. Also, they are willing to devote time for training which will cover suggestive innovative methods to improve efficiency performances and life span of machine.

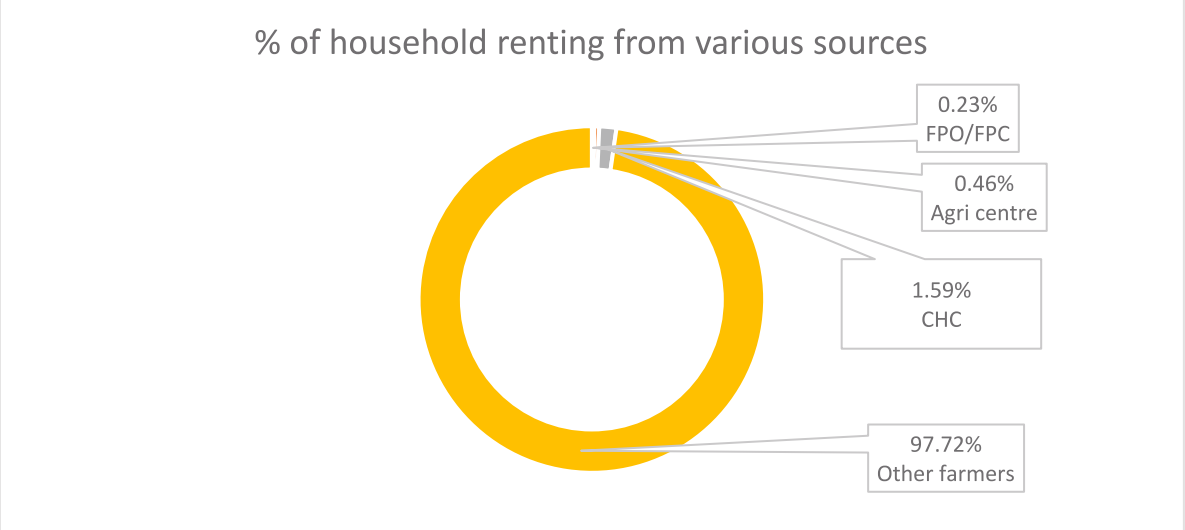
In Gujarat, widely used machine for threshing is threshers. Out of all the land owners, 84% respondent use threshers with 86% households in Bharuch block and 52% in Valia block of Bharuch district, 99% land holder reposndet in Himmatmnagar block and 97% in Talod block of Himmatnagar district. The 16% land owners don't use any threshing machine as their crops are nit suitable for use of machines.

Figure 8.22: Use of threshing machines



Out of all the users, 92% respondent owned the threshers and rest 8% rented it. Majority of renting which is 97.2 % of the total respondent who rent thresher is done through other farmers followed by CHC with 1.59% renting from CHC. CHCs presence was found in Bharuch, Valia and Himmatnagar. FPO was present in Himmatnagar Block. The average cost of operations per acre of thresher is Rs 1064 per acre with self-ownership. The average cost of rental for thresher varied from Rs 500 to Rs 2000 per hour. The average cost of rental was Rs 974 per hour. The highest rental cost was found in Talod with Rs 1029 per hour and lowest in Valia with Rs 890 per hour. With 439 respondents renting the tractors, only 24% have found the rentals to be affordable. Rest, 76% respondents have reported the rental charges to be non-affordable.

Figure 8.23: Sources of machine rentals

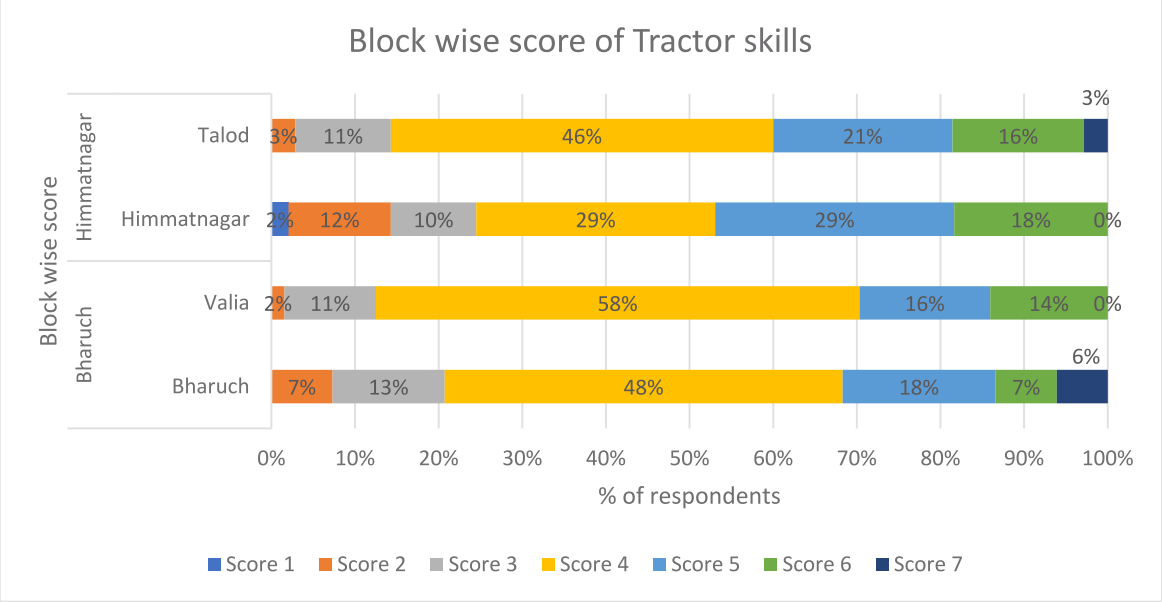


The non-availability of the machine is observed by 5% of the renters due to the high demand of the machine during the peak season of groundnut, soyabean, Tur, castor, paddy and wheat, sugarcane. In case of no availability, 91% respondent wait for the machine by delaying their operations and only 9% hire manual labour. Due to delayed in availability of machines, various impacts have been observed with 26% respondent stating crop loss, 22% reported productivity loss and 13% stated that higher expenses were incurred due to hiring of extra labour. Out of 478 thresher users, 95% hire operators and 5% operate by self. The data shows that the respondent have experience of average of 3.5 years of operating the machine and average of 12 years of owning the machine. Moreover, all the ones who operate have learnt it form their friends/relatives. There is large gap in the formal training of the thresher operators. All of the respondents were willing to undertake training and devote time for average of 3 days. The work of the hired operators was found satisfactorily by 100% of the respondents who hired. All of the owners of the thresher undertook regular maintenance of the threshers and are willing to adopt any suggestion for increasing the efficiency and life span of threshers.

Section 4: Skill gap and access to extension services

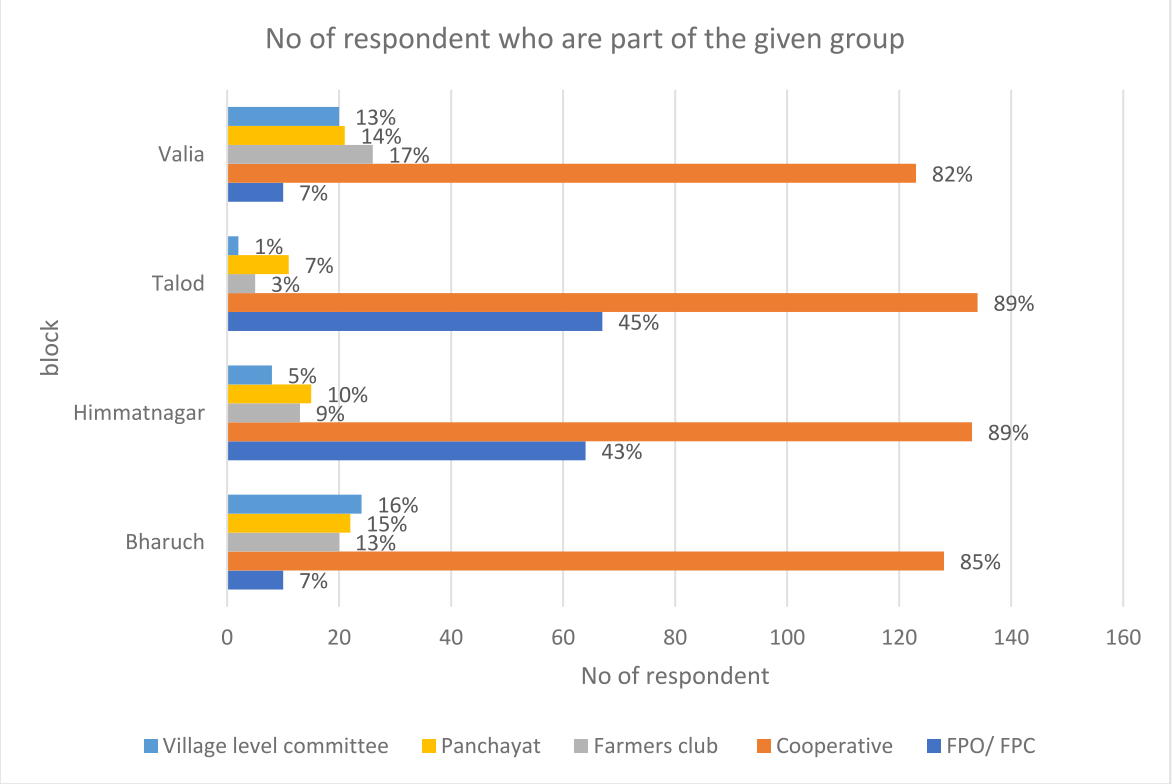
Tractor operators play a crucial role in agriculture operations, and their skill level can have a significant impact on the success of a farm. Tractor operators need skill in agriculture operations as it improves efficiency and safety. It also ensures equipment maintenance and crop management. Skilled tractor operators can perform tasks more efficiently and quickly, which can increase productivity and save time. This is particularly important during busy seasons when there are tight deadlines to meet. They need to be able to operate their machinery safely and effectively. Skilled operators are less likely to make mistakes that can cause accidents or damage to the equipment, reducing the risk of injury and downtime. The operators who have knowledge of how the machinery works and how to maintain it properly can help prevent breakdowns and prolong the life of the equipment. They can also spot potential problems early on and make repairs before they become more serious issues. A skilled tractor operator can help to optimize crop yields and ensure that the farm is operating at peak efficiency.

Figure 8.24: Scoring of tractor skills



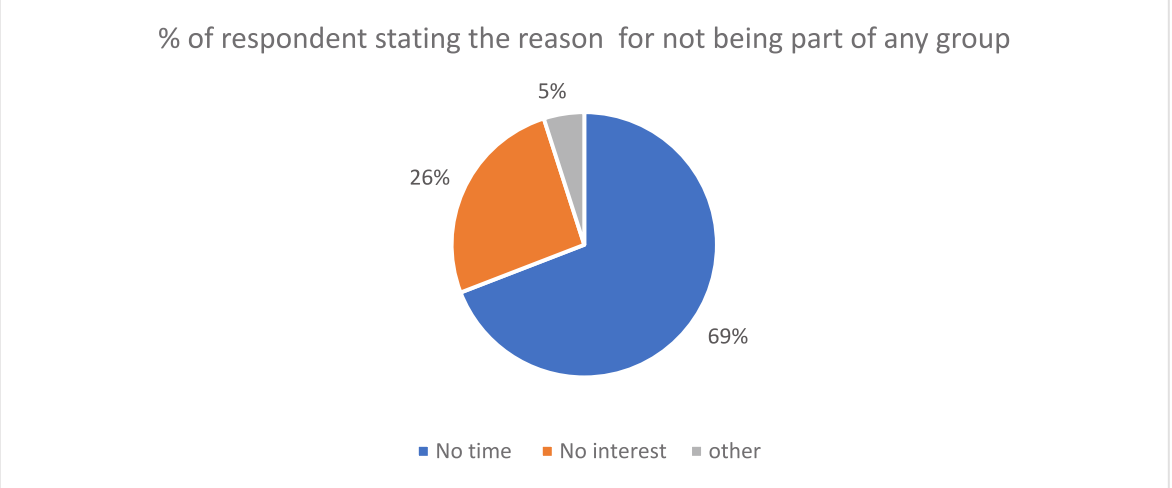
The assessment for knowledge and information about tractor operations and their maintenance was captured with set of questions administered to the respondent who operate the tractors or are responsible for maintenance of the tractors. Out of all the users of tractors, 37.30% respondent owned the tractors and 62.70% rented it. About 47% respondents are responsible for the operations and maintenance of the tractors and their responses have been captured for below analysis. The scoring is done based on the responses provided by the respondents. All the right answers from 8 questions have been summed up to derive the total score of the respondent. So, the 1 to 8 is the score of scaling the farmers, 1 being least information and knowledge and 8 being the highest information and knowledge about tractor operations and maintenance. The highest number of respondents are from Bharuch, followed by Talod, Valia and Himmatnagar. Majority of the respondents have scored 4 for their knowledge and information about tractor operations and maintenance. Valia has higher respondent who scored 4 (58%), followed by Bharuch (48%), Talod (46%) and Himmatnagar (29%). It is observed that Himmatnagar has respondent scoring highest than the other blocks in the state where 29% responded scored 5 and 18% scored 6. Himmatnagar is followed by Talod where 21% respondent scored 5, 16% scored 6 and 3% scored 7. Highest score being 7 of the complete scoring process, Bharuch and Talod lead with the most informative respondents. In terms of information and knowledge, Gujarat fares better than the other states under the study. But given, tractor operations are crucial for agriculture, there remains a gap in respondents understanding. Working on imparting right skill set to the tractor operators and maintenance takers will not only increase the efficiency of the operations but also increase the shelf life of the tractor and its equipment.

Figure 8.25: Participation in community organisations



Out of all the respondent 48.66 per cent were not part of any community. Majority of respondents i.e., 86% were part of cooperative while 25% were part of FPO. The block wise proportion of respondent is given in figure 8.25.

Figure 8.26: Respondent reason for not being a part of any group



Out of the total, 99% of the respondents have own bank account and when it comes to kisan card 72% of respondents own and only 28% of respondents don't have it. Majority of the respondent 85%, get information regarding farming or livestock related topics such as new seeds, technology, crop rotation or animal health from Gram sevak and 64% adopt the advice from grama sevak. Around 45% respondent seek information through social media though only 11% adopt the information received from social media. Media or radio or TV or newspaper

rank third as a source of information for farmers with 36% seeking information but only 3% adopt the information available through these sources. 30% of respondent gather information from family members and 11% adopt it. Private shop or suppliers and other government agency were the least opted for adopting the agriculture related information with no one adopting the information from these and followed by NGO and Community members or cooperative with only 1% respondents adopt their information. The table 8.8 shows sources of information from where respondent farmers get agriculture information and also maps the most preferred source for adapting advices.

Table 8.8: Source of information for respondents

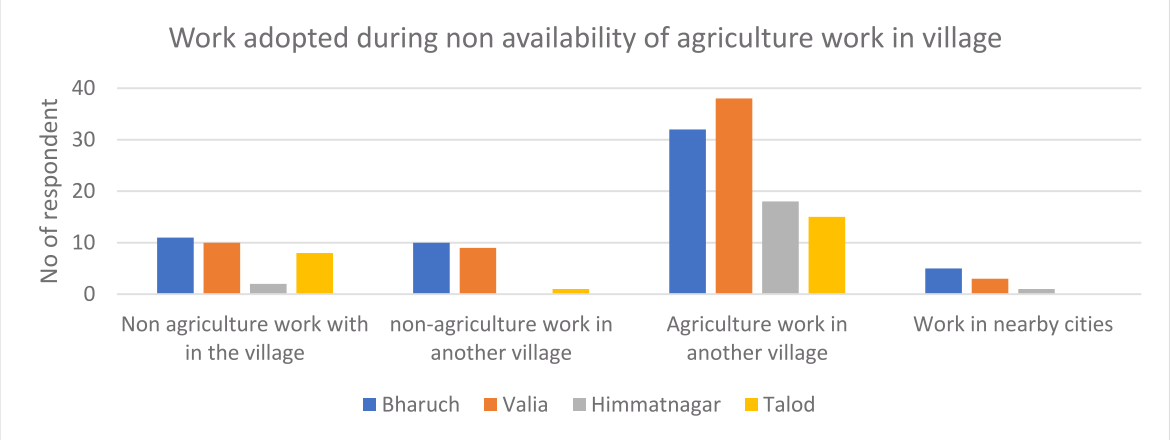
Source of information	% Respondent for given sources	% Respondent adopting the advice from given sources
Government outlet or depot	20%	8%
NGO or NGO outlet	12%	1%
Private shop or suppliers	18%	0%
Community members or cooperative	17%	1%
Family member	30%	11%
Media or radio or TV or newspaper	36%	3%
social media	45%	11%
Gram sevak	85%	64%
Kisan Mitra	30%	6%
KVK	17%	5%
Other government agency	7%	0%
Other	50%	3%

Out of 599 respondents, 99% respondents have visited government departments for various information and subsidy.

Labour Perception about Machines:

Out of all household who performed agriculture operations on own or others field, responses were captured for status of availability of labour for manual operations. Out of total respondent, 63% reported easy availability of the labour for manual work in the village. Out of which 70% of respondent found there were enough agricultural work to be found in the village. 30% respondent reported that not enough work is available in the village. 37% of the respondents' found labour is not easily available in the village and out of these 223 respondents 96.4% found farmers were arranging labour from the people who are migrant from another village. Most of the respondents find migration from rural to urban areas, shifting to a regular/ permanent job in the non-farm sector and higher wages in other jobs available locally or lower remuneration in agriculture were the reason for not finding labour in the village. March, October, September are the months majority of the respondent are engaged in agriculture work followed by February, November, August and April. By capturing the recall of previous 5 years, 60% respondent stated situations was not similar which implies that labour and work was not easily available even before 5 years. Out of total responses captured only 2% found that agriculture work is not available in all day and rest 98% respondents find agriculture work in all days.

Figure 8.27: Work adopted during non-availability of agriculture work in village



With decrease in work or decrease in labour demand majority of the respondent from all four-block preferred agriculture related work in another village that is 63% of the respondents, followed by 19% of respondents prefer Non agriculture work with in the village. 12% of respondent are ready to accept non-agriculture work in other village if there is no work available in their village. Only 6% of the respondent preferred to work in nearby cities.

With 600 respondents engaged in agriculture operations, responses were captured for households' perception on the impact of machines on various aspects. The impacts considered for analysis are; time use, cost of cultivation, productivity, income diversification, education level, health status, food expenditures, demand of agriculture labour, demand of non-agriculture labour, overall income, agricultural wages, migration from rural to urban places, youth in agriculture. All household have given their responses for the impact observed with the use of machines. Table 8.9 indicates the % of respondent who observed any increase/ decrease/ no change in the given impacts. 42% of the respondents agreed to the decrease in the time requirements while 28% of respondent felt no change in time requirement while using the machines for agriculture operations. 53% of the respondent found mechanisation has increased the cost of cultivation. On other hand majority of the respondents agreed that mechanisation has increased the productivity (68%), income diversification (58%), education level (53%), overall income (64%), agriculture wages (71%) and migration from rural to urban places (47%). 51% of the respondents found there is no change in the participation of youth in agricultural activities and 53% of them found no change in health. The percentages are coloured in green where there are >50% of respondents.

Impact of using machines in agricultural operations

The responses were captured for household perception on the impact of machines on various aspects. The impacts considered for analysis are: time use, cost of cultivation, productivity, income diversification, education level, health status, food expenditures, demand of agriculture labour, demand of non-agriculture labour, overall income, agricultural wages, migration from rural to urban places, youth in agriculture. About 71 % respondents observed increase in agricultural wages, 68% observed increase in productivity, 58% observed diversified income, 64% observed increased income, 51% increase in food expenditure. Also 53% observed increase in cost of cultivation.

Table 8.9: Impacts of using machines in agricultural operations

Impacts of using machines in agricultural operations	Increase	No change	Decrease
time use	31%	28%	42%
cost of cultivation	53%	29%	19%
productivity	68%	30%	2%
income diversification	58%	41%	1%
education level	53%	46%	1%
health status	45%	53%	2%
food expenditure	51%	48%	1%
demand of agriculture labour	42%	29%	29%
demand of non-agriculture	48%	44%	8%
overall income	64%	34%	2%
agriculture wages	71%	27%	2%
migration from rural to urban places	47%	40%	13%
youth in agriculture	40%	51%	9%

Household have given their responses for the impact observed with the use of machines. Table 8.9 indicates the percentage of respondent who observed any increase/ decrease/ no change in the given impacts. Highest increase has been reported under agriculture wages followed by productivity. The percentages are indicated in the table 8.9. The percentages are coloured in green where there are >50% of respondents.

Section 5: Women adoption of machinery and labour-saving technology

This section examines the women's access to agriculture information and extension services. Age split of the women respondent is as given in the table 8.10. Majority women are in age group of 46-55 years followed by 56-65 years.

Table 8.10: Age split of the women respondent

Age category	Percentage of women Respondents
25-35	10.53%
36-45	10.53%
46-55	42.11%
56-65	26.32%
66-75	10.53%
Total	100 %

Highest women participation is found in weeding, out of total women respondents 63% of them were engaged in weeding ranging from 2 to 8 hours per day for 4 to 50 days per year. For sowing activities, 47% of women were engaged for 2 to 8 hours per day for 2 to 30 days per year. For harvesting, 32% of the women respondent were engaged in 3 to 8 hours per day for 10 to 20 hours per year. 26% of the women were engaged in threshing work for 4 to 8 hours for 2 to 20 years. All these operations by all women respondents were performed without

any usage of machines/tools. They perform all the options manually. Under the study, various reasons were explored for women not using the machines for performing various agriculture operations.

Table 8.11: Split of women performing the agricultural operations

	Percent	Hours	Days
Land Preparation	5%	1	20
Sowing/Transplanting	47%	2-8	2-30
Weeding	63%	2-8	4-50
Spraying/Applying fertilizer	11%	2	15
Irrigation	5%	2	15
Harvesting	32%	3-8	10-30
Threshing	26%	4-8	2-20
Sorting/Packing	5%	8	3

Out of the total women respondent, 94% respondent reported that they were not allowed to use the machine because of gender norms followed by 10.53% of the women respondent consider the machine would be too expensive to handle by them and 5.26% of respondent felt that they may mishandle the machine (table 8.12). Another 5.26% of them felt they might not be able to operate. All the women respondent responded that they don't use the machine because there is a gender norm. the table 8.12 below summarizes all the reasons for non-usage of machines by women.

Table 8. 12: Reason of non-allowance for using the rest of the machines

Reason of non-allowance for using the rest of the machines	% of women respondent
Gendered norms	94.74 %
Machines being expensive	10.53 %
Women might mis handle the machine	5.26 %
Women might not be able to operate	5.26 %

Out of total women respondent, 42.11% of the women responded that using machines for agriculture increases the yield of produce, area under cultivated land, efficiency of work and improve the easiness of performance of task. While 36% of the respondents found mechanisation decreases amount of time spend on a task. About 58% of the respondent found no change due to mechanisation in agriculture.

Table 8.13: Changes observed by women due to machine usage in Agriculture

Changes due to machine usage	Increase	Decrease	No change
Amount of time spent on a task	5.26 %	36.84 %	57.90 %
Task easier to perform	42.11 %		57.89 %
Change in Yield of produce	42.11 %		57.89 %
Change in area under cultivated land	42.11 %		57.89 %
Change in efficiency of work	42.11 %		57.89 %

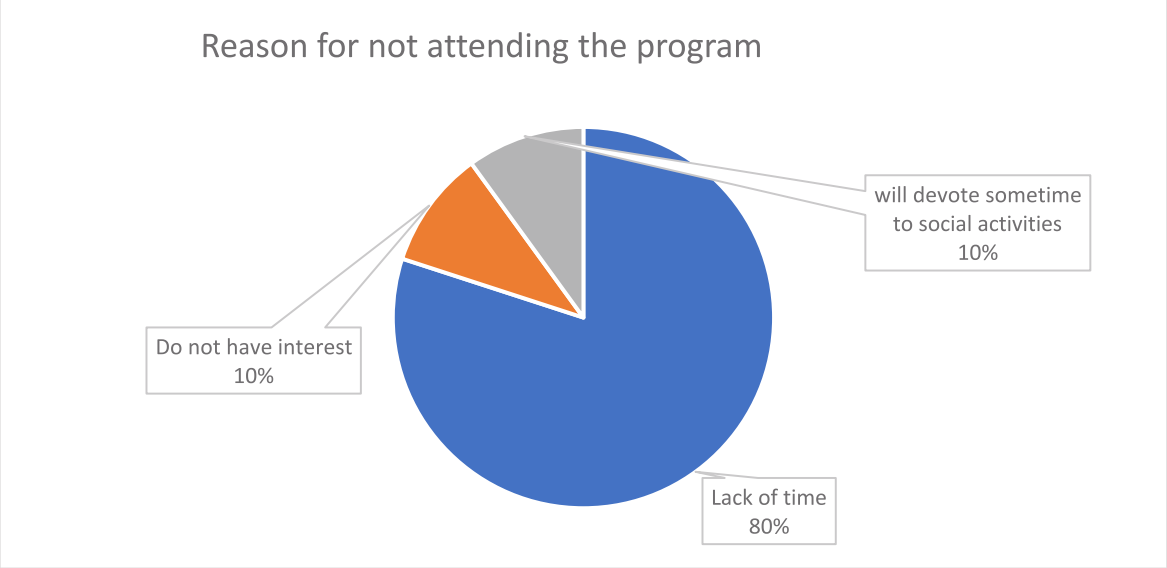
Majority of the women respondent seek information from gram sevak and around 95% of them receive information from gram sevak. 84.21% of the respondents are receiving information through social media though nobody seeks information from social media. Around 5.26% of women respondents are receiving information from Community members or cooperative, Family member, Government outlet or depot and Private shop or suppliers. 5.26% of the respondents seek information from community members or cooperative, Family member, KVK, Government outlet or depot and NGO or NGO outlet. In the sample, women seek no information from other government agencies, Media/radio/Television and Kisan Mitra.

Table 8.14: Sources of information of women respondent

Sources of Information	% women respondent receiving information from these sources	% women respondent seeking information from sources
Community members or cooperative	5.26 %	5.26 %
Family member	5.26 %	5.26 %
KVK	-	5.26 %
Gram sevak	94.74 %	89.47 %
Government outlet or depot	5.26 %	5.26 %
social media	84.21 %	-
NGO or NGO outlet	-	5.26 %
Private shop or suppliers	5.26 %	-

Only around 10% of the women were met with extension officer, but 90% of the women respondents would like to receive agriculture related information from extension officer, in that around 79% would like to receive information from female extension officers. 63% of the respondents have visited KVK/ other agriculture related institutes. Majority of the women respondents (52.63%) are not interested to attend any programs, meetings organized for agriculture information while 47% of the respondents are willing to attend. 80% of the respondents stated that lack time is the reason for not attending any meeting. 10% of the respondents are not interested in meetings while another 10% of them will devote the time to social work.

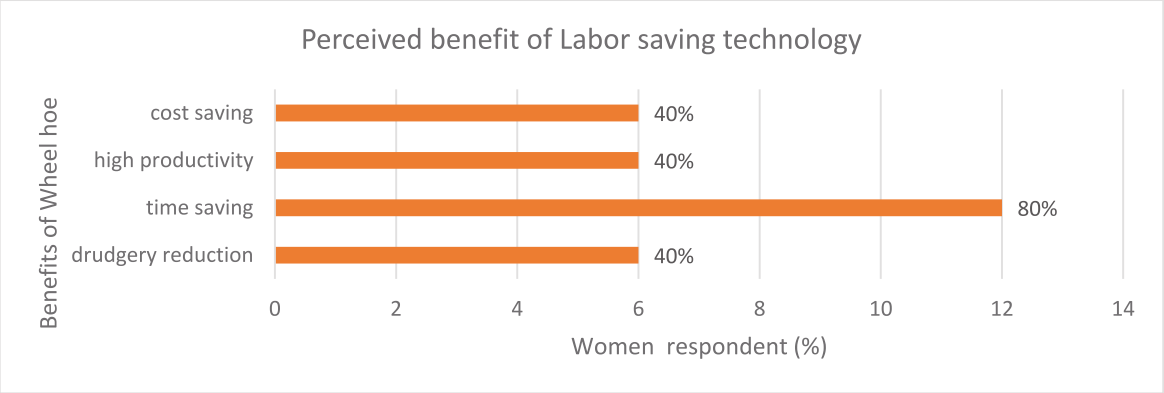
Figure 8.28: Reason for not attending any program related to agriculture information



Labour Saving Technology

Out of total, 29 women responded during household survey carried out in Gujarat. Bharuch and Valia had 35% respondent each. From all the women respondent only 6% women have attended demonstrations/farmer meeting/training. The interview captured women perception of labour-saving technology by showing digital videos to women who were involved in agriculture operations on their own or others farm. One tool was presented, wheel hoe for weeding. Around 52% of the women had seen wheel hoe before. On inquiring about wheel hoe, there were various perception captured which are discussed further. Out of all the women, 31% women found the agriculture labour work tedious and 69% didn't. Out of total women respondent, 50% of them wanted to adopt this labour-saving tool while 31% of them are not sure about adopting and rest 19% of them didn't want to adopt the tool. 75% of the respondent found the wheel hoe is time saving, 37% of the respondent found the tool would help in drudgery reduction and cost saving, 38% of the respondent related wheel hoe with high productivity since the reduced weed count reduces nutrition for crop plant.

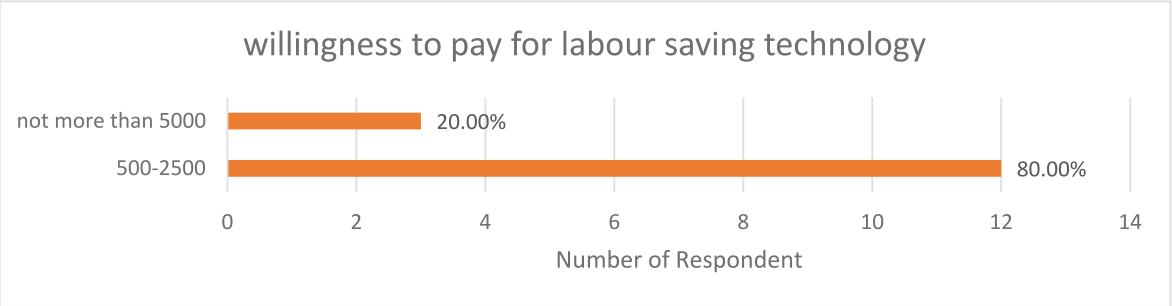
Figure 8.29: Ranking the perceived attributes of wheel hoe



With these perceived benefits, 75% of the women were willing to purchase wheel hoe from the block level markets and 62.5% of women were willing to purchase if the wheel hoe is available at village level markets. A high proportion of women i.e., 80% were willing to pay up

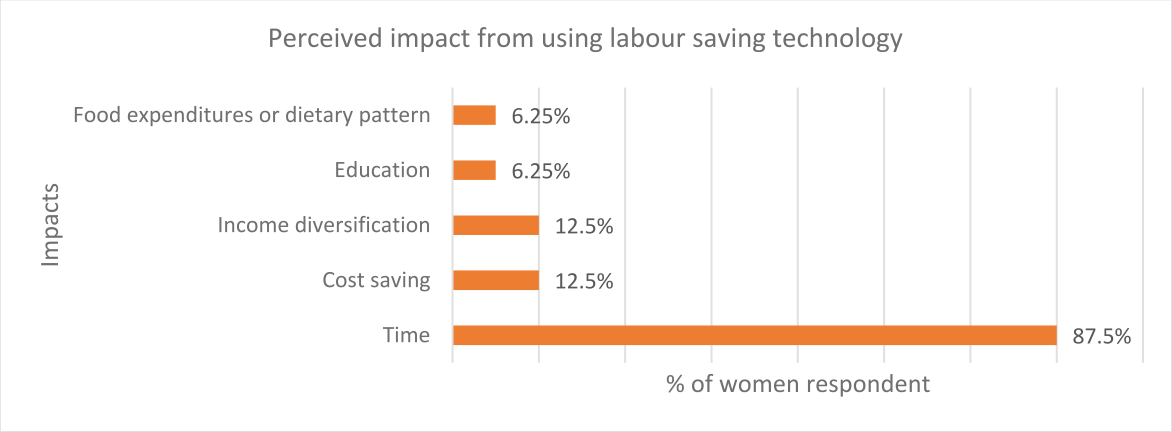
to Rs 2500 and only 20% of women were ready to pay up to Rs 5000. This indicate that lower pricing will help in widespread adoption of wheel hoe.

Figure 8.30: Willingness to pay for labour saving technology



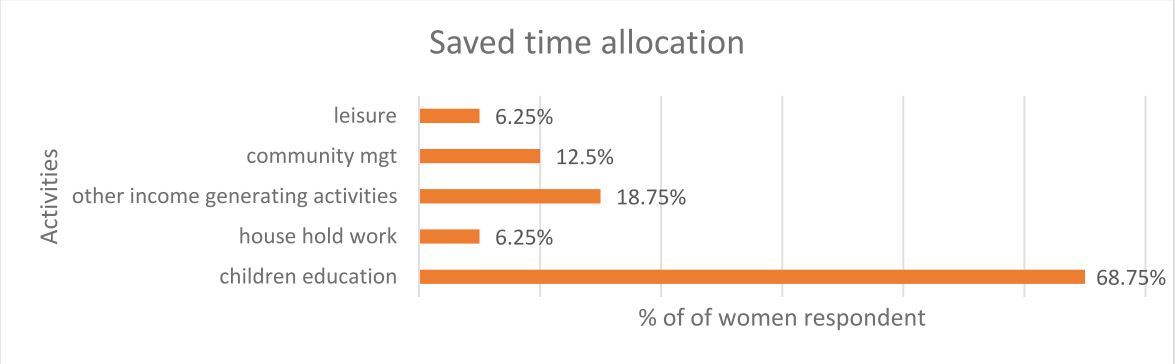
For perceived price of wheel hoe, women opted for multiple funding options like bank, own savings, subsidy and husband with 25% of the women opted for buying the tool using their own savings while only 6.25% of them relied on husband for funds. Even with clear indications towards willingness to pay, women still don't have any sole power to decide whether to purchase the tool. All the women respondent, household head decides whether to make that purchase. Out of total, 50% women will not buy the tool if the head denies and only 43.75% will make it a point to convince the head to purchase the tool. Same time 56.25% of them were ready to rent the wheel hoe for the operations. While asked about the perceived benefits of wheel hoe, Time, Cost saving, Income diversification, Education and Food expenditure or dietary pattern were voted by 87.5%, 12.5%, 12.5%, 6.25% and 6.25% women respectively.

Figure 8.31: Perceived impact from using labour saving technology



Dwelling deeper into time use patterns of women and how would they use the surplus time available after adoption of labour-saving tool, wheel hoe, child education. Other income generating activities. Community management, household work and leisure are the priority with 68,75%, 18.75%, 12.5%, 6.25% and 6.25% women respectively allocating the saved time in these activities.

Figure 8.32: Allocation of time in other activities with time savings from labour-saving technology



Takeaways:

Tractors are the most widely used machine, followed by cultivators, power tillers, disc ploughs, and rotavators. Joint ownership of tractors is observed. Out of all the users of tractors, 37.30% respondent owned the tractors and 62.70% rented it. Most of the rentals are from other farmers. Spread of CHCs and FMBs is not widespread. Only 3% of tractor operators were trained through private dealers and 82% receive training from their friends/relatives. Non-availability of the machine is faced during the peak agriculture time. There are issues with finding operators on time, inefficiency of the operators, inappropriate way of handling machines and higher fuel consumption. The state has mechanization in most of the activities accept weeding where proportion of adopters are very less. There is a gap in respondents understanding. Working on imparting right skill set to the tractor operators and maintenance takers will not only increase the efficiency of the operations but also increase the shelf life of the tractor and its equipment. Labour saving tools were not prevalent and have a huge potential due to various horticulture crop production. SHGs models are successful in Gujarat and collaboration of gender friendly technology with women group can spread the adoption of LSTs.

CHAPTER 9

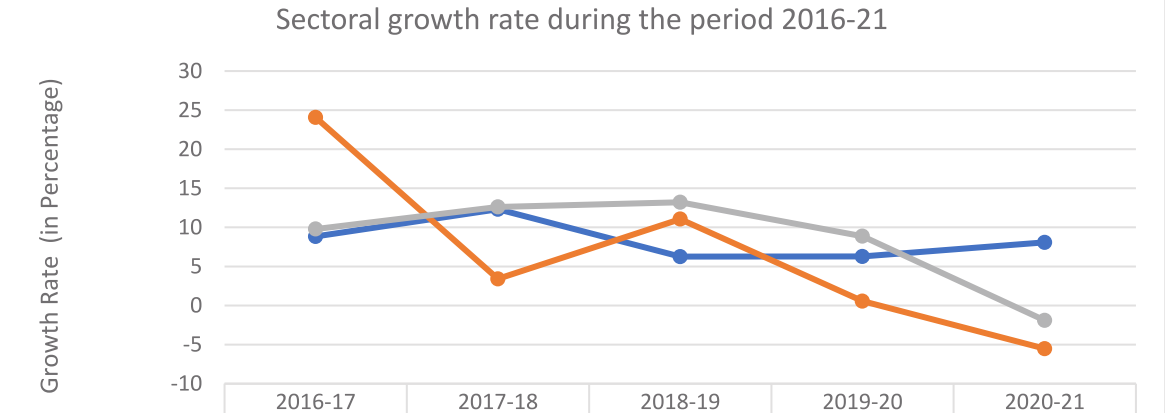
MECHANIZATION STATUS AND ASSESSMENT OF SKILL AAP ACROSS UTTAR PRADESH

Section 1: State overview

The most populous state in India, Uttar Pradesh, is found in the country's north and is home to more than 17% of the country's population. The state has 75 districts, with Lucknow serving as its capital and it has 18 divisions, 915 urban entities, and 8135 Nyaya Panchayats for administrative convenience. Two major rivers, the Ganga and the Yamuna, drain the state. Geographically, it takes up 7.3% of India's total land area (240.928 square kilometres) and ranks fourth behind Rajasthan, Madhya Pradesh and Maharashtra. GSDP of UP in 2020–2021 is Rs. 1,705,593 crores in current prices, with agricultural alone accounting for 16.53% of total GDSP[21]. During 2019-20, per capita income of the State stood at ₹ 65,704 at current prices which was 51 per cent lower than the per capita income (₹ 1,34,226) of India. Uttar Pradesh has a tropical monsoon climate with mild temperatures all year long. The state experiences annual rainfall ranging from 600-1,000 mm in the west to 1,000-2,000 mm in the east. The southwest monsoon, which lasts from around June to September, brings about 90% of the rainfall. Due to the concentration of the majority of the rainfall over those four months, floods are a regular issue that can result in fatalities and significant crop and property damage.

Uttar Pradesh holds an important place in the country not only from point of polity or economy but also from agriculture. Agriculture constitutes the backbone of the state as it 2/3rd of the population has agriculture as livelihood. The state has ample alluvial soil along with diverse agro-climatic zones which supports the cultivation of variety of crops. The state is largest producer of wheat, potato, sugarcane and milk and third largest producer of rice. With large cultivated area, its share in national agricultural production is impressive but has a low crop productivity. During 2019-20, per capita income of the State stood at ₹ 65,704 at current prices which was 51 per cent lower than the per capita income (₹ 1,34,226) of India.

Figure 9.1: Sectoral growth rate in Uttar Pradesh during the period 2016-21



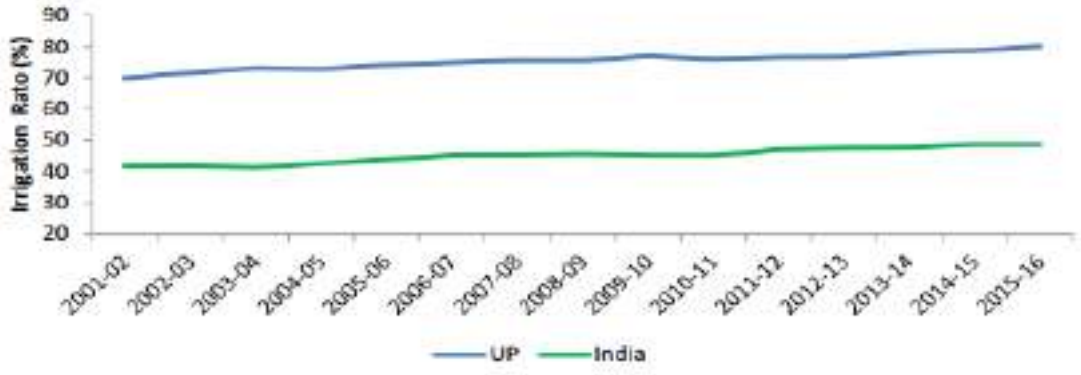
	2016-17	2017-18	2018-19	2019-20	2020-21
Agriculture	8.84	12.32	6.26	6.28	8.08
Industry	24.06	3.41	11.06	0.56	-5.52
Service	9.79	12.61	13.21	8.87	-1.91

Source: *Ministry of Statistics and Programme Implementation, Government of India*

[21] https://statisticstimes.com/economy/india/indian-states-gdp.php

Service sector was the largest contributor with 44.23 % to State's GSDP followed by Agriculture sector (24.83 %) and Industry sector (21.37 %). The growth rate of Service Sector and Industry sector showed a declining trend an increasing trend till 2018-19 but thereafter showed a decreasing trend, leading to a decreasing trend in GSDP growth of the State in the years 2019-20 and 2020-21. About 44% of India's sugarcane, 28% wheat and 12% rice is produced by the state. There is large variation across Western UP, Eastern UP, Central UP and Bundelkhand region. Where wester UP is highly progressive in the state because of its output from agriculture and Bundelkhand lags far behind. Irrigation is one of the most crucial variables that has benefited agriculture in UP. With a gross irrigated area of 80.2% in 2014–15, the state has a robust irrigation system that is well-endowed. Under the Pradhan Mantri Krishi Sinchayee Yojana (PMKS), the GoI had designated 99 current major/medium irrigation projects that must be finished by December 2019. These initiatives, which have been in operation for some years, were approved as part of the Accelerated Irrigation Benefits Programme (AIBP). In order to increase agricultural production and water consumption, as well as to provide an appropriate policy framework for more effective use of water resources, the World Bank approved the second phase of the USD 515 million water sector restructuring project in Uttar Pradesh in August 2013.

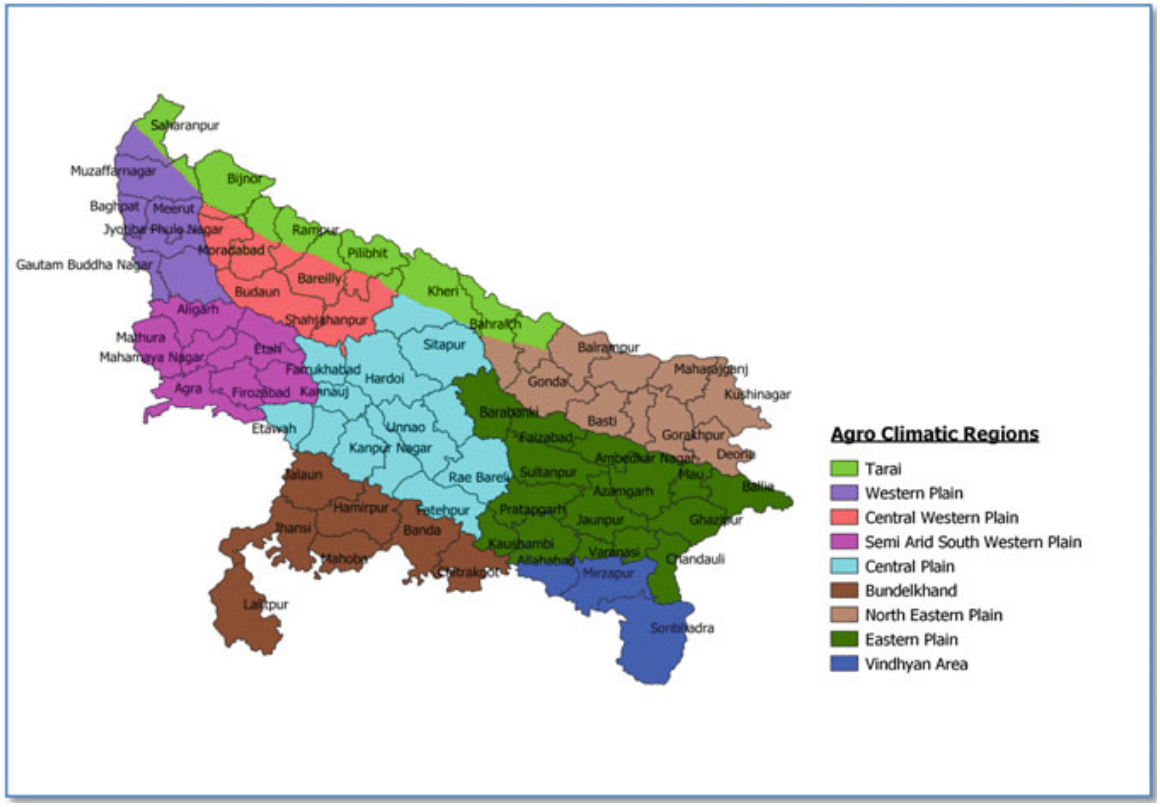
Figure 9.2: Irrigation ratio in Uttar Pradesh and India



Source: *Directorate of Economics and Statistics*

The state has ample alluvial soil along with diverse agro-climatic zones which supports the cultivation of variety of crops. UP is divided in nine agro-climate zones-Terai, western plains, midwestern plains, western semi-dry plains, mid-western south plains, south-western semi-dry plains, Bundelkhand, north-eastern plains and Vindhyachal.

Figure 9.3: Agroclimatic zones of Uttar Pradesh



Source: *Created using QGIS from Government of Uttar Pradesh's data*

Farm Power availability in Uttar Pradesh

According to the report 'Monitoring, Concurrent Evaluation And Impact Assessment Of Sub-Mission On Agricultural Mechanization' (2018) of Ministry Of Agriculture & Farmers Welfare (Department of Agriculture, Cooperation & Farmers Welfare, Mechanization and Technology, Prior to the adoption of SMAM, the average farm power availability in the State of Uttar Pradesh was 2.416 kW/ha (2014); by the end of 2016–17, it had climbed to 2.836 kW/ha, representing a 17.4% increase in FPA in three years. By the end of 2016–17, Uttar Pradesh's FPA, which was 2.025 kW/ha, was 40% more than the national average. The State of Uttar Pradesh's district-level farm power availability (2016–17) is rated as follows.

Table 9.1: Farm power availability across districts in Uttar Pradesh

Name of the District	Farm Power Availability (kW/ha)	Legend
Agra	2.896	
Aligarh	1.775	
Allahabad	2.620	
Ambedkar Nagar	1.673	
Auraiya	1.920	
Azamgarh	3.171	
Baghpat	4.123	
Bahraich	2.107	
Ballia	1.636	FPA more than 2.03 kW/ha FPA between 1.00 to 2.03 kW/ha FPA less than 1.00 kW/ha
Balrampur	2.457	
Banda	0.941	
Bara banki	4.144	
Bareilly	3.338	
Basti	3.751	
Bijnor	3.946	
Budaun	3.456	
Bulandshahr	2.568	
Chandauli	2.192	
Chitrakoot	1.063	
Deoria	3.024	
Etah	4.253	
Etawah	1.510	
Faizabad	3.057	
Farrukhabad	2.991	
Fatehpur	1.684	
Firozabad	2.546	
Gautam Buddha Nagar	5.359	
Ghaziabad	8.447	
Ghazipur	2.353	
Gonda	2.352	
Gorakhpur	3.096	

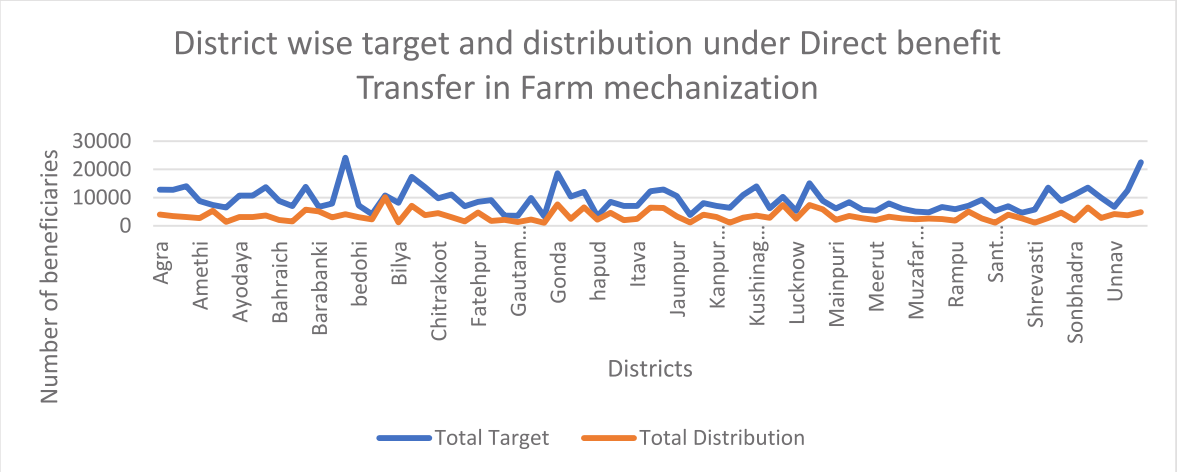
Name of the District	Farm Power Availability (kW/ha)	Legend
Hamirpur	1.651	
Hardoi	1.647	
Jalaun	1.608	
Jaunpur	3.113	
Jhansi	2.112	
Kannauj	3.213	
Kanpur Dehat	1.649	
Kanpur Nagar	1.343	
Kaushambi	1.513	
Kheri	2.464	
Kushinagar	2.966	
Lalitpur	2.169	
Lucknow	2.767	
Mahamaya Nagar	2.527	
Mahoba	2.081	
Mahrajganj	3.558	
Mainpuri	1.756	
Mathura	3.452	
Mau	2.629	
Meerut	4.523	
Mirzapur	2.317	
Moradabad	7.718	
Muzaffarnagar	4.536	
Pilibhit District	3.619	
Pratapgarh	2.183	
Rae Bareli	4.230	
Rampur	7.142	
Saharanpur	7.217	
Sant Kabir Nagar	2.510	
Sant Ravidas Nagar, Bhadohi	3.213	
Shahjahanpur	2.277	
Shrawasti	2.094	
Siddharthnagar	2.890	
Sitapur	2.670	

Name of the District	Farm Power Availability (kW/ha)	Legend
Sonbhadra	2.536	
Sultanpur	4.351	
Unnao	2.193	
Varanasi	2.661	
Average	2.836	

Source: *Mechanization & Technology Division, Ministry of Agriculture & Farmers Welfare*

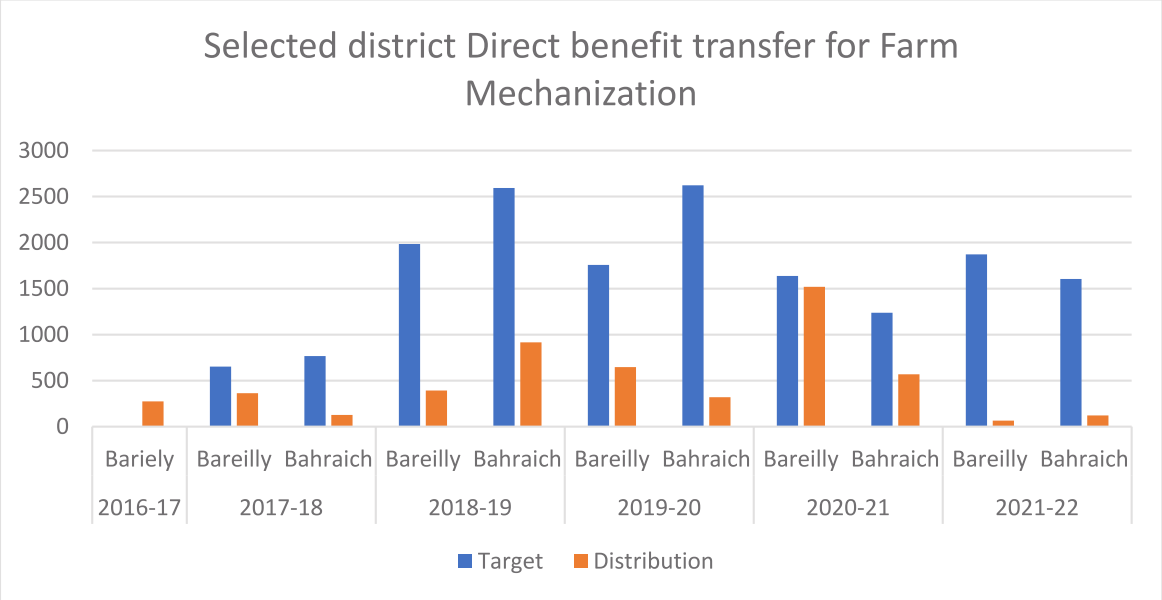
There have been number of schemes in Uttar Pradesh to promote agriculture in Uttar Pradesh. In 2015, Pradhan Mantri Krishi Sinchai Yojana was implemented to extend coverage of irrigation 'Har Khet ko Pani' and improve water use efficiency 'More Crop per Drop' in focused manner. In 2017, Kisan Uday Yojana was launched to in 2018, U.P Fasal Rin Mochan Yojan was launched to benefit about 86 lakh farmers across the state whose loans would be waived off by the government. In 2020, U.P Kisan Asan Kist Yojana was launched so that farmers can pay their outstanding tube well electricity bills in instalments (kishts). Mukhyamantri Krishak Durghatna Kalyan Yojana in 2020 was launched to provide accidental insurance scheme. The state govt. will provide financial assistance to family of farmer's who die or become handicapped while working in fields. This new scheme will replace the existing U.P Mukhyamantri Krishak Durghatna Jivan Bima Yojana. U.P Mukhyamantri Kisan & Sarvhit Bima Yojana. Sub Mission on Agricultural mechanization is implemented with guidelines of central government.

Figure 9.4: District wise target and distribution under direct benefit transfer in farm mechanization



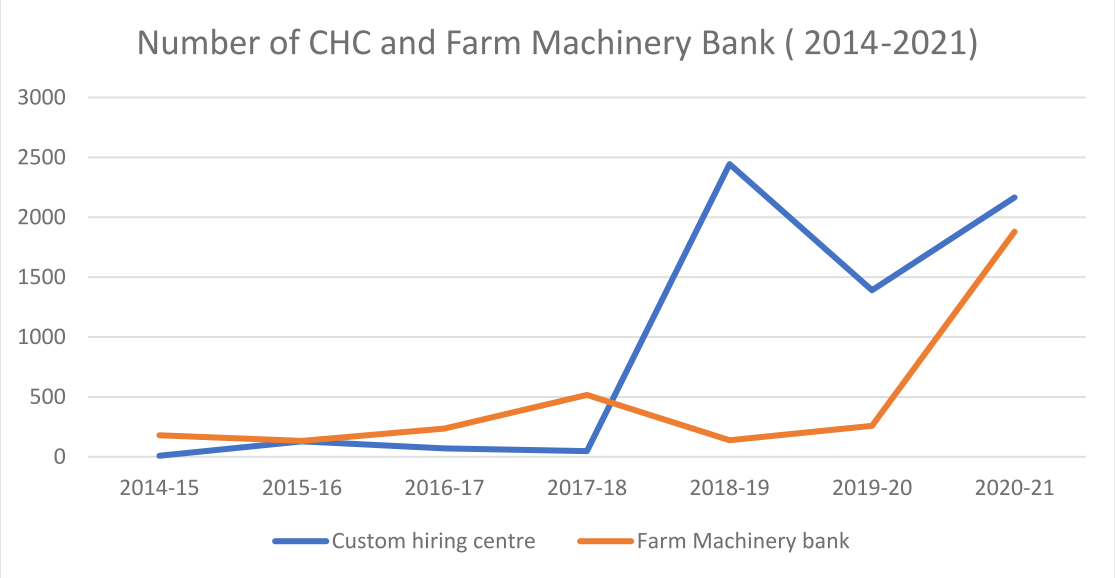
Source: *Department of Agriculture, Uttar Pradesh*

Figure 9.5: Year wise direct benefit transfer for farm mechanization for districts under the study



Source: *Department of Agriculture, Uttar Pradesh*

Figure 9. 6: Number of CHC and Farm Machinery Bank in Uttar Pradesh (2014-2021)



Source: *Department of Agriculture, Uttar Pradesh*

Section 2: Village and household profiling from primary data

With the given methodology, 5 villages were selected in each block of two districts of Uttar Pradesh. The list of the villages where surveys were conducted is given in Table 9.2.

Table 9. 2: Block wise list of sampled villages

District	**Bahraich**		**Bareilly**	
Block	Chittaura	Huzoorpur	Baheri	Bithri Chainpur
Village	Begumpur	Adilpur	Dunda Sumali	Ismailpur
	Bhagwanpur Mafi	Chiraiya Tod	Fazilpur	Khaikhera
	Chakujot	Karmullapur	Gursauli	Maheshpur
	Gulhariya	Nivui Khurd	Khejarpur	Nathurampura
	Soharwa	Shivnaha	Sukotia	Sahua

In the state, Marginal farmers consist of 42% of the population across all the blocks followed by 31% of small farmers, 16% of medium farmers, 10% by agricultural labour and 1% of large farmers (figure 9.7). All blocks have presence of Self-help groups. Presence of CHC is only in Chittaura and Huzoorpur block. There is no presence of Farm machinery banks in these blocks. Also, there are no farmers club but there is 1 farmer producer organization in Chittaura block. Agriculture cooperatives are present in all 3 blocks but not in Chittaura. All blocks have presence of dairy cooperative. Only Baheri and Huzoorpur have agri clinic and business centre. The presence of various organisations/entities in the blocks can be seen in the figure 9.8 There is a very high penetration of SHGs in Uttar Pradesh as shown in the figure 9.8.

Figure 9.7: Number of farmers in each land category across total villages under the study

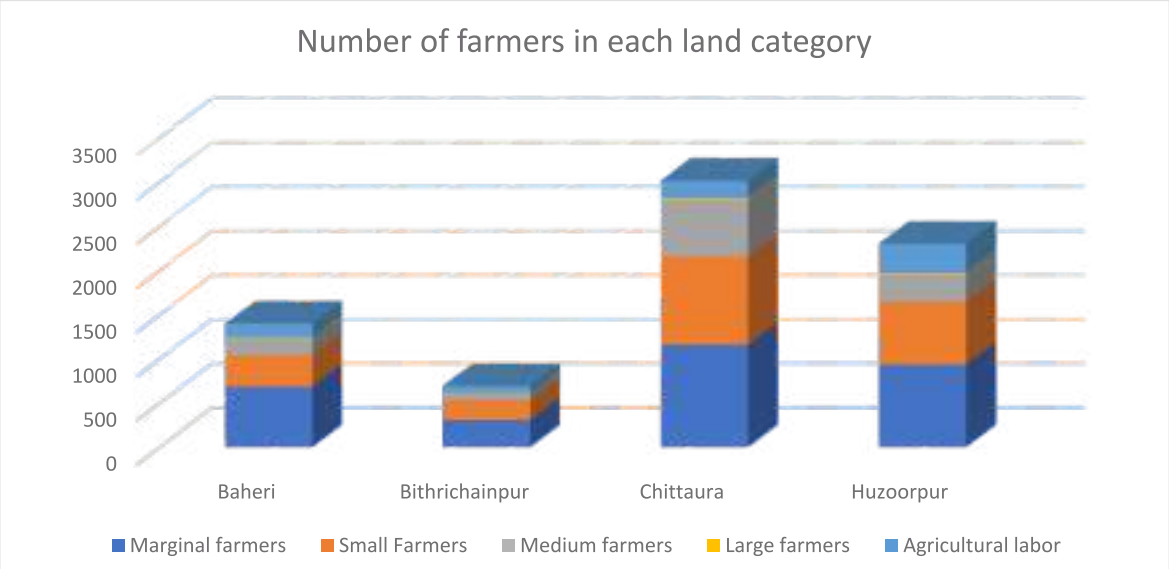


Figure 9.8: Number of community organization across blocks

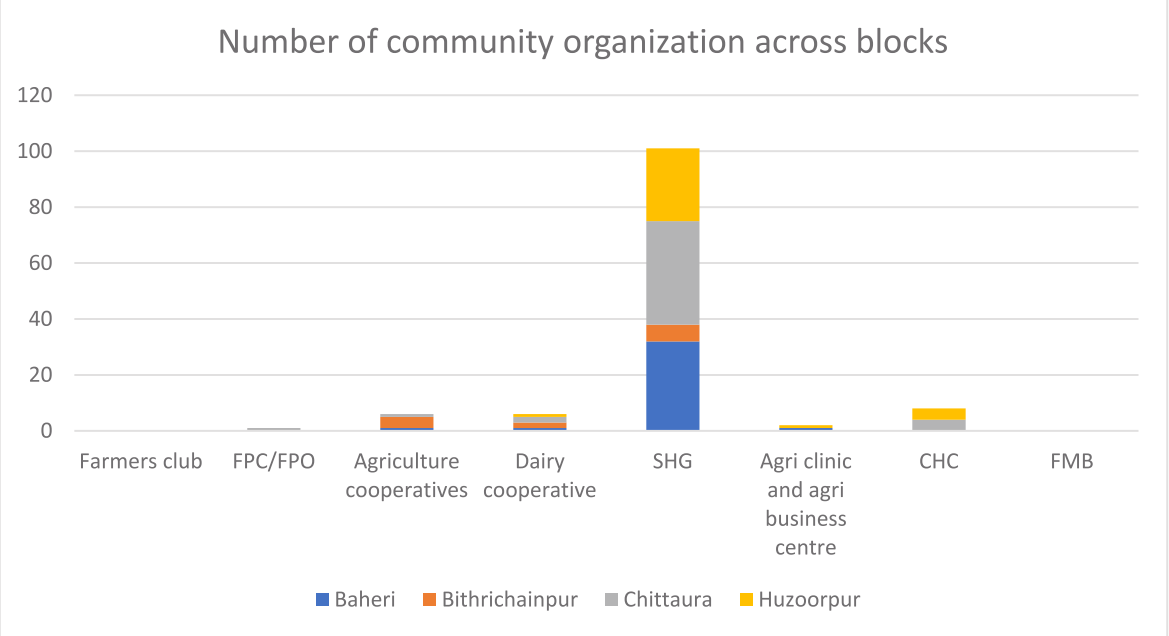
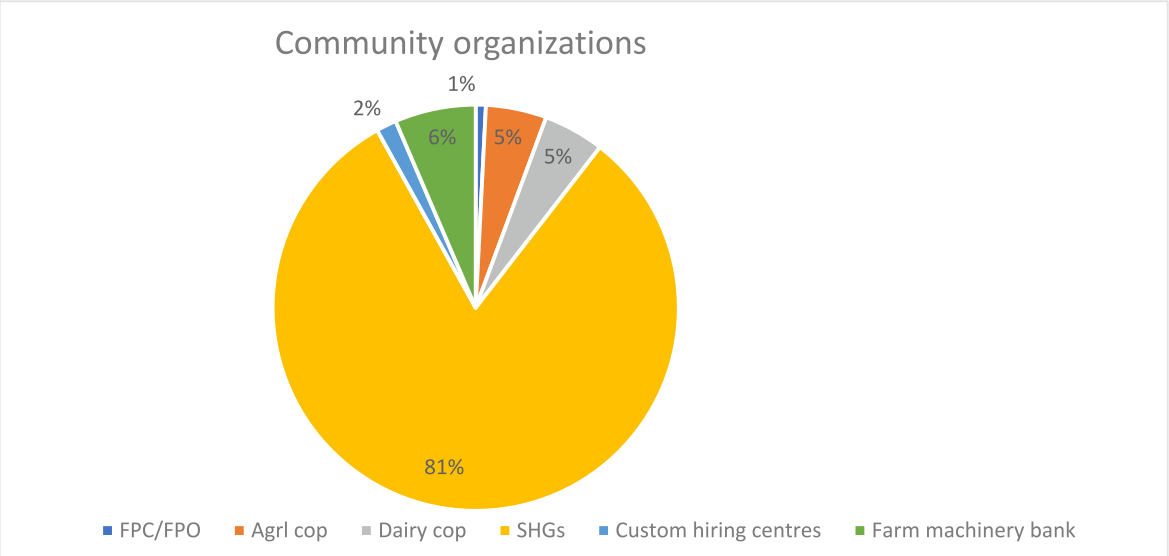
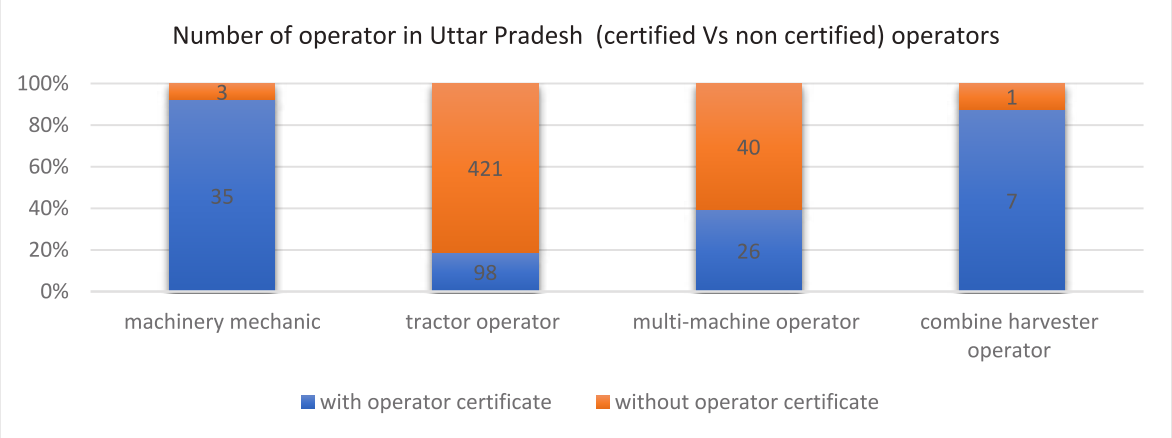


Figure 9.9: Respondent part of community organization



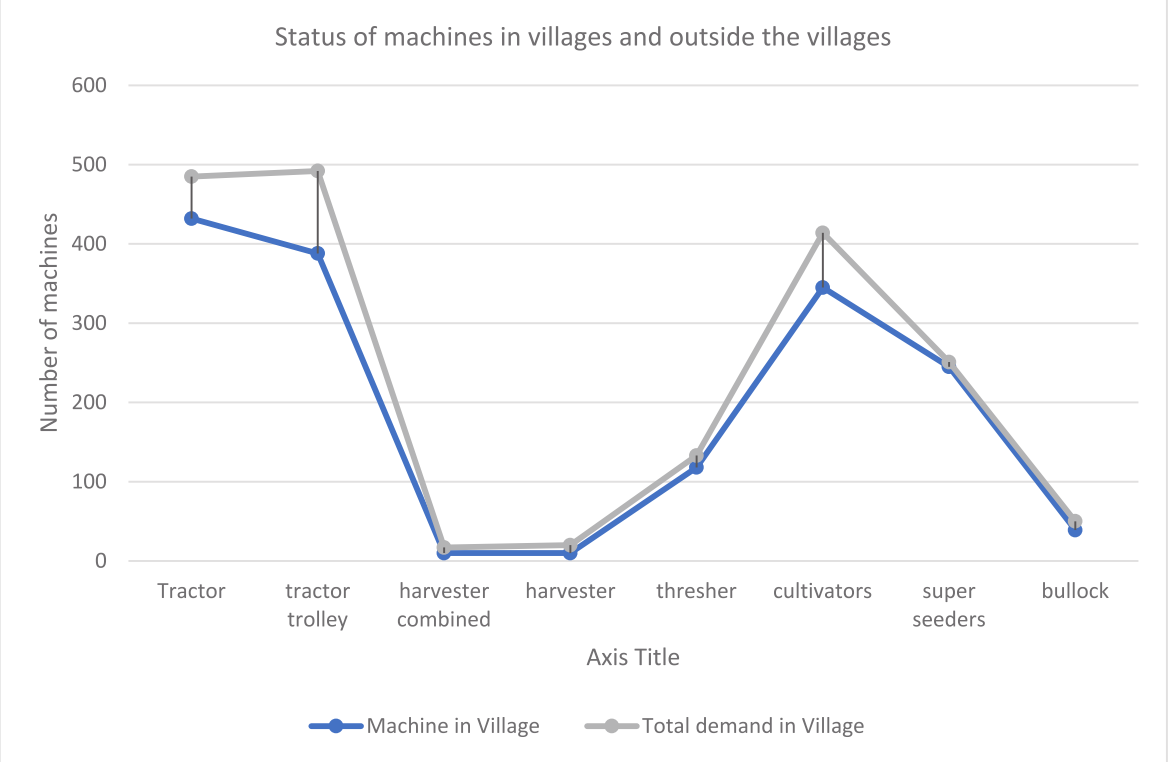
A village level analysis showed that the only a small proportion of tractor operators and multi machine operators are certified. But the proportion of certificate holders are high for combine harvesters and mechanics of agricultural machinery. This certification indicates that the operators and mechanics have undertaken a formal training process. The probable reason for this trend is due to the fact that combine harvesters are not so prevalent and are relatively technical than a tractor. Owing to the complexities, a proper training is required to operate them. Also, availability of combines is limited and hence everyone cannot have access to it for trials. For mechanic, it requires a higher level of knowledge for repairs and spare parts. It is imperative to have training for these complexities. The machine wise split of certified operator and non-certified operator can be seen in the figure 9.10.

Figure 9.10: State wise presence of certified operators



A gap in availability of the machine is found at the village level (Figure 9.11). This gap is covered by renting machines from outside of the village. A large gap is seen in tractors, tractor trolleys and cultivators. A small gap is seen in combine harvesters, harvesters, threshers and super seeder. The machines which are rented from the village are of low rental rates than the machines which are rented from outside the village. There is no gap in chaff cutters, diesel and electric motors and sprayers. These are mostly individually owned.

Figure 9.11: Status of machines in villages and outside the villages



Socio-Economic and Farm-Level Characteristics

This section describes the socio-economic background of the households surveyed across four blocks in Uttar Pradesh. Socio-economic profile indicates information on the average age, education qualification, ownership of APL/BPL card, caste, gender, occupation, family size, members involved in agriculture and non-agriculture work.

Table 9.3: Block wise category of households with respect to land ownership

District		Bahraich		Bareilly		Total	
Category	**Land size**	**Chittaura**	**Huzoorpur**	**Baheri**	**Bithri Chainpur**	**Household covered for each category in the state**	**% Household covered for each category in the state**
Landless	0	15	17	13	13	58	10%
Marginal	Less than 2.5 Acres	83	82	75	83	323	54%
Small	2.5 -5 Acres	25	28	37	28	118	20%
Semi Medium	5 - 10 Acres	23	16	17	23	79	13%
Medium	10 - 25 Acres	4	1	8	3	16	3%
Large	25 Acre and above	0	0	0	0	0	0%
		150	144	150	150	594	

The household have been classified into six categories i.e., Landless, Marginal (less than 2.5 acre), Small (2.5 – 5 acres), Semi medium (5-10 acres), Medium (10-25 acre) and large (25 acre and above). The details of the household related to the categories have been provided in the table 9.3. The number of the household surveyed in each block is 150 including all the six categories.

Figure 9.12: Age of the respondent

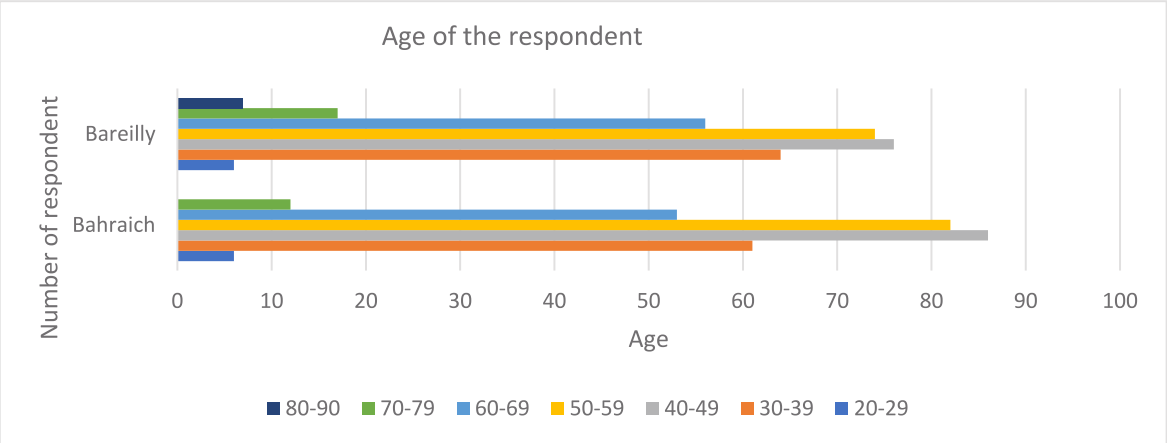


Table 9.4: Family demography and engagement in work in Uttar Pradesh

	Landless	Marginal Landowner (up to 2.5 Acre)	Small Landowner (2.5-5 Acre)	Semi Medium Landowner (5-10 Acre)	Medium Landowner (10-25 Acre)
Average Age	45.5	48.0	51.4	51.7	58.0
Average number of total family members	5.4	5.6	5.9	6.3	7.2
Average number of children (0-5 years)	0.6	0.7	0.7	0.7	0.9
Average number of children (6-14 years)	1.1	1.0	0.9	0.9	0.9
Average number of Adult Male	2.0	2.0	2.3	2.4	3.0
Average number of adult females	2.0	1.8	2.0	2.3	2.6
Average number of Male in agriculture	1.8	1.8	1.9	1.9	2.0
Average number of females in agriculture	0.5	0.4	0.2	0.1	0.1
Average number of Children in agriculture	0.0	0.0	0.0	0.0	0.0
Average number of Male in non-agriculture	0.7	0.2	0.2	0.1	0.1
Average number of females in non-agriculture	0.2	0.1	0.1	0.2	0.1
Average number of children in non-agriculture	0.0	0.0	0.0	0.0	0.0

Figure 9.12 shows the distribution of the age of respondents and we see that majority of respondents are in age group of 40 to 60 years. The trend is quite similar across the two districts indicating that people who are farming lie in the later age category. Table 9.4 indicates the family profile of the households. Generally, the trend reflects that older people are engaged in farm related activities. Households with larger land holdings also have higher average age indicating that older people continue to engage in agriculture activities when it's their own land (this is not so obvious, may be the elder are the household heads and stay back home etc). The average family size was highest in medium landowners followed by semi medium landowner, small landowner and marginal landowner respectively. The lowest average family size is of landless households. The results also indicate the level of male and female engagement in agriculture and non-agricultural work. Medium size landowners have more men and fewer women involved in agriculture. Women from landless category have higher participation in agriculture and non-agriculture work. Female participation declines with increase in land size. Male participation in agriculture is increasing with increase in land size.

Table 9.5: Block wise family demography and engagement in work

		Bareilly		Bahraich	
		Baheri	**Bithri Chainpur**	**Chittaura**	**Huzoorpur**
Landless	Average Age	47.1	46.6	43.5	45.2
	Average number of total family members	5.7	5.3	5.3	5.4
	Average number of children (0-5 years)	0.3	0.2	0.9	0.8
	Average number of children (6-14 years)	1.4	0.7	1.2	0.9
	Average number of Adult Male	2.2	2.3	1.7	1.9
	Average number of adult females	1.8	2.2	1.4	2.5
	Average number of Male in agriculture	1.5	1.6	1.7	2.3
	Average number of females in agriculture	0.9	0.4	0.7	0.0
	Average number of Children in agriculture	0.0	0.0	0.0	0.0
	Average number of Male in non-agriculture	1.2	0.0	1.5	0.2
	Average number of females in non-agriculture	0.5	0.0	0.2	0.0
	Average number of children in non-agriculture	0.0	0.0	0.0	0.0
Marginal Landowner (up to 2.5)	Average Age	46.2	49.7	46.7	49.3
	Average number of total family members	5.2	5.9	5.2	5.9
	Average number of children (0-5 years)	0.5	0.7	0.6	0.8
	Average number of children (6-14 years)	0.8	1.1	0.9	1.0
	Average number of Adult Male	2.0	2.2	2.0	2.0
	Average number of adult females	1.9	2.0	1.7	1.8
	Average number of Male in agriculture	1.6	1.8	1.9	2.0
	Average number of females in agriculture	0.7	0.5	0.4	0.1
	Average number of Children in agriculture	0.0	0.0	0.0	0.0
	Average number of Male in non-agriculture	0.5	0.0	0.3	0.0

		Bareilly		Bahraich	
		Baheri	**Bithri Chainpur**	**Chittaura**	**Huzoorpur**
	Average number of females in non-agriculture	0.2	0.0	0.1	0.0
	Average number of children in non-agriculture	0.0	0.0	0.0	0.0
Small Landowner (2.5-5 Acre)	Average Age	53.3	50.0	51.9	49.9
	Average number of total family members	6.3	5.0	5.9	6.5
	Average number of children (0-5 years)	0.6	0.5	1.0	0.8
	Average number of children (6-14 years)	1.1	0.8	0.8	0.9
	Average number of Adult Male	2.5	2.0	2.3	2.4
	Average number of adult females	2.1	1.8	1.8	2.2
	Average number of Male in agriculture	2.0	1.5	2.1	2.1
	Average number of females in agriculture	0.2	0.3	0.2	0.1
	Average number of Children in agriculture	0.0	0.0	0.0	0.1
	Average number of Male in non-agriculture	0.3	0.0	0.3	0.0
	Average number of females in non-agriculture	0.2	0.0	0.3	0.0
	Average number of children in non-agriculture	0.0	0.0	0.0	0.0
Semi Medium Landowner (5-10 Acre)	Average Age	53.9	51.7	51.8	48.9
	Average number of total family members	6.2	5.6	5.9	7.9
	Average number of children (0-5 years)	0.8	0.3	0.4	1.4
	Average number of children (6-14 years)	1.0	0.8	0.9	1.1
	Average number of Adult Male	2.0	2.3	2.4	3.0
	Average number of adult females	2.4	2.0	2.2	2.4
	Average number of Male in agriculture	1.5	1.9	2.1	2.0
	Average number of females in agriculture	0.0	0.2	0.0	0.0

		Bareilly		Bahraich	
		Baheri	Bithri Chainpur	Chittaura	Huzoorpur
	Average number of Children in agriculture	0.0	0.0	0.0	0.0
	Average number of Male in non-agriculture	0.3	0.0	0.2	0.0
	Average number of females in non-agriculture	0.4	0.0	0.3	0.0
	Average number of children in non-agriculture	0.0	0.0	0.0	0.0
Medium Landowner (10-25 Acre)	Average Age	52.6	68.7	60.3	60.0
	Average number of total family members	7.3	6.3	8.0	6.0
	Average number of children (0-5 years)	0.9	0.0	1.3	2.0
	Average number of children (6-14 years)	0.6	0.7	1.3	2.0
	Average number of Adult Male	3.0	3.3	3.0	2.0
	Average number of adult females	2.8	2.3	2.5	2.0
	Average number of Male in agriculture	1.9	2.3	2.0	2.0
	Average number of females in agriculture	0.0	0.7	0.0	0.0
	Average number of Children in agriculture	0.0	0.0	0.0	0.0
	Average number of Male in non-agriculture	0.3	0.0	0.0	0.0
	Average number of females in non-agriculture	0.1	0.0	0.0	0.0
	Average number of children in non-agriculture	0.0	0.0	0.0	0.0

All the respondents owned the house that they are living in. Major source of lighting at home is electricity whereas it is diesel/petrol pump set for agriculture land (figure 9.13). LPG is used as the major cooking fuel across the 4 blocks and firewood is the secondary. Huzoorpur and Bithri Chainpur block has 100 % respondent using smart phones as their main phone (figure 9.14). In Chittaura, 91% respondent have been using smart phone and rest 14% still rely on keypad phone for main use. In Baheri, 85% respondent use smart phone, 10% use keypad phones and 5% respondent do not use any phone. Out of the total 600 household surveyed, 94% respondent use smart phones. Out of the total keypad phone users, 69% respondent are above age of 55 years.

Figure 9.13: Block wise main source of energy

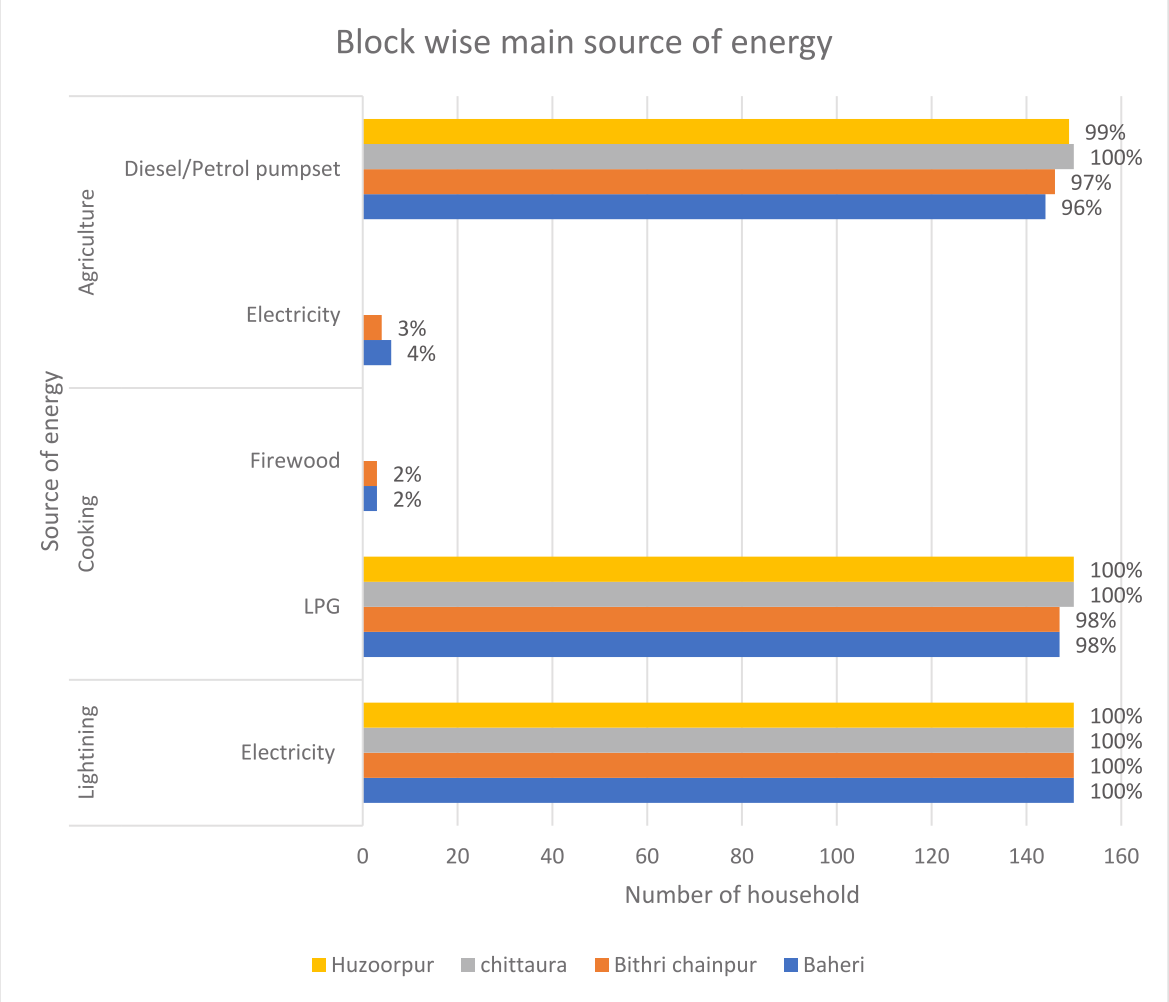


Figure 9.14: Block wise usage of smartphones

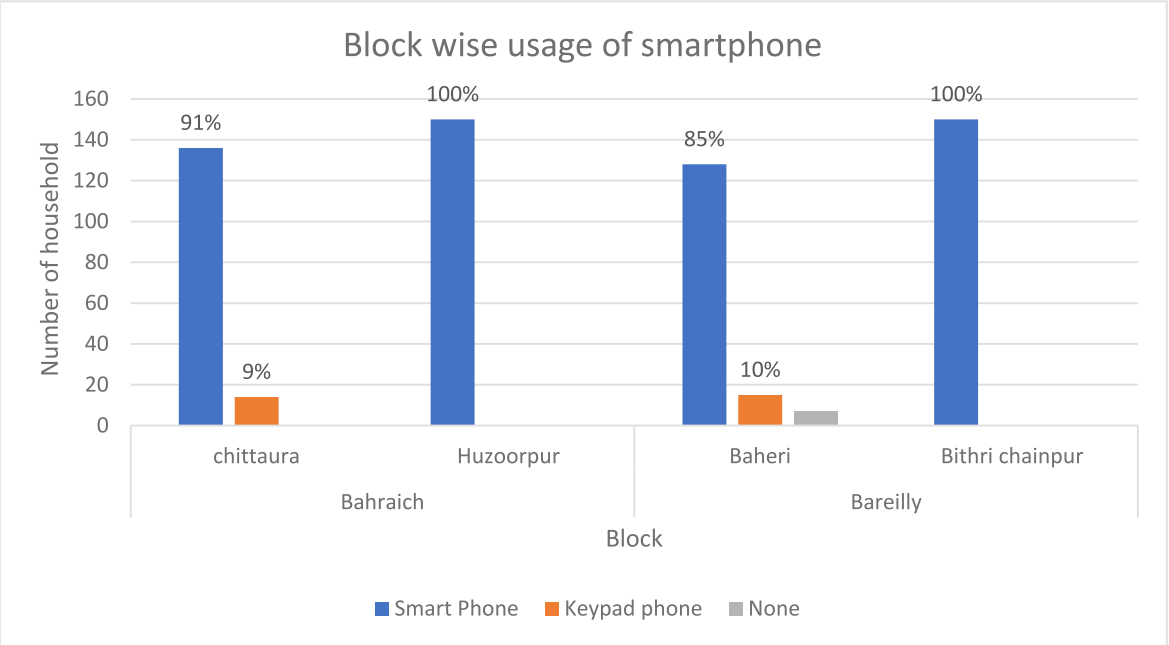


Figure 9.15: Block wise occupation of households

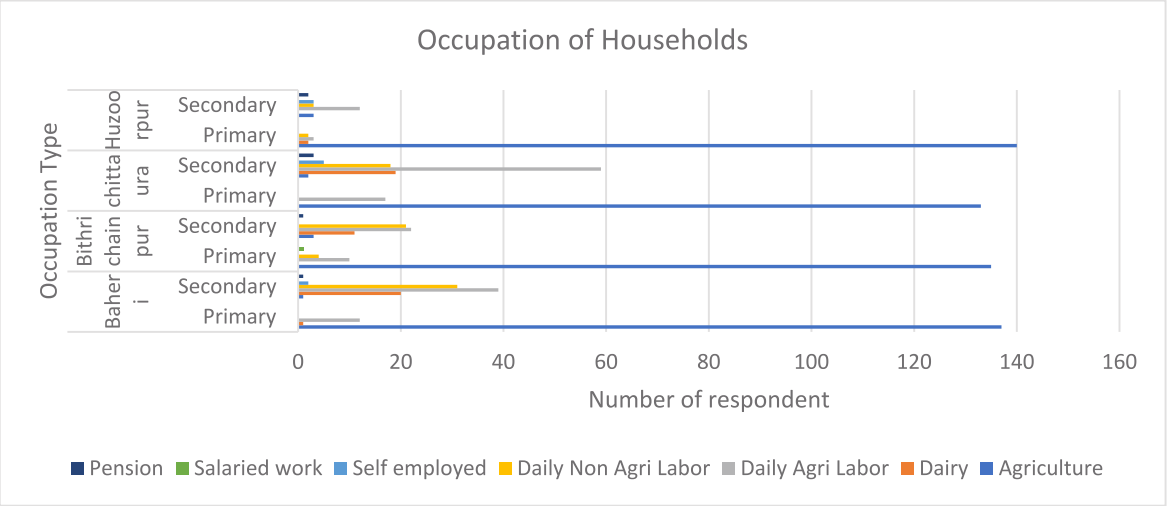


Figure 9.15 gives a sense of the proportion of households having agriculture and non-agriculture sources of income as primary and secondary occupation. As per results it seems that the highest percentage of respondent have agriculture as their primary occupation (91.33% respondent in Baheri, 90% in Bithri Chainpur, 88.67% in Chittaura and 95.14% in Huzoorpur) whereas daily agriculture labour is second most opted primary occupation engaging 8%, 6.67%, 11.33% and 2.08% respondents in Baheri, Bithri Chainpur, Chittaura and Huzoorpur respectively. Out of 150 respondents in all 4 blocks, total of 51.67% doesn't have any secondary occupation. For secondary option, the highest number of respondents have daily agriculture labour as secondary occupation followed by daily non agriculture labour. The table 9.6 can be referred to find the proportions of all the primary and secondary occupations of the respondent.

Table 9.6: Primary and secondary occupation

	Baheri		Bithri Chainpur		Chittaura		Huzoorpur	
Occupation	**Primary**	**Secondary**	**Primary**	**Secondary**	**Primary**	**Secondary**	**Primary**	**Secondary**
Agriculture	91.33%	0.67%	90.00%	2.00%	88.67%	1.33%	95.24%	4.00%
Dairy	0.67%	13.33%	0.00%	7.33%	0.00%	12.67%	1.36%	0.00%
Daily Agri Labour	8.00%	26.00%	6.67%	14.67%	11.33%	39.33%	2.04%	8.00%
Daily Non Agri Labour	0.00%	20.67%	2.67%	14.00%	0.00%	12.00%	1.36%	2.00%
Self employed	0.00%	2.00%	0.00%	0.00%	0.00%	3.33%	0.00%	2.00%
Salaried work	0.00%	0.00%	0.67%	0.00%	0.00%	0.00%	0.00%	0.00%
Pension	0.00%	0.67%	0.00%	0.67%	0.00%	2.00%	0.00%	1.33%
Other	0.00%	0.00%	0.00%	2.67%	0.00%	0.00%	0.00%	0.67%
No secondary occupation	0.00%	36.67%	0.00%	58.67%	0.00%	29.33%	0.00%	82.00%
Total respondent	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Figure 9.16: Activity wise engagement of the respondent

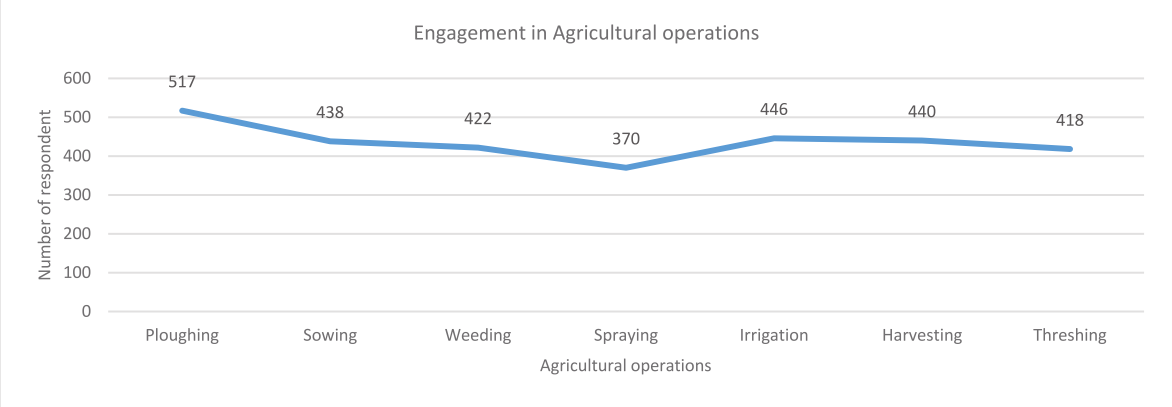
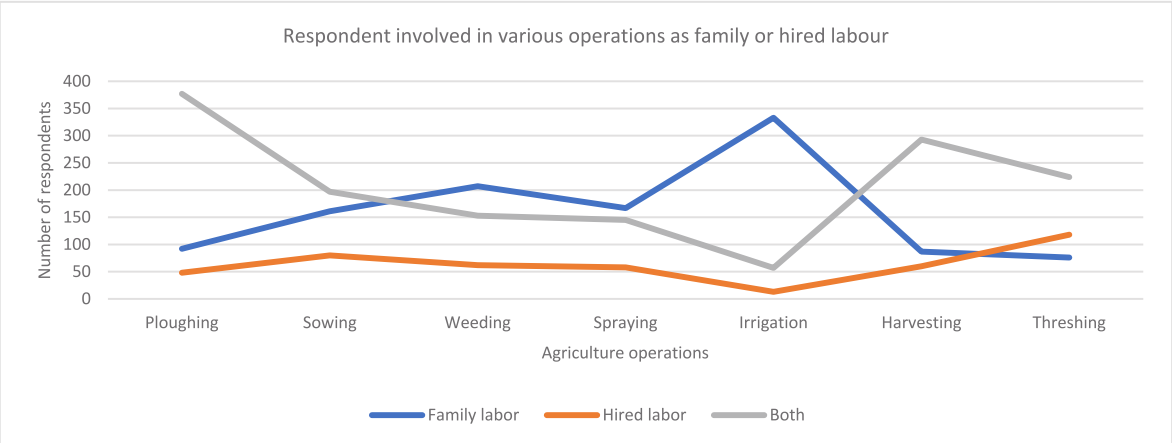


Figure 9.17: Activity wise engagement of labour (Family Vs Hired)



The figure 9.16 shows number of people engaged in various agriculture operations: 86% respondent are engaged in ploughing, 73% are in sowing, 70% are involved in weeding, 62% are involved in spraying, 74% are engaged in irrigation activities, 73% are in harvesting and 70% are in threshing. These figures represent percentage of respondent who are involved in various operations personally. These respondents are either performing these activities on their own or other's farms. It is observed in figure 9.17 that majorly respondent (73%) worked on their own farms as family labour for land preparation and also worked on other farms. Rest 9% worked as only hired labour and 18% worked as only family labour. As land preparation is power intensive activity, women do not engage. Women operations are restricted to labour intensive activities like weeding, transplanting, manual harvesting.

Table 9.7: Engagement of family and hired labour in agriculture operations

	Family labour	Hired labour	Both	Grand Total
Ploughing	92	48	377	517
	18%	9%	73%	
Sowing	161	80	197	438
	37%	18%	45%	
Weeding	207	62	153	422
	49%	15%	36%	
Spraying	167	58	145	370
	45%	16%	39%	
Irrigation	333	13	57	403
	83%	3%	14%	
Harvesting	87	60	293	440
	20%	14%	67%	
Threshing	76	118	224	418
	18%	28%	54%	

The table 9.7 shows the proportion of respondent involved in various agricultural activities as family labour, hired labour or as both. For ploughing, sowing, harvesting and threshing majority of labour worked as both (family and hired labour) whereas majority worked as family labour for weeding, spraying and irrigation. This indicates that the involvement of family labour is higher in the latter activities and less of hired labour is involved in these operations. For the state, respondent is engaged in ploughing activity for average of 12 days in a year. The respondent engagement ranges from 4 days to 22 days in a year.

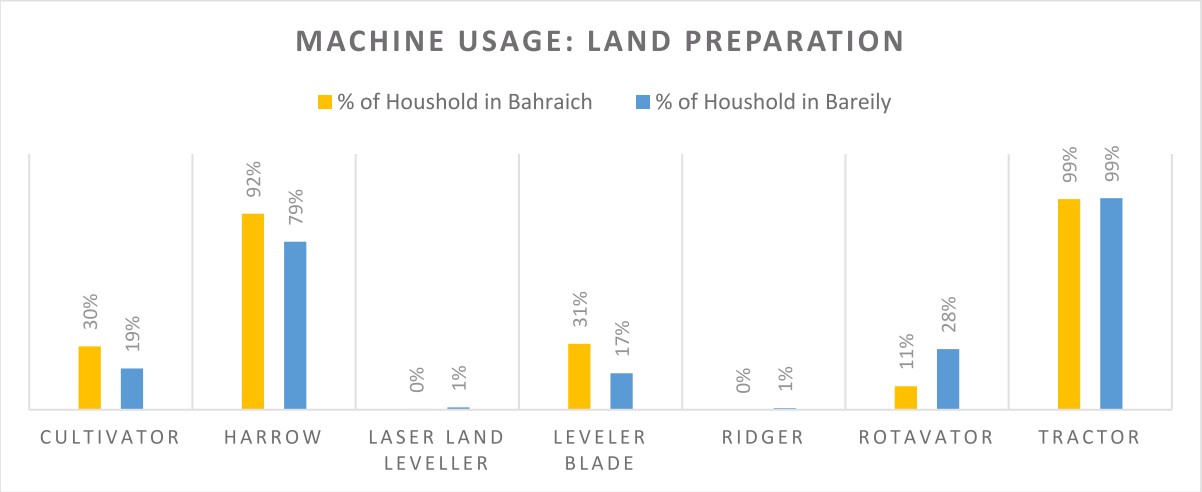
Section 3: Machine and labour dynamics in state

Machine Usage for Agriculture operations

Out of 600 households, 89% respondents own land and 11% did not own any land. Out of the land owners, of those having the own land are using the machinery for different activities such as tilling, rotation of the crops, making ridges for row crops, levelling land etc. Highest usage of machinery is found for tractors followed by harrow. The least is usage is ridger and laser land leveller. Laser land leveller are used for specific purpose of levelling the land

levels to ensure land efficiency in crop production. Not all land types need land leveller. Only unlevelled land required usage of laser land levellers. A huge proportion i.e., 99% of the respondent use tractors both in Bareilly and Bahraich districts. Only 1% are not using the tractors due to various reasons discussed further. Usage of harrow is up to 92% respondents in Bahraich and 79% respondent in Bareilly.

Figure 9.18: Agriculture machine usage in land preparation



The major reasons which were captured from the respondent for non-adoption of machineries in land preparations can be categorised in to expenses and labour availability. The non users indicated that the machines are expensive to hire and purchase and incurs high maintenance cost. Also, availability of cheap manual labour, availability of family labour and ownerships of bullocks resulted in non-usage of machines.

Figure 9.19: Ownership of tractor

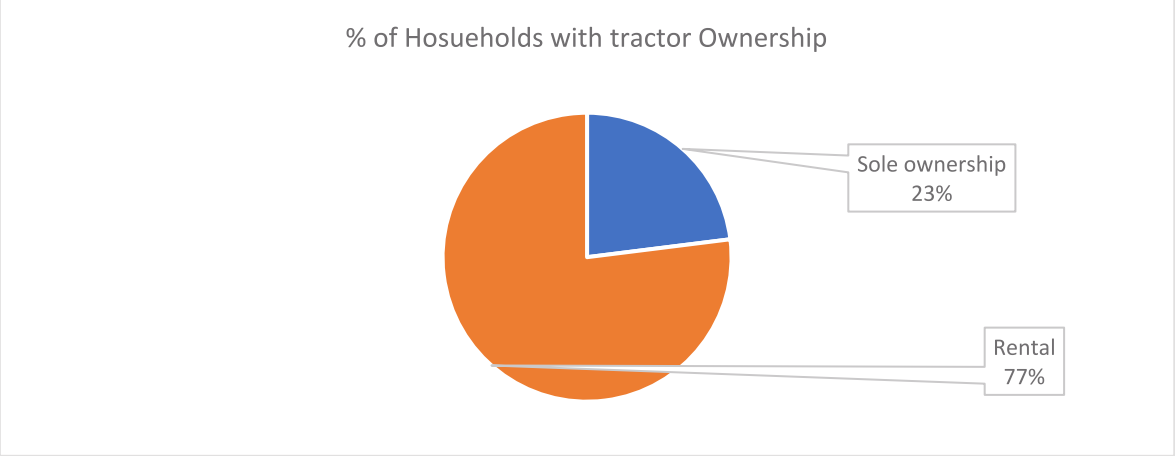
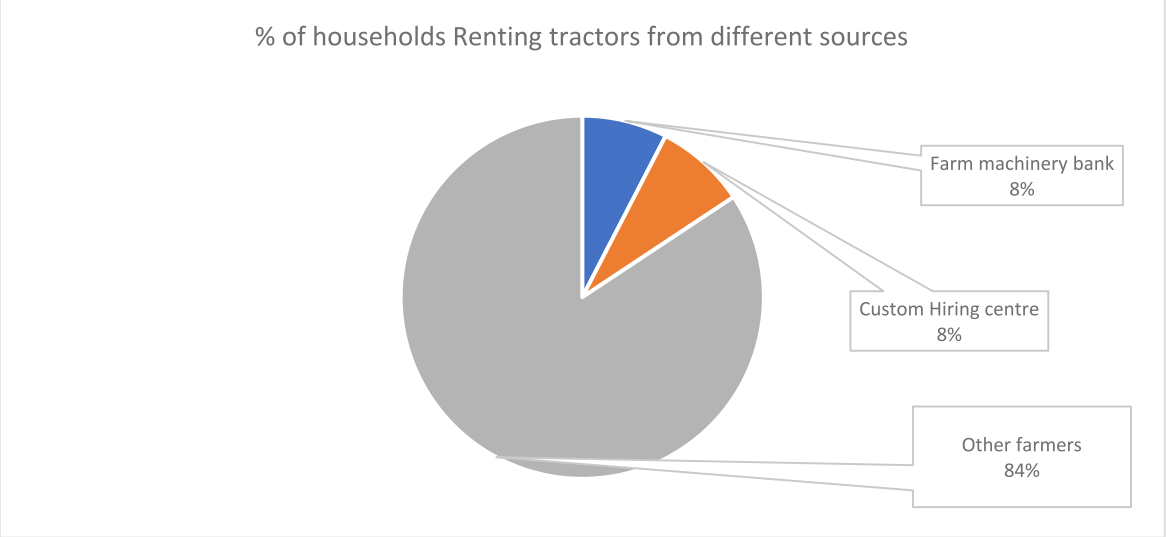
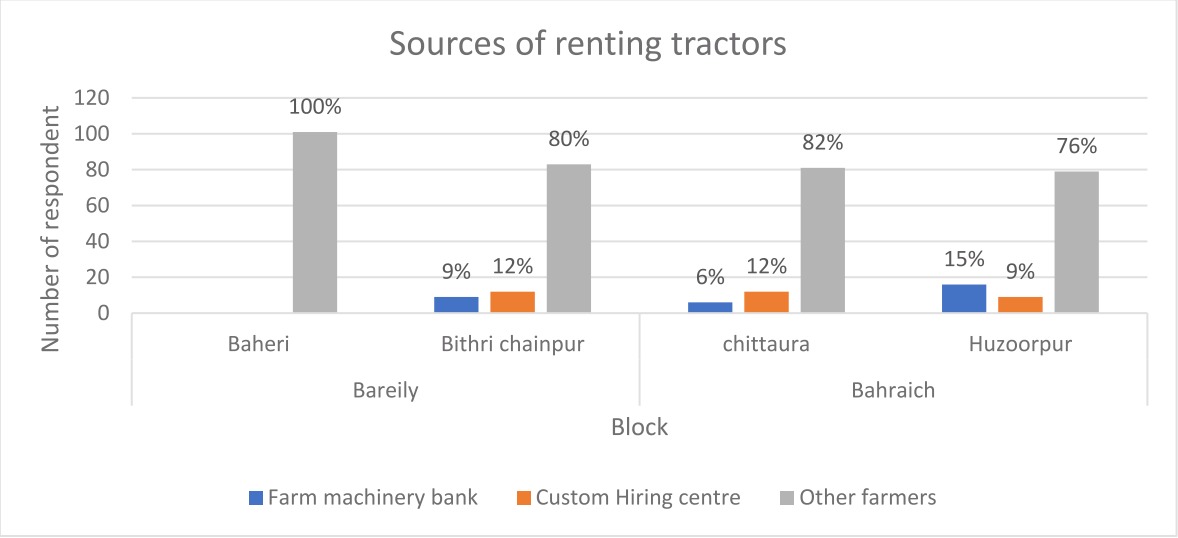


Figure 9.20: Sources of renting tractors



Not many households' own tractors but rental of tractors is common practice across all the blocks in two districts. Out of the total landowners, 23% owned tractors and 77% were renting it from various sources for agriculture operations. Renting tractors from other farmers was widely observed where out of total households renting, 84% households rented from other farmers, 8% from custom hiring centres (CHC) and 8% from farm machinery banks (FMB).

Figure 9.21: Block wise rental sources used by households



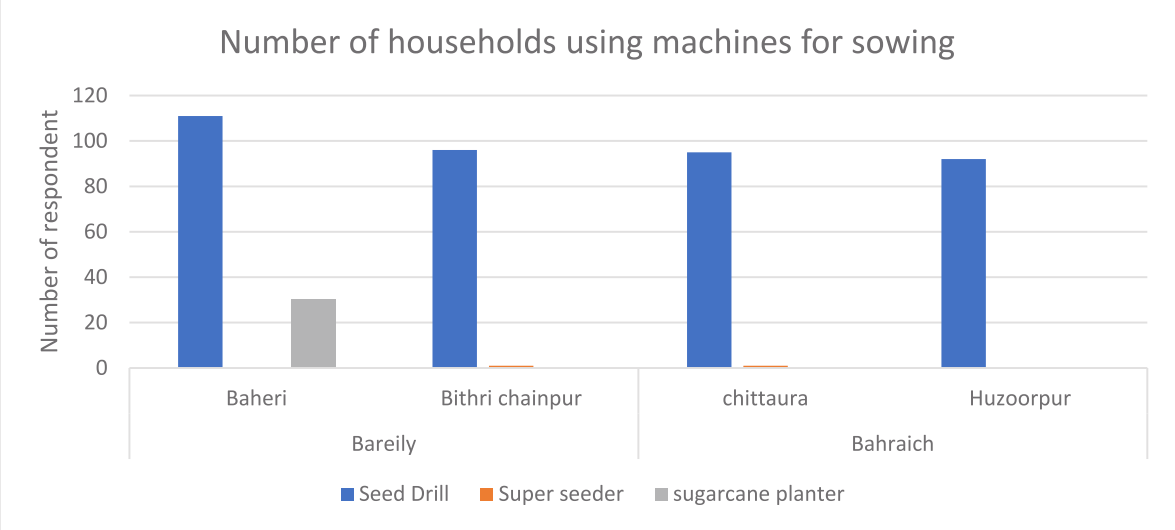
Above graph indicates the popular renting options. Presence of CHCs and FMBs is nil in Baheri block but in other 3 blocks of Bithri Chainpur, Chittaura and Huzoorpur, CHCs and FMBs are one of the sources of renting. From the total renters, 81% respondent found the rental charges to be affordable and rest 19% found it to be non-affordable.

From the total tractor users, 86% respondent hired operators for driving but 14% operated the tractors themselves. All of the operators learned driving a tractor from family members/ friends. They did not undergo any formal training process from either of the sources mentioned: Private dealers/suppliers, FMTTIS (training institute), KVKs, Block agriculture office, ATMA, Gram sevak, Kisan mitra, NGOs or any other private organisation. There has

been no involvement of women in tractor operations. Out of the total tractor owners, 61% respondent undertook maintenance at regular intervals and only 30% respondents did it when a break down would occur. The frequency of breakdown has been captured from the respondents where it was found that only 7% respondent didn't have any breakdowns, 50% respondent incurred one breakdown in last 6 months and 25% respondent incurred it twice. Major proportion of respondent (88%) could diagnose and repair their tractors themselves and only 12% needed to approach the mechanic at village level and 38% witnessed delay in repair services as there are not enough mechanics in village.

Sowing:

Figure 9.22: Block wise usage of machines for sowing



Out of 536 household, 24% did not use any machine for sowing operations. Seed drills emerged as the popular machines with 74% households using it for sowing. Few respondents use multiple machines as per the crop requirement, 6% respondent used sugarcane planter and only 0.37% used super seeder. Sugarcane planter usage was observed across Baheri block only.

Out of 130 households which don't use any machine for sowing, 97% respondent cited that these machines are expensive to purchase and 98% cited that they are expensive to hire. Apart from these affordability issues, 23% respondent cited that they have high maintenance cost. Also, labour availability came up as an important factor with 79% citing engagement of family labour and 51% cited availability of cheaper manual labour. Only 5% respondent owned bullocks and hence didn't want to use machines for sowing operations.

Reasons for not taking land preparation machines	*% of Respondent*
Machines are expensive to purchase and hire	98%
High maintenance cost	23%
Engagement of family labour	79%
Availability of inexpensive labour	51%
Ownership of bullocks	5%

Only 1% household owned seed drills and 99% are renting it. Only 6% rented it from custom

hiring centres but rest 94% rented from other farmers. The cost is in range of Rs 50,000 to Rs 1 lakh. All the seed drills were brought from the nearby block with their own capital/savings. The cost of operation for owned seed drill is Rs 1400 per acre. For rentals, all the machines are hired based on per acre charges. Out of all the user household, all felt that the rental charges are affordable. All the respondent confirmed that machine is available whenever it is required for operation. All relied on hired operators which came along with the machines while renting. All the responded said that operators are easily available for all the machines and their work is satisfactorily.

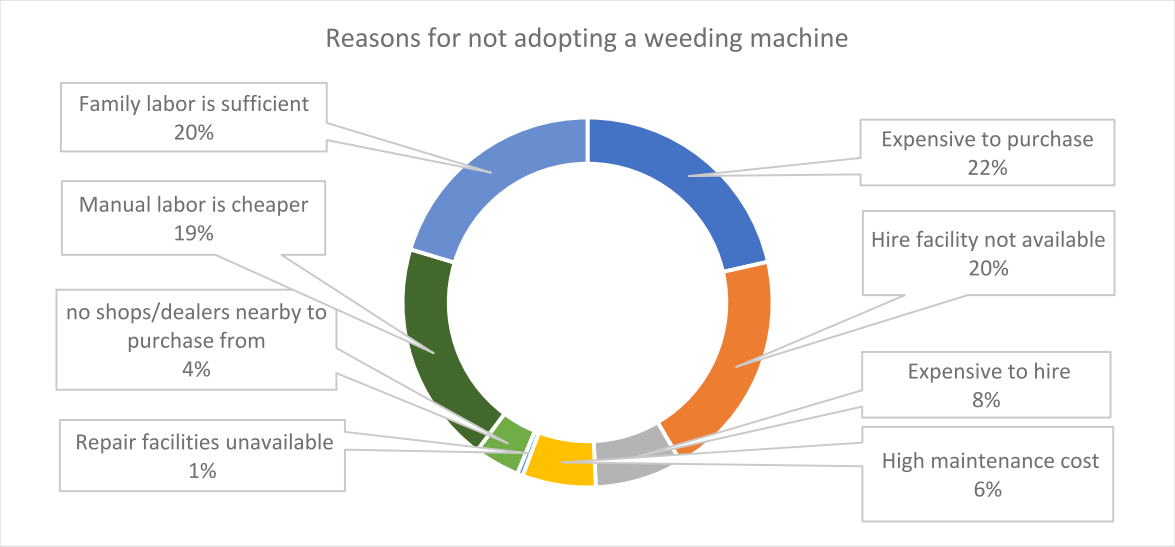
The owners of the machine didn't find the manual useful. The major problem faced by the owners is of calibration. There is no frequent machine break down but the owners faced machine breakdown at least once in every 6 months. These issues were tackled by self- repair. There were no formal trainings received by the owners of the machines. But they are willing to adopt suggestive innovative methods of improving efficiency performances and life span of machines.

Average cost of renting seed drills is Rs 1500 per acre across all the blocks. But the average operating cost of rental machines varies across blocks with Rs 2048, Rs 2132, Rs 2118 and Rs 2131 per acre in Baheri, Bithri Chainpur, Chittaura and Huzoorpur respectively. For super seeder, the average cost of renting is Rs 1500 and average operating cost is Rs 2000. For Sugarcane planter, average rental cost is Rs 2000 and average operating cost is Rs 2625.

Weeding:

Across the state, in all four blocks of Baheri, Bithri Chainpur, Chittaura and Huzoorpur, there was no use of any kind of weeding machine. Manual weeding was preferred in all the crops cultivated. Among the 536 households, reasons of non-usage of weeding tools were interviewed and the results are in the graph.

Figure 9.23: Reasons for not adopting a weeding machine

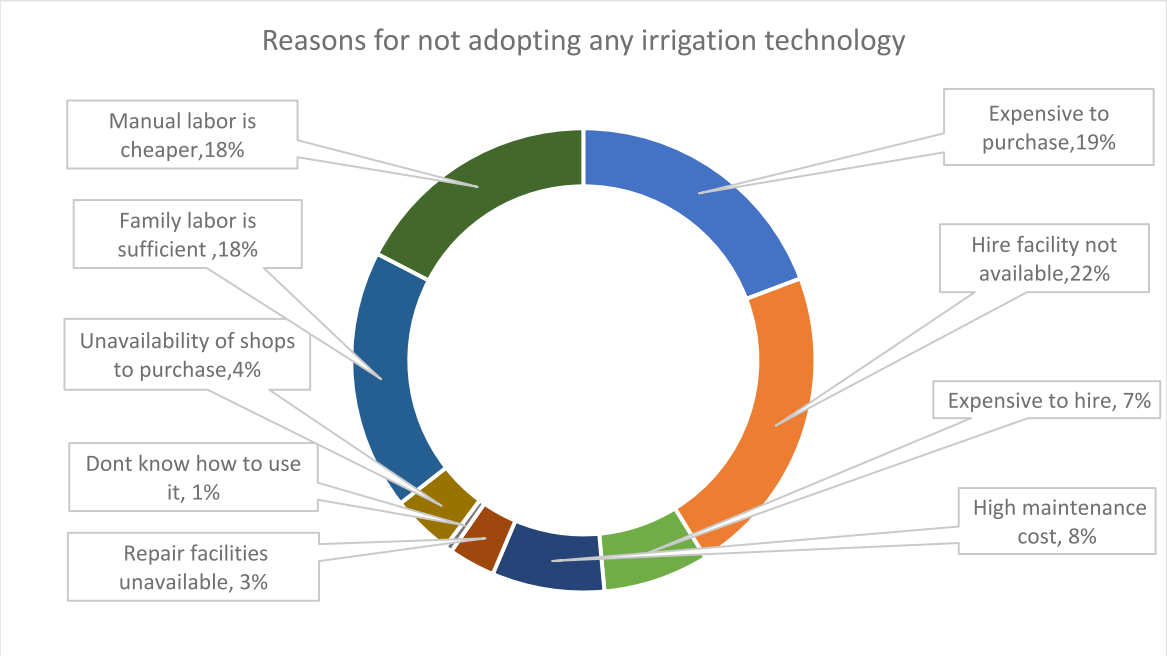


Out of all, 22% households found weeding machines expensive to purchase, 20% have sufficient family labour and hence engage them in weeding activities instead of spending on machines, 20% households don't have any hiring facility as they found rentals affordable, 19% find that manual labour is cheaper and hiring them is affordable, 8% cited expensive rental of weeding machines and resort to traditional ways of weeding like manual hired or family labour , 6% cited that these machines have high maintenance cost, 4% cited unavailability of shops or dealers nearby to purchase machines from and only 1% found that the repair facilities for these machines is not available and hence buying them will be burden when it

comes to their repair.

Irrigation:

Figure 9.24: Reasons for not adopting any irrigation technology

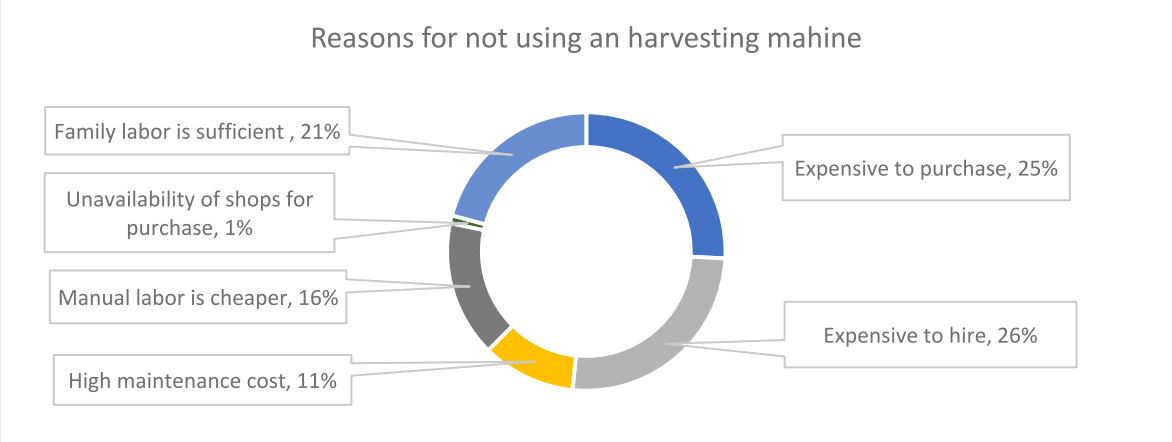


For irrigation, the spread of irrigation technology like drip/ sprinkler/ rain irrigation was captured across all the blocks in Uttar Pradesh. From the total respondent, 19 % households found irrigation technology expensive to purchase for implementation, 18 % have sufficient family labour and hence engage them for irrigation activities instead of spending on new technology, 22 % households don't have any hiring facility (irrigation setup are not available for rentals), 18 % find that manual labour is cheaper and hiring them is affordable, 8 % cited that these machines have high maintenance cost, 4 % cited unavailability of shops or dealers nearby to purchase machines from and only 3 % found that the repair facilities for these machines is not available and hence buying them will be burden when it comes to their repair.

Harvesting:

Combine harvesters are the popular machine for harvesting operations across all blocks in Uttar Pradesh with 66% respondents using combine harvesters. Out of the total users, only 2% owned combine harvesters and rest 98% rented it. Around 6% respondents rented it from Custom hiring centres and 94% respondents from other farmers. The major reasons for not using harvesters by the respondents are mapped in figure 9.25.

Figure 9.25: Reasons for not using a harvesting machine



Among the various reasons of not using the harvester is the affordability with 25% respondents finding it expensive to purchase and 26% respondents finding it expensive to hire. Another reason is the availability of labour where 21% respondents cited sufficient family labour and 16% cited availability of cheap manual labour. Only 1% had problems with accessibility of shops to purchase the combine harvesters and 11% respondent found the maintenance cost to be high.

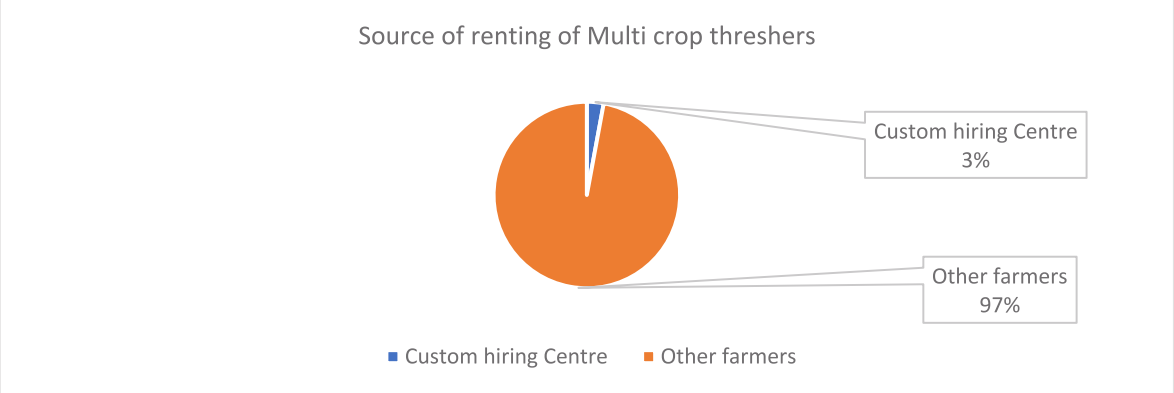
All the owned combine harvesters are of John Deere brand with 55 hp power. They have been purchased from the block level with loan from the bank. The average operational cost of operating own combine harvester is Rs 1572 per acre. The average per day labour charges in the state for harvesting operations is Rs 306.87 ranging from Rs 302 to Rs 320 per day across blocks. There is no involvement of women in harvesting operations with combine harvester.

Average cost of rental of combine harvester is Rs 3000 per acre and average cost of operations of rental combine harvester is Rs 3441 per acre. All of the households renting the combine harvester have stated that renting charges are affordable and they are able to access and use the machine when required. All of them have hired operator with the machine and found their work to be satisfactorily. From all the combine owners, no respondents have read the manual which came along. Also, all of them undertook repairing and maintenance when there was a break down in the machine. None of the owner of the machine conducted regular maintenance on fixed intervals. Majorly, there were issues in starting of the combines. None of them faced any major breakdown issues. All the owners of combine were willing to adopt suggestive innovative methods of improving efficiency performances and life span of their machine.

Threshing:

The 66 % of respondent which is 352 households have responded usage of combine threshers for harvesting operations. Multi crop thresher is being used by 32% of the respondents and 1% respondent do not use nay machines. All the respondent not using the machine stated that multi crop threshers are expensive to purchase and hire and they engage family labour, 38% found manual labour to be cheaper. All the users of thresher use fuel operated multi crop thresher. Additionally, two labour is required during multi thresher operation. Majorly labour is available for Rs 300 – Rs 400 per day. All the threshers have been rented and no respondents own any multi crop threshers. Only 3% of the respondents rent it from custom hiring centre and 97% from other farmers.

Figure 9.26: Source of renting multi crop threshers

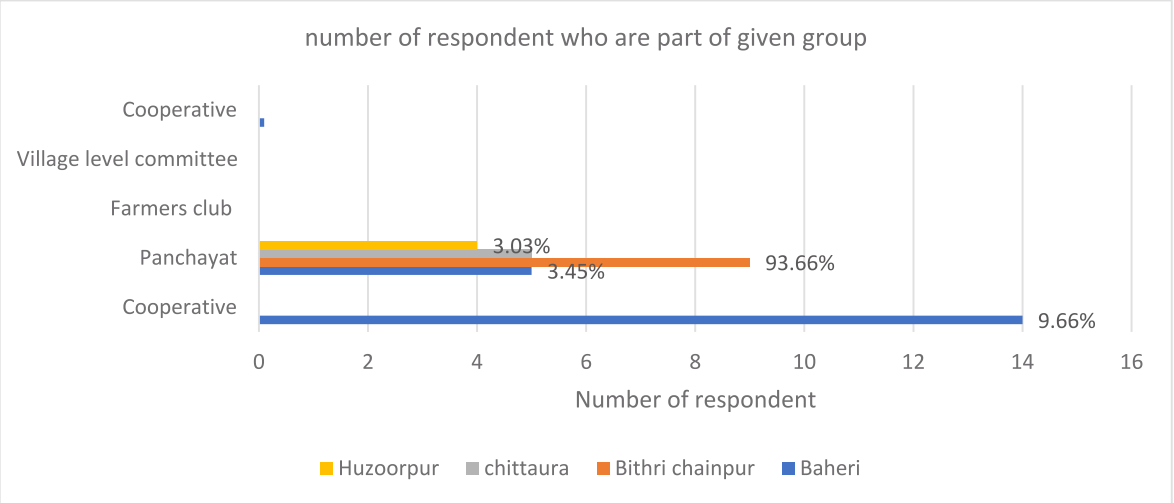


The cost of rental is Rs 1300 per hour and the cost of operation with multi crop thresher is Rs 1500 per acre. All the respondent found these rental charges to be affordable. The machine availability hasn't been a problem as all the household could easily arrange for renting multi crop thresher as and when required for operations. Out of 172, 11% respondent operated the multi crop thresher by themselves and rest 89% hire operators. None of them received any formal training for operating the machine. From the total respondent who hire operators, 98% could find the operators easily and 95% could find the operators work satisfactory.

Section 4: Skill gap and access to extension services

Adoption of technology/machines depends on the level of its awareness, availability and affordability. The adoption and sustained usage of machines will be decided by 3A's. The conceptual framework adopted for the adoption of machines which focusses on 3A' (Awareness of the machines, Availability of machines and Affordability of the machines) is used for capturing status of household If a machine is to be used by a farmer, then question arises: who provides information on that particular machine, where to purchase the machine, who will operate the machines, who provides training to operate the machine, who repairs and maintains the machine, where are the spare parts available for the machine. In this section, primary survey captures the sources of information with rural households.

Figure 9.27: Block wise participation of farmers in various groups/ community organizations



The figure 9.27 gives an idea of the engagement of the farmers in community organization across the state. Cooperatives see the highest participation in Baheri block. Engagement with Panchayat is seen in all the blocks. From the land owners and landless respondents, 93% respondents were not part of any community, 4% are member of panchayat and 2% are member of cooperative (figure 9.28). From 521 respondent, 98% own bank account and only 2% did not own it. For Kisan credit card, 97% respondent own it and only 3% did not.

Figure 9.28: Number of respondents who are part of given group across the state

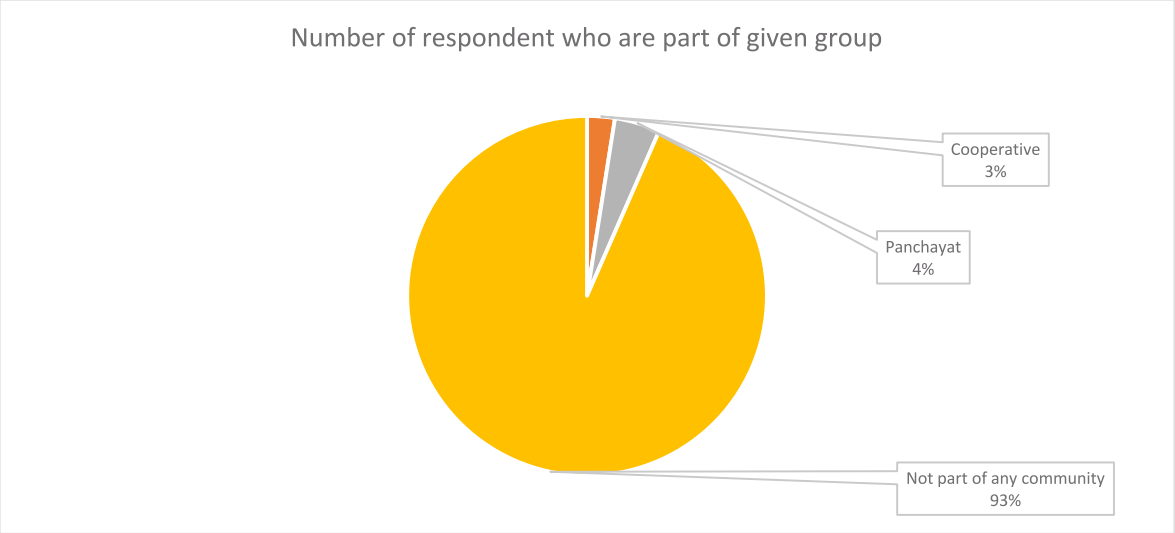
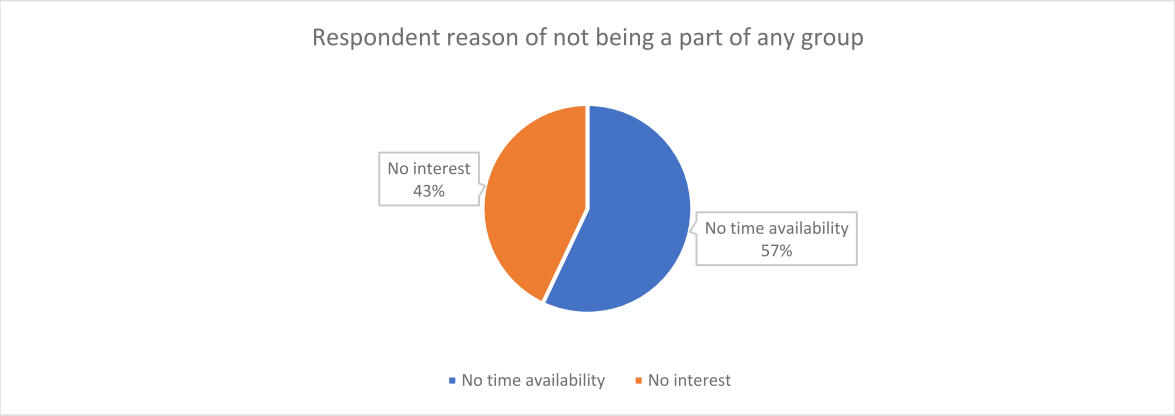


Figure 9.29: Reason of not being part of any group



Majority of the respondent 75%, get information regarding farming or livestock related topics such as new seeds, technology, crop rotation or animal health from cooperatives/ community members. Around 59% respondent approach their family members for agriculture related information. Private shops or suppliers rank third as a source of information for farmers with 41% seeking information. These shops are majorly visited by farmer for buying agriculture inputs and hence they have established connect with these shops. They also follow the guidelines given by the shop dealers. Media/ Radio/ TV/ Newspaper are referred by 38% respondents for similar information. A very few farmers respondent, 12%, 11%, 2% and 0.2% get information from social media, KVK, NGO, government outlet respectively. This is very less proportion than farmers getting information from community members/ cooperatives, family members, private shops and media (radio, TV, newspaper). Even though 41% respondent farmers get information from private shops but only 6% adopt their advice/information. Similarly, 38% respondent farmer get information from media sources (TV, newspaper, radio)

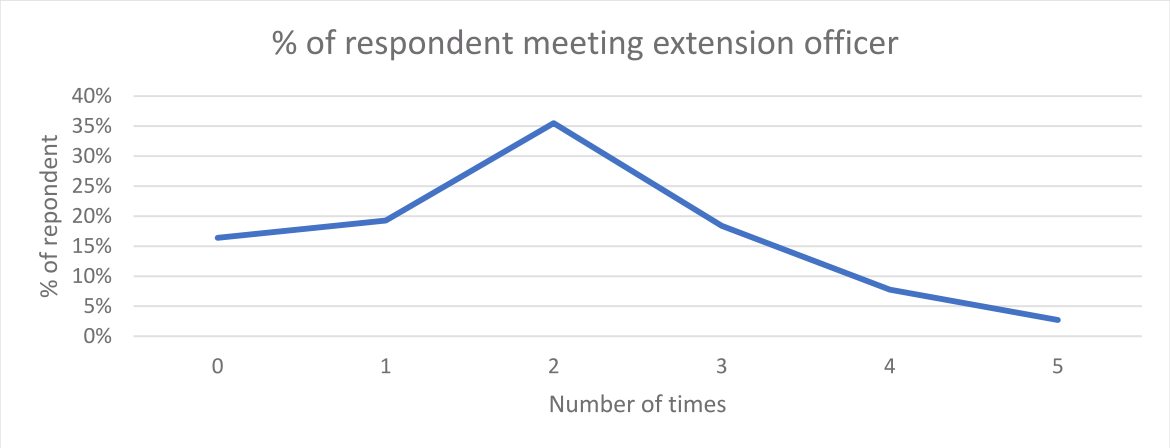
but only 0.2% adopt their advice. The table 9.8 shows rank wise sources of information from where respondent farmers get agriculture information and also maps the most preferred source for adapting advices. Gram sevak and Kisan mitra had no presence among the sample households.

Table 9.8: Sources and adoption of information

Source of information	% Respondent for given sources	% Respondent adopting the advice from given sources
Community members or cooperative	75%	55%
Family member	59%	34%
Private shop or suppliers	41%	6%
Media or radio or TV or newspaper	38%	0.2%
social media	12%	0%
KVK	11%	5%
NGO or NGO outlet	2%	0%
Government outlet or depot	0.2%	0%
Other government agency	0.2%	0%

Out of 555 respondent, 77% respondent have visited government departments for various information and subsidy. Out of these responses, who haven't been to any of government departments, 70% are landowners and 30% are landless. A total of 464 respondents met extension officers in the entire year. Majority of 35% respondents met the extension officer twice in a year.

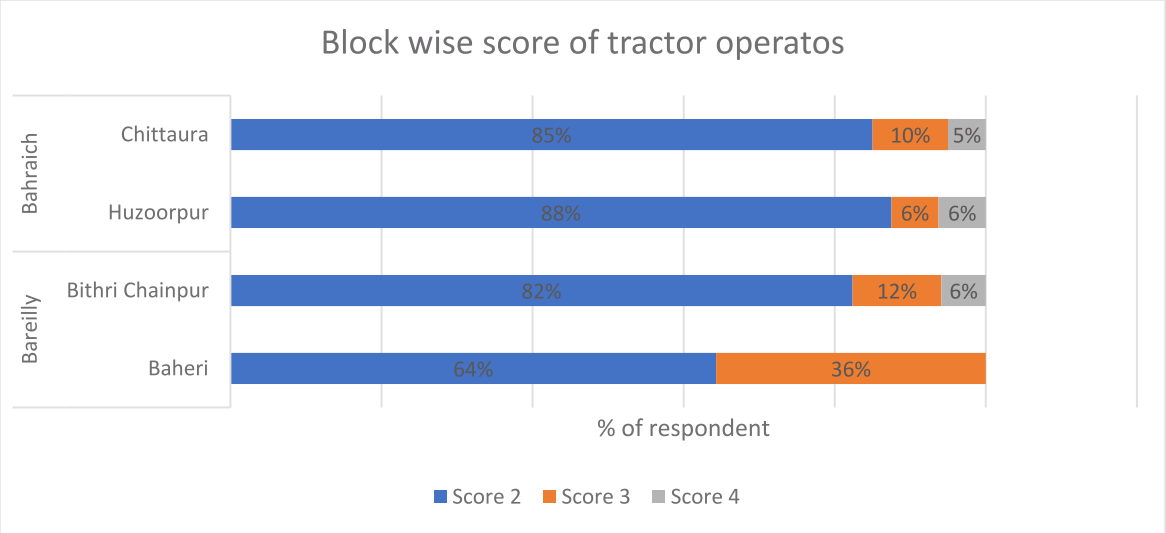
Figure 9.30: Meeting with extension officer



The assessment for knowledge and information about tractor and their maintenance was captured with set of questions administered to the respondent who operate the tractors or are responsible for maintenance of the tractors. The scoring is done based on the right responses provided by the respondents. All the right answers from 8 questions have been summed up to derive the total score of the respondent. The highest number of tractor operator/ responsible for maintenance in Huzoorpur block with only 17% respondents from the total respondent of the survey. Out of the total, only 13% in Chittaura block, 11% in Bithri Chainpur block and

9% Baheri block are tractor operator/ responsible for maintenance. In Baheri block, only 36% respondent scored 3, rest 64% score 2. In Bithri Chainpur, atleast 65 respondent scored 4 and 12% scored 3, rest 82% scored 2. In Huzoorpur block with highest tractor operators, only 5% sored 4, 10 % scored 3 and 85% scored 85%. The score across the block is towards the lower end and brings attention towards creating a better knowledge and information base for effective machinery usage and maintenance.

Figure 9.31: Block wise score of tractor operators



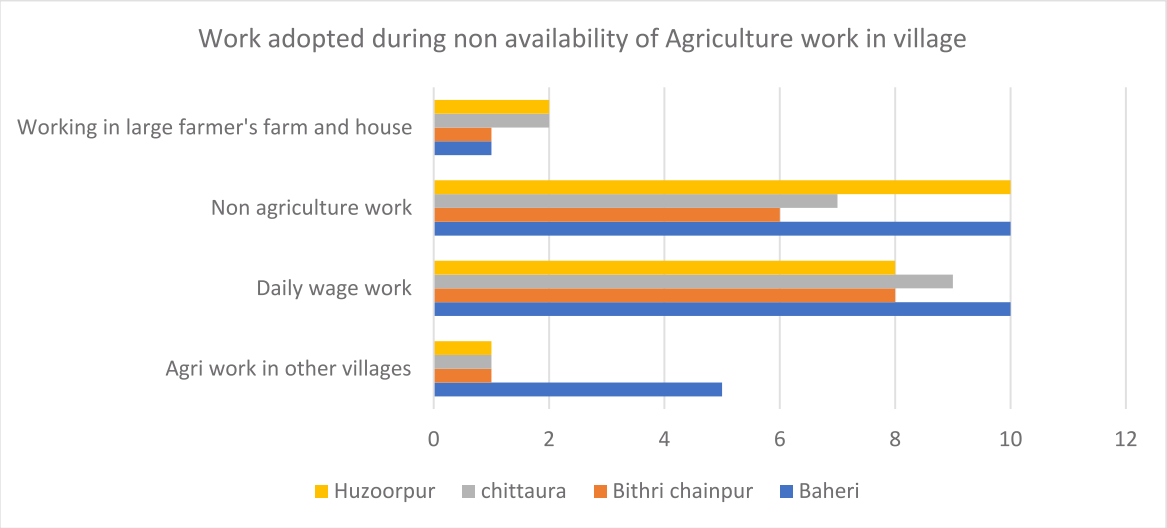
The assessment for knowledge and information about tractor operations and their maintenance was captured with set of questions administered to the respondent who operate the tractors or are responsible for maintenance of the tractors. The scoring is done based on the responses provided by the respondents. All the right answers from 8 questions have been summed up to derive the total score of the respondent. So, the 1 to 8 is the score of scaling the farmers, 1 being least information and knowledge and 8 being the highest information and knowledge about tractor operations and maintenance. Majority of the respondents have scored 2 for their knowledge and information about tractor operations and maintenance. Huzoorpur has higher respondent who scored 2 (85%), followed by Chittaura (85%), Bithri Chainpur (82%) and Baheri (64%). It is observed that Baheri has respondent scoring highest than the other blocks in the state where 36% responded scored 4 and 64% scored 2. Baheri is followed by Bithri Chainpur where 12% respondent scored 4 and 6% scored 4 (highest in UP). Highest score being 4 of the complete scoring process, Huzoorpur and Bithri Chainpur lead with the most informative respondents. In terms of information and knowledge, Uttar Pradesh lags than Gujarat. But given, tractor operations are crucial for agriculture, there remains a gap in respondents understanding. Working on imparting right skill set to the tractor operators and maintenance takers will not only increase the efficiency of the operations but also increase the shelf life of the tractor and its equipment.

Labour Perception about Machines:

Out of 544 household who performed agriculture operations on own or others field, responses were captured for status of availability of labour for manual operations. April and November are the season where majority of the respondent are engaged in agriculture work followed by October, May and March. By capturing the recall of previous 5 years, 24% of the respondent stated a change in the labour situation, implying that there was difficulty in finding labour and labour work. Out of total responses captured, 17% found that agriculture work is not available

in all days. From the respondent who did not find any agriculture work in the village, 40% respondents undertook daily wage labour, 38% respondents opted for non-agriculture work, 7% respondents found agriculture work in other villages, 6% worked in farms and house of other farmers. Majority of the respondent get engaged in non-agriculture work and daily wage work.

Figure 9.32: Work adopted during non-availability of agriculture work in village



Other income option is ranked based on preference of respondents where they seek work in case of decrease in labour demand in the village. Non agriculture work with in the village is preferred by 92% respondent followed by non-agriculture work in another village by 66% respondents, agriculture work in another village by 62% and least preferred is seeking work in nearby cities. Given the opportunity, respondents would like to stay back in the village and engage in available work options. During qualitative field discussion, it was collected that labour issues have been persistent in villages. These challenges are attributed to the increase in demand of labour in urban spaces for constructions, contractual work etc. and the widespread coverage of welfare scheme has pushed labour out of the agriculture work.

With 544 respondents engaged in agriculture operations, responses were captured for households' perception on the impact of machines on various aspects. The impacts considered for analysis are; time use, cost of cultivation, productivity, income diversification, education level, health status, food expenditures, demand of agriculture labour, demand of non-agriculture labour, overall income, agricultural wages, migration from rural to urban places, youth in agriculture. About 97.4 % household have given their responses for the impact observed with the use of machines. Table 9.9 indicates the % of respondent who observed any increase/ decrease/ no change in the given impacts. All 100% respondents agreed to the decrease in the time requirements and cost of cultivation while using the machines for agriculture operations. Majority of the respondents (>75% respondents) reported that use of machines has led to increase in productivity (86%), education level (80%), food expenditure (87%) and agriculture wages (96%). This majority is followed by respondents (50%-75%) who reported increase in health status (73%), overall income (74%) and youth in agriculture (71%). Relatively less respondents reported in diversified income (39%) and demand of non-agriculture labour (35%). Interestingly, reported impact on migration hasn't seen any increase with spread of machines instead migration from rural to urban places have declined as mentioned by 49% or remain unchanged as reported by 51% respondents.

Table 9.9: Impacts of using machines in agriculture operations

Impacts of using machines in agriculture operations	Impacts reported by respondent (%)		
	Increase	No change	Decrease
Time use	0%	0%	100%
Cost of cultivation	0%	0%	100%
Productivity	86%	14%	0%
Income diversification	39%	35%	25%
Education level	80%	20%	0%
Health status	73%	27%	0%
Food expenditure	87%	13%	0%
Demand of agriculture labour	83%	0%	17%
Demand of non – agriculture labour	35%	43%	21%
Overall Income	74%	26%	0%
Agriculture wages	96%	4%	0%
Migration from rural to urban places	0%	51%	49%
Youth in agriculture	71%	17%	12%

Section 5: Women adoption of machinery and labour-saving technology

This section examines the women's access to agriculture information and extension services. Age split of the women respondent is as given in the table 9.10

Table 9.10: Age of women respondent

Age	% of women respondent
31-35	21%
36-40	29%
46-50	14%
51-55	21%
56-60	14%

No women were involved in land preparation and spraying/ applying fertilizer operation. Out of total women who were covered under the survey, 43% were involved in sowing activities ranging from 3 to 8 hours per day for period of 6 and 14 days in a year. On an average, women spent 6.16 hours per day and 10 days per year on sowing activities. For weeding activities, 93% of women were engaged for 2 to 8 hours for 8 to 18 days in a year. On an average, women spent 6.38 hours per day and 11.92 days in a year on weeding activities. For irrigation activities, 14% women were engaged for around 4 hours in a day for 8 days in a year. For harvesting activity, 93% women were engaged with time involvement of 1 to 8 hours per day for 2 to 18 days in a year. On an average, women spent 6.69 hours per day for 11.38 days in a year. For threshing activity ,50% of women were involved for 1 to 6 hours per day or 2 to 14 days in a year. On an average, women spent 4.14 hours for 7.86 days in a year. All

these operations by all women respondents were performed without any usage of machines/ tools. They perform all the options manually. Under the study, various reasons were explored for women not using the machines for performing various agriculture operations. All the women respondent reported that they don't use the machine as they don't know to operate the machines and 79% respondent pointed out that they might not be able to operate. Out of the total, 71% women felt comfortable performing the operations using their conventional ways instead of experimenting with the machines and 71% felt that they might mis handle the machines. With 57% of women considering the machines to be expensive and hence to avoid any usage. The non-usage of machines also contributed to machine's height and weight also known as ergonomic factors. From all, 36 % women indicated towards the discomfort of using machines due to the ergonomics. Safety issues while using the machines came up as well by 21% women. The table 9.11 summarizes all the reasons for non-usage of machines by women.

Table 9.11: Reasons for not using any machines for agriculture operations

Reasons for not using any machines for agriculture operations	% of women respondent
Do not know how to operate	100%
Women might not be able to operate	79%
Women might mis handle the machine	71%
Comfortable doing the job by traditional methods	71%
Machines being expensive	57%
Uncomfortable while using due to height or weight	36%
Safety issues and risk	21%

Operating machines is trickier for women and hence trainings are important. While exploring women preferences for training, it was found that out of the responses recorded for whether women would like to receive training for how to use the machine at ease, how to operate it for full efficiency, basic repair, maintenance etc, 54% women didn't want to receive any training, 38% did not respond to the question and only 8% showed positive inclination for receiving training. Only 30% of the respondent were willing to devote 2-3 hours for a training program and only 8% could travel outside the village to attend such programs. The above figures indicate a very low inclination of women to learn new technology and information's. There is also time scarcity of women and mobility issues which hinders their opportunities to learn and get trained. Not that women don't acknowledge the benefits of using the machines. They are aware of the changes which have been observed with machine usage.

Table 9.12: Changes due to machine usage observed by women

Changes due to machine usage	Increase	Decrease	No change
Amount of time spent on a task		100%	
Task easier to perform	100%		
Change in Yield of produce	36%		64%
Change in area under cultivated land	29%		71%
Change in efficiency of work	100%		

From table 9.12, almost 100% women responded that machine use increases the ease of performing task and the efficiency of work along with decrease in the amount of time

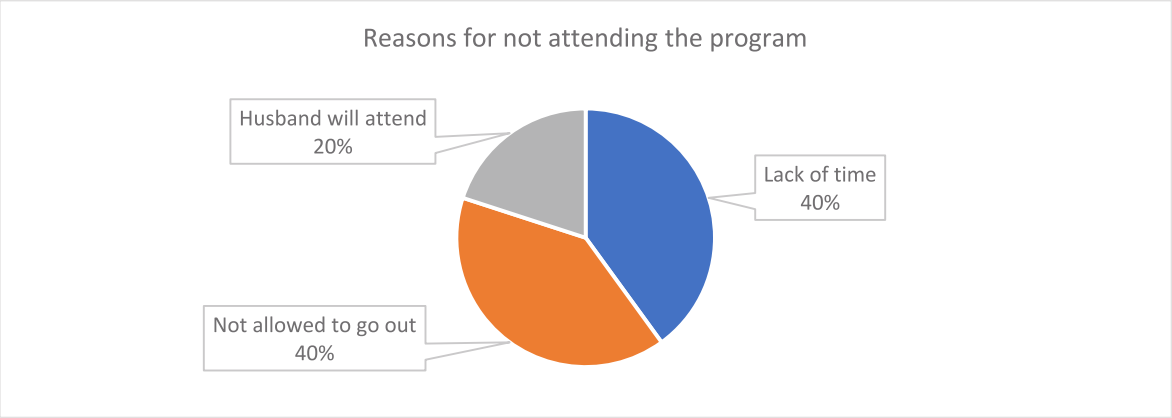
spent on the tasks. Around 36% women found that using the machine increase the yield of produce, 64% said no change in the production yields. For change in area under cultivation, 29% women reported increase in the area but 71% also reported no change in the area with machine usage. With much awareness about use of machines and its impact, women are still lagging in its usage and adoption.

Table 9.13: Sources and adoption of information by women

Sources of Information	% women respondent receiving information from these sources	% women respondent seeking information from sources
Community members or cooperative	14%	14%
Family member	79%	71%
Media or radio or TV or newspaper	21%	-

As observed in the table 9.13, women have limited sources from where they receive agriculture related information. The responses were captured from sources like community members/ cooperatives, family members, KVK, government agencies, Media/TV/newspaper, Kisan Mitra, Gram Sevak, government outlet or depot, social media, NGO, private shops or suppliers. Only 14% women receive information from community-based organization or their members, 21% receive it from media/radio/TV/newspaper and 79% of women respondent receive it from family members. When it came to seeking information, 14% seeked it from community-based organization or their members and 71% relied on their family members. No women have ever met extension agents ever but 93% women are willing to receive information from extension agents if they are women themselves. Around 7% of women respondents were not interested in receiving any information from any extension agents. Only 29% women were willing to attend any kind of program/meetings organized for agricultural information in their villages and rest have even denied being part for any of the programs. The major reason stated by 40% of women was lack of time availability,

Figure 9.33: Reasons for not attending the program



Also, women participation in community group was limited. Only 21% women were part of SHG and 14% were part of village level committee. Rest of the women who were not part of any group stated reason of lack of time availability (33%) and lack of interest (67%) for not being in any group.

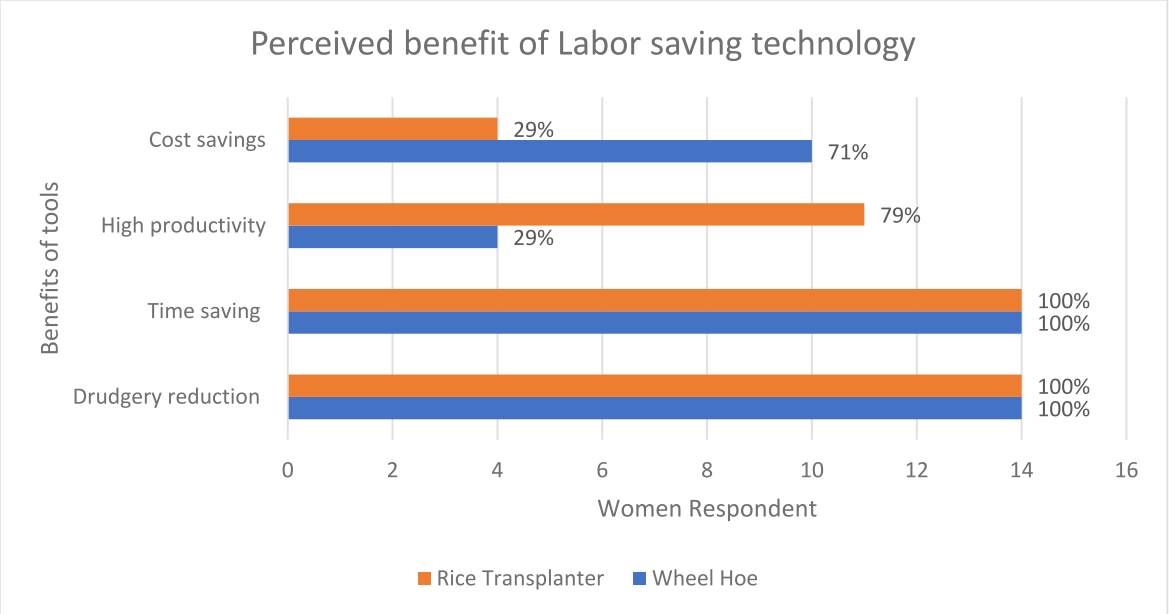
Labour Saving Technology

Out of total, 14 women responded during the household survey carried out in Uttar Pradesh. Baheri, Bithri Chainpur and Huzoorpur blocks had 21% women respondent each. Chittaura block had highest of 36 % women respondent.

From all of the women respondent, only 14% women have attended farmer meeting/ demonstration/training. The interview captured women perception of labour-saving technology by showing digital videos to women who were involved in agriculture operations on their own or others farm. Two tools were presented: 1) Wheel hoe for weeding and 2) Rice transplanter. None of the women had seen both these tools earlier. On inquiring about these tools, there were various perception captured which are discussed further. Out of all the women, 86% women found the agriculture labour work tedious and 14% didn't. But all the women respondent wanted to adopt to these labour-saving tools for their weeding and transplanting operations. All the respondent (100%) found the wheel hoe and rice transplanter to reduce drudgery and save time during operations. Only 29% women related wheel hoe with high productivity but 79% women related the rice transplanter with high productivity. The video highlights the aspects of rice transplanter as fast-moving machine which transplants saplings quickly with high precision. Hence, majority of women could relate to high productivity of the paddy using the transplanter. Only 29% women perceived rice transplanter to be cost saving but on the other hand, majority of women i.e., 71% found wheel hoe to be beneficial in cost savings. This could be highly because of the expenditures which might occur in buying the tool. Rice transplanter being a sophisticated machine looks expensive then the wheel hoe.

Ranking the perceived attributes of Tool 1 and Tool 2:

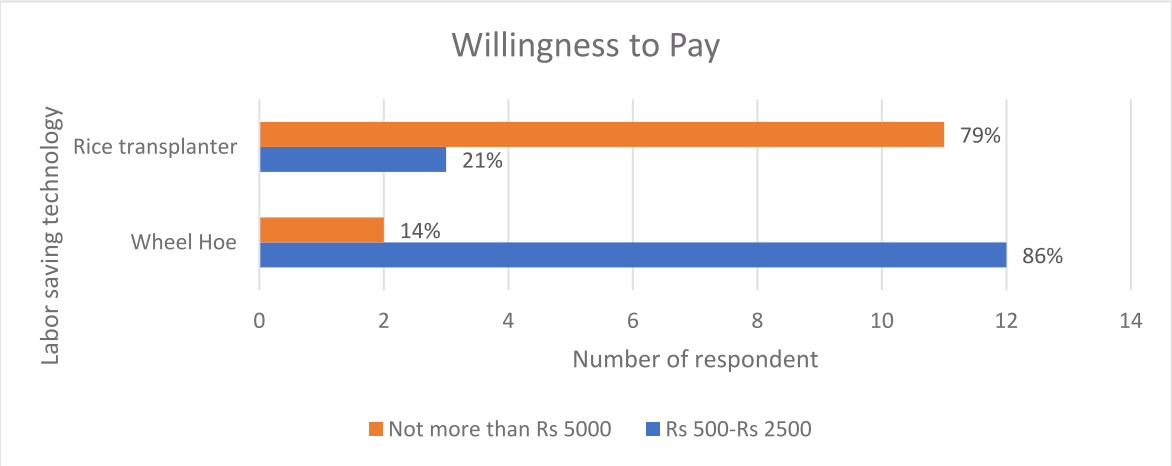
Figure 9.34: Perceived benefit of labour-saving technology



With so many perceived benefits, all women were willing to purchase both the tools from village and block level markets. But the willingness to pay for the tool varied. The willingness to pay for wheel hoe was less than the rice transplanter. Around 14% women were willing to pay up to Rs 5000 for wheel hoe but 86% women were willing to pay up to Rs 2500 for the wheel hoe. A lower pricing of the tool will help in widespread adoption. In case of rice transplanter, willingness to pay was higher where 79% women were ready to pay up to Rs

5000 for purchasing and only 21% women restricted themselves up to Rs 2500. This indicates a high paying capacity for rice transplanter.

Figure 9.35: Willingness to pay for labour-saving technology



For perceived price of wheel hoe, women opted for multiple funding options like bank, husband, and own saving. For rice transplanter, 86% women opted for their savings and only 14% relied on husband for husband's fund for purchase. Even with clear indications towards willingness to pay, women still don't have any sole power to decide whether to purchase the tool. For both the tools and all the women respondent, household head decides whether to make that purchase. Out of total, 79% women will not buy the tool if the head denies and only 21% will make it a point to convince the head to purchase the tool. Owing to the constraint of investing money in the tools, all women were open to the idea of renting these tools for the operations.

Rice transplanter appears to be more sophisticated than the wheel hoe and its operations seems more complex. On the other hand, wheel hoe captured higher perceived benefits from the rice transplanter. For wheel hoe, Time use, Drudgery, Productivity, Income diversification, Cost savings, Education were voted as the perceived benefits by 100%, 100%, 86%, 50%, 29% and 14% women respectively. For rice transplanter, time use, drudgery, productivity, cost savings were voted by 86%, 79%, 79% and 29% women respectively.

Dwelling deeper into time use patterns of women and how would they use the surplus time available after adoption of these labour-saving tools. For wheel hoe, other income generating activities, leisure, children education, community engagement had major time allocations with 71%, 64%, 57%, 57% women allocating the saved time in these activities. Out of all, 29% women voted household work as well for time allocation. For rice transplanter, other income generating activities and leisure had major time allocations with 71% and 64% women splitting the saved time in these activities. Followed by household work and children education opted by 29% and 14% women respectively.

Figure 9.36: Perceived impact from using labour-saving technology

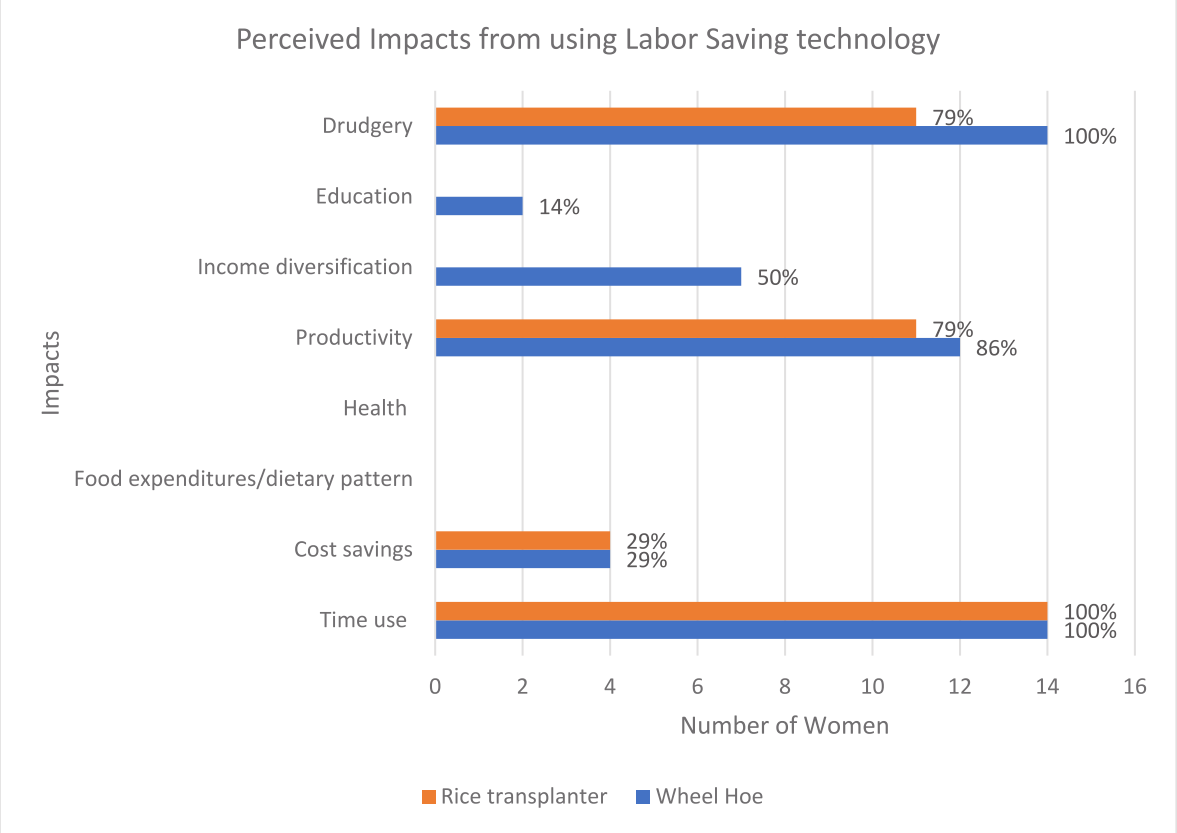
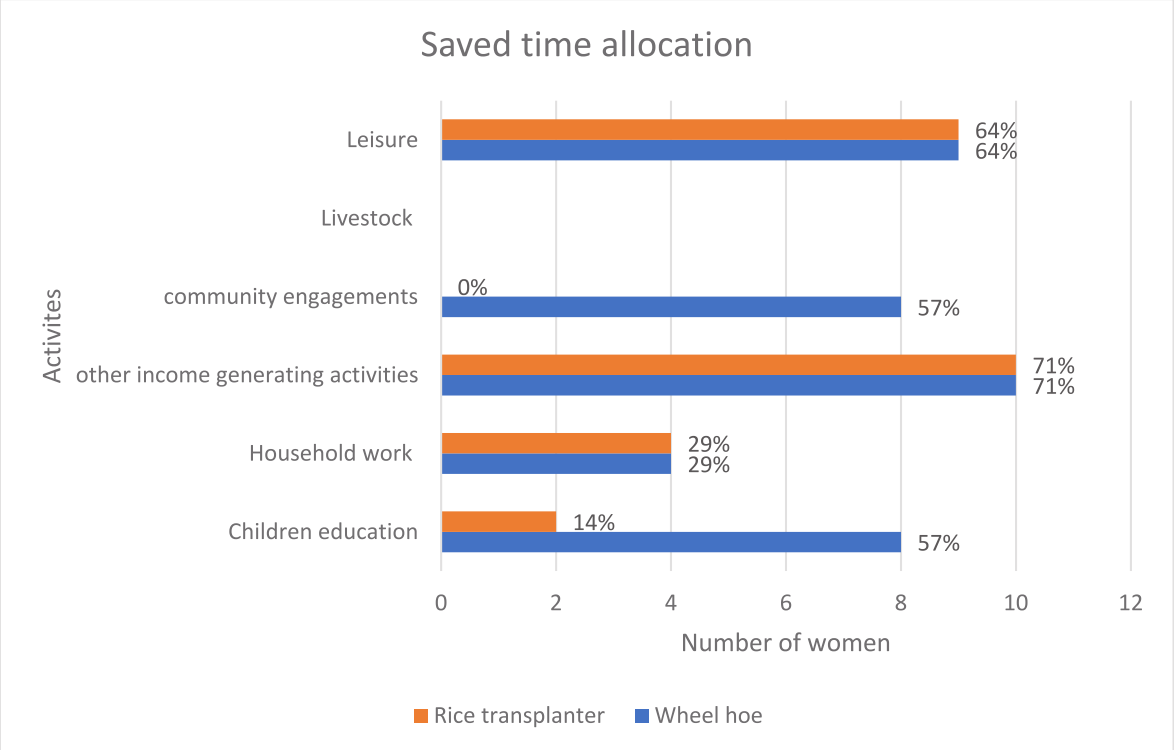


Figure 9.37: Allocation of time in other activities with time savings from labour-saving technology



Takeaway:

Custom Hiring Centres and Farm Machinery Banks are not so popular in the states. Majority of farmers are still renting from other farmers. Only 6% rented seed drills from custom hiring centres but rest 94% rented from other farmers. Even the presence of CHCs and Farm Machinery banks is uneven. The state witnessed affordable rental charges. From the total tractor users, 86% respondent hired operators for driving but 14% operated the tractors themselves. All of the operators learned driving a tractor from family members/friends. They did not undergo any formal training process from either of the sources mentioned: Private dealers/suppliers, FMTTIS (training institute), KVKs, Block agriculture office, ATMA, Gram sevak, Kisan mitra, NGOs or any other private organisation. There has been no involvement of women in tractor operations. Out of the total tractor owners, 61% respondent undertook maintenance at regular intervals and only 30% respondents did it when a break down would occur. The frequency of breakdown has been captured from the respondents where it was found that only 7% respondent didn't have any breakdowns, 50% respondent incurred one breakdown in last 6 months and 25% respondent incurred it twice. Major proportion of respondent (88%) could diagnose and repair their tractors themselves and only 12% needed to approach the mechanic at village level and 38% witnessed delay in repair services as there are not enough mechanics in village. The owners of the machine didn't find the manual useful. The major problem faced by the owners is of calibration. There is no frequent machine break down but the owners faced machine breakdown at least once in every 6 months. These issues were tackled by self- repair. There were no formal trainings received by the owners of the machines. But they are willing to adopt suggestive innovative methods of improving efficiency performances and life span of machines.

Agriculutre Operations	Machines	% of respondent who could operate the machine		% of respondent who hired the operator with machine		% of farmer who are not satisfied with the working of the operator		% of farmer who received operating training from family//friends /relative		% of farmers who carry out 'regular maintenance on fixed intervals'		% of farmers carry out maintenance of tractor when there is break down		% of farmer facing delay in repair and services due to lack of mechanic		%of farmers who feel mechanic are not competent		% of farmers who face issues in availability of spare parts		On an average, how many times machine breaks down in 6 months?		% of farmer willing to adopt innovative methods of improving performance and efficiency of machine	
		Bahraich	Bareilly	Bahraich	Bareilly	Bahraich	Bareilly	Bahraich	Bareilly	Bahraich	Bareilly	Bahraich	Bareilly	Bahraich	Bareilly	Bahraich	Bareilly	Bahraich	Bareilly	Bahraich	Bareilly	Bahraich	Bareilly
Land preparation	Tractors	15%	13%	85%	87%	0%	0%	100%	100%	65%	69%	35%	31%	0%	8%	0%	0%	0%	0%	1.196	1.236	45%	55%
	Harrow	5%	4%	95%	96%	100%	96%	0%	0%	81%	88%	19%	12%	-	-	-	-	-	-	0.048	0.026	86%	100%
Sowing	Seed drill	0%	0.48%	100%	99.52%	0%	0.97%	0%	0%	100%	75%	NA	25%	0%	0%	0%	0%	0%	0%	1	1	100%	100%
	Sugar Cane planter	NA	0%	NA	100%	NA	-	NA	0%	NA	0%	NA	NA	NA	0%	NA	0%	NA	0%	NA	0	NA	0%
Weeding																							
Irrigation																							
Application of fertiliser/pesticide	Power opearted spray pump	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0	0	0%	0%
	Manual operated spray pump	0%	0%	100%	100%	0%	0%	0%	0%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	2	2	100%	100%
Harvesting	Combine harvester	0%	0%	100%	100%	100%	100%	0%	0%	0%	0%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0	1	100%
Threshing	Multi Crop Thresher	12.94%	9.20%	86.59%	87.36%	46.94%	51.02%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0	-	-

CHAPTER 10

MECHANIZATION STATUS AND ASSESSMENT OF SKILL GAP ACROSS TAMIL NADU

Section 1: State overview

Tamil Nadu, tenth largest state in India with a geographical area of 130 lakh ha is located in South-Eastern part of Peninsular India. The Gross State Domestic Product (GSDP) of Tamil Nadu for the year 2020-21(A.E) at Constant Prices stood at Rs.12,96,659 crores, whereas the Gross State Value Added (GSVA) on crop sector alone at Constant Prices stood at Rs.53,703 crores. The GSDP at Current Prices stood at about Rs.19,02,688 crores while the GSVA on crop sector at Current Prices stood at Rs.1,04,410 crores. In Tamil Nadu, agriculture engages 70% of the rural people. Agriculture is vital for socio economic development of the state. Agriculture has some of the biggest challenges to deal. Small and marginal landholdings, conversion of agriculture land, scarcity of labour, uncertain climate conditions price volatility of agri produce are few to name. Understanding the delicate nature of agriculture and its importance in the economic development, central and state government are working towards developing the agriculture sector. There has been introduction of varieties of seeds in respect to the prevailing climate, rainfall and soil fertility. The government is promoting usage of latest technologies to increase production. Integrated farming system is being introduced and popularised to sustain the income of the farmers by adopting activities like Cattle/Sheep rearing, Fish Ponds, Agro Forestry and Apiary. Implementation of various schemes like paddy production scheme, nutrient rich Millet Mission, Pulses production scheme and Oilseeds production are carried to enhance food grain production.

The governments are progressing for creating a robust agriculture system with future vision. In 2021, Mettur Dam for irrigation and the Kuruvai Package Scheme has been implemented for strengthening the irrigation infrastructure in Tamil Nadu state. This led to additional area of 1.69 lakh acre under cultivation, increasing the cultivation area from of 3.21 lakh acre to 4.9 lakh acre. Increased area in Kuruvai Season and favourable rainfall during the year 2021-22 has contributed to the increased food grain production. Organic farming is being promoted to reduce input cost and sustainable environment through integrated nutrient management and plant protection. In 2002-21, Under Pradhan Mantri Fasal Bima Yojana (PMFBY), an amount of Rs.2,082 crore has been sanctioned and released to 9.65 lakh farmers as compensation for overcoming the loss from natural disasters. The government have been designing and implementing interventions in this sector creating major impact in the agriculture sector. For planning agricultural development, the state is divided into seven Agro-climatic sub zones based on rainfall distribution, irrigation pattern, cropping pattern, soil characteristics and other physical, ecological and social characteristics. The following are the seven agro-climatic zones of the State of Tamil Nadu: 1. Cauvery Delta zone 2. North Eastern zone 3. Western zone 4. North Western zone 5. High Altitude zone 6. Southern zone and 7. High Rainfall zone

Figure 10.1: Division of Agro Climatic Zones by Tamil Nadu state

Source: *Disaster Management Authority (TNSDMA)*

Various schemes are introduced by the state under Agricultural Inputs Subsidy Schemes namely Distribution of Certified Seeds of maize, Distribution of Certified Seeds of Oil seeds, Distribution of Gypsum, Distribution of manually operated Plant Protection Equipment, Distribution of mini kits at free of cost, Farmers Training, Farmers Interest group generator subsidy, Production of Foundation and Certified Seeds, Tamil Nadu Agricultural Modernization and Water bodies Restoration Management (TAMWARM) , Seed Village Scheme, Agricultural Mechanisation Programme , Land Development Scheme Area of operation, Replacement of old Pump sets with new Pump sets. Few schemes are targeted to promote adoption of machines and equipment by farmers.

The mechanization schemes are very important for the spread of the machinery. With the state comprising majority of small and marginal farmers, these schemes make it affordable for them as well. Mechanization is also solution for increased challenge of labour availability and increment in cost of labour over the years. Migration and development in other sectors are one of the few reasons for pulling the labour out of agriculture. With this shortage of labour, farmers face challenges to perform manual operation timely. Even if labour is available, then the cost of labour shoots up the overall cost of cultivation for farmers. With machines, the operations are performed timely and are more efficient than the manual labour. It has been

gradual process for the spread of machinery in the state. With the spread of machines, there is a question about skilled manpower who can operate the machines and also attend to repair and maintenance of these machines. Any lag in these will result in non-usage or dis-adoption of agriculture machines. Hence, along with scheme for promotion of machines, states are focussed on imparting training for repair, maintenance and operation of the machine.

Farm Power availability in Tamil Nadu

In 2018, Ministry of Agriculture & Farmers Welfare (Department of Agriculture, Cooperation & Farmers Welfare, Mechanization and Technology division published a report 'Monitoring, Concurrent Evaluation and Impact Assessment of Sub-Mission on Agricultural Mechanization' which states that the average farm power availability in the state increased from 2.361 kW/ha (2014) to 2.907 kW/ha by 2016-17. It registered a 23.1 % increase in three years due to the result of implementation of SMAM. The farm power availability in the state is 44 % more than the national average i.e., 2.025 kW/ha (2016-17). The district-wise farm power availability (2016-17) in the state is graded as given below:

Table 10.1: Farm power availability in Tamil Nadu

Name of the District	Farm Power Availability (kW/ha)	Legend
Coimbatore	2.340	
Cuddalore	2.059	
Dharmapuri	5.690	
Dindigul	2.703	
Erode	3.425	
Kancheepuram	4.052	
Kanniyakumari	0.724	
Karur	2.639	
Krishnagiri	3.265	
Madurai	2.226	
Nagapattinam	2.376	
Namakkal	3.587	
Perambalur	1.882	
Pudukkottai	2.288	
Ramanathapuram	0.607	
Salem	5.378	
Sivagangai	1.511	
Thanjavur	2.329	
Theni	1.694	
Thiruvallur	3.217	
Thiruvarur	6.011	
Thoothukkudi	1.104	
Tiruchirappalli	1.924	
Tirunelveli	3.283	
Tiruvannamalai	3.530	
Vellore	2.147	
Villupuram	4.780	
Virudhunagar	1.394	
Average	2.907	

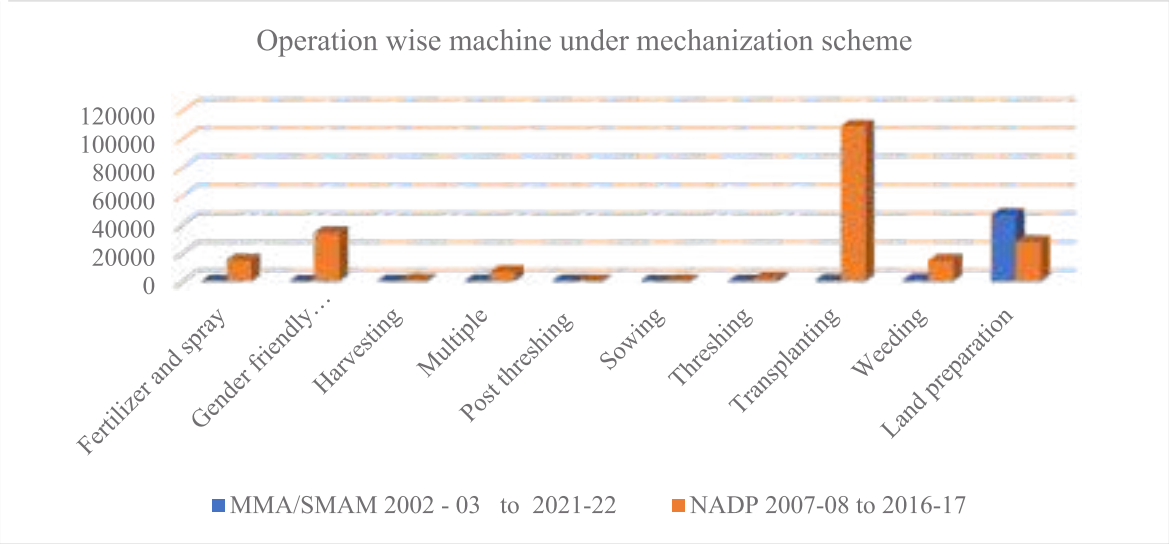
FPA more than 2.03 kW/ha
FPA between 1.00 to 2.03 kW/ha
FPA less than 1.00 kW/ha

Source: *Mechanization & Technology Division, Ministry of Agriculture & Farmers Welfare*

Section 2: Spread of Agricultural Machine

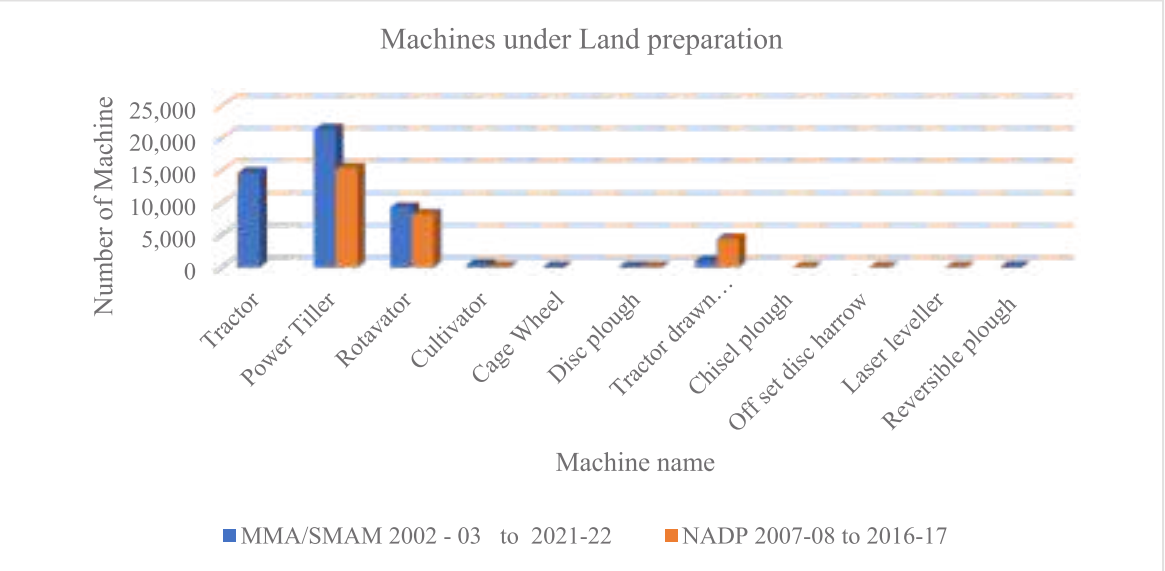
Figure 10.2 shows the number of machines allotted across agricultural operations under both the SMAM and NADP. Land preparation as an operation has maximum variety of machines used for specific purposes. The data in the figure is collated for tractor, power tiller, rotavator, cultivator, cage wheel, disc plough, tractor drawn implements, chisel plough, off set disc harrow, laser leveller and reversible plough. Power tillers rank first in allotment followed by rotavator and tractors.

Figure 10.2: Machines distributed under schemes in state of Tamil Nadu from 2002-2022



Source: *Agricultural Engineering Department, Tamil Nadu*

Figure 10.3: Number of machines for land preparation operation distributed under the schemes from 2002-2022

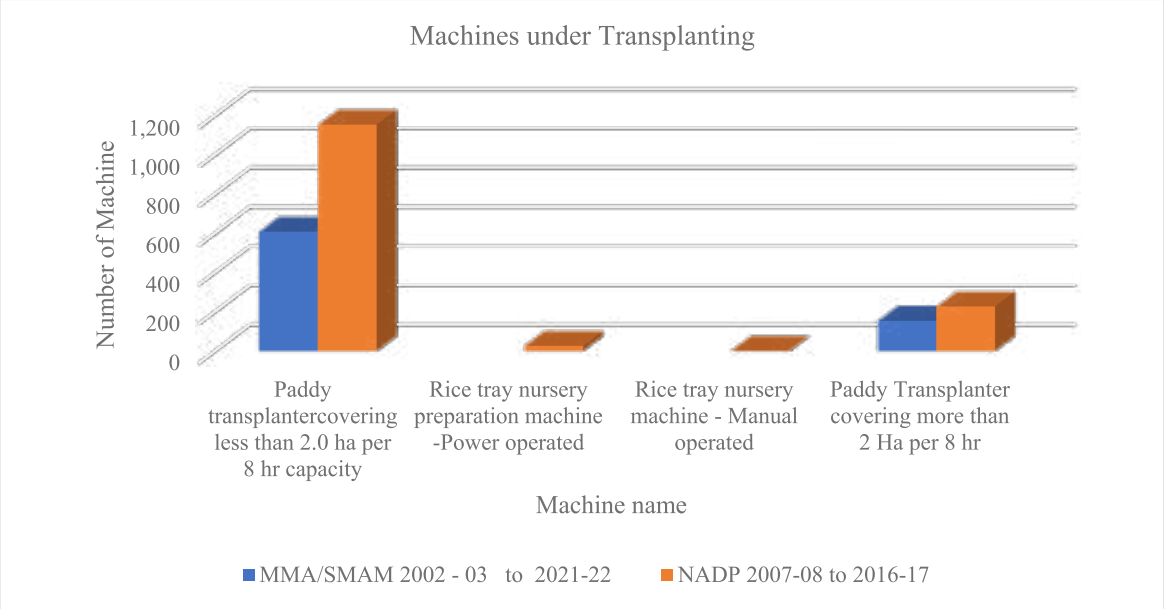


Source: *Agricultural Engineering Department, Tamil Nadu*

Gender friendly tools include manually operated equipment (gender friendly) like drum seeder, paddy weeder, dry land weeder, etc and has seen higher uptake under NADP scheme. For sowing, the machines included are Seed cum Fertilizer drill /Zero till Seed cum fertilizer

drill 11 types, zero till seed drill and post hole digger for plantations. For weeding, there are multiple machines namely, Power operated single row paddy weeder, Power operated multi row paddy weeder, Power weeder walk behind type including weed cutter, paddy weeder less than 8 HP, Power weeder riding type 4 wheel driven < 20 HP and Brush Cutter. Apart from these, manual weeding tools are availed under gender friendly tools which is taken as a separate category. For threshing, the data collated is for multi crop thresher, power thresher including maize sheller, maize husker sheller, coconut de husker and paddy reaper. IN post threshing operations, number of shredders, sugarcane trash shredder, sugarcane stubble shaver, tractor operated leaf shredder, baler, coconut frond chopper has been taken into account.

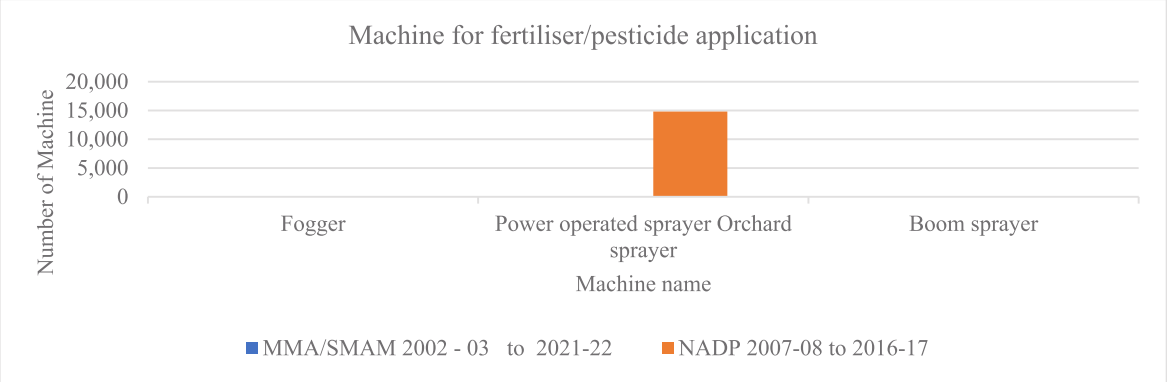
Figure 10.4: Number of machines for transplanting operation distributed under the schemes from 2002-2022



***Source**: Agricultural Engineering Department, Tamil Nadu*

Machines and equipment under transplanting are allocated in large numbers and it comprises of paddy transplanters covering less than 2.0 ha per 8 hr capacity, rice tray nursery preparation machine -Power operated, Rice tray nursery machine - Manual operated and Paddy Transplanter covering more than 2 Ha per 8 hr. In Figure 4, higher preference has been observed for paddy transplanter covering less than 2.0 ha per 8 hr capacity. Almost negligible interest has been observed for manually operated transplanters.

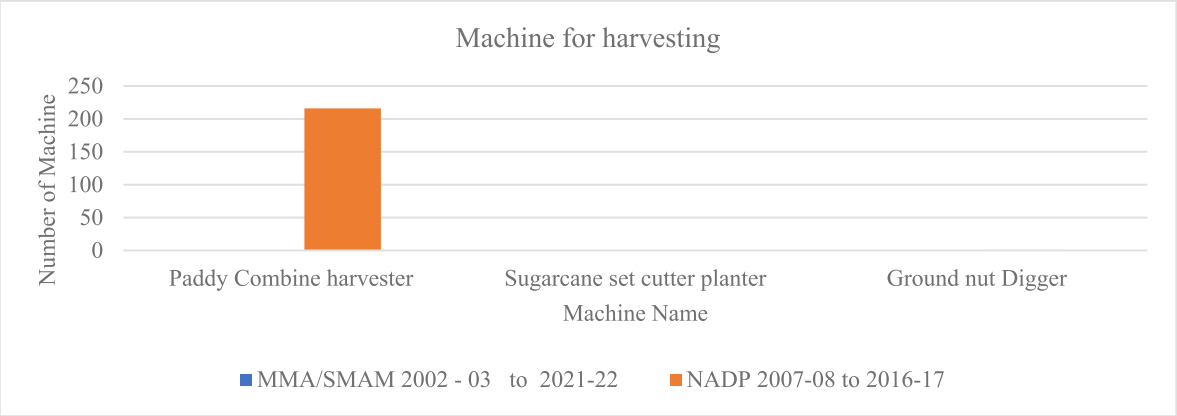
Figure 10.5: Number of machines for application of fertiliser and pesticides distributed under the schemes from 2002-2022



Source: *Agricultural Engineering Department, Tamil Nadu*

For application of fertiliser and pesticides, there is popularity for power operated sprayer /orchard sprayer. These are easier to operate and increase the speed of the operation. In Figure 10.5, power operated sprayer has been demanded and allocated in higher number as compared to fogger and boom sprayer.

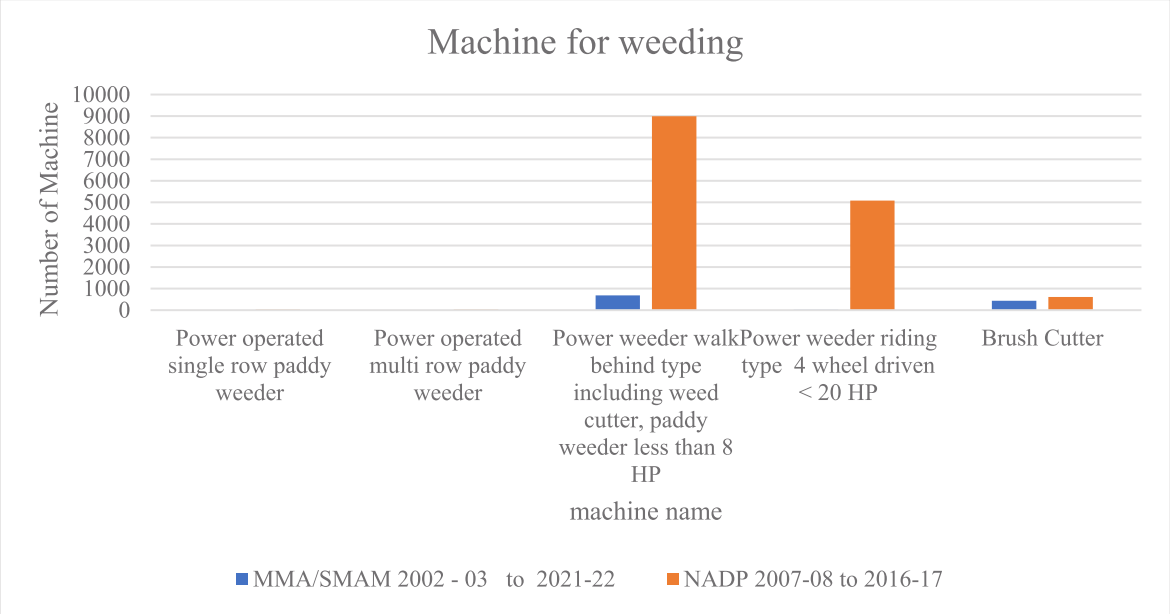
Figure 10.6: Number of machines for harvesting operation distributed under the schemes from 2002-2022



Source: *Agricultural Engineering Department, Tamil Nadu*

Paddy combines harvester are largely in demand due to the spread of paddy crop in Tamil Nadu. Combine harvesters are capable of performing harvesting and threshing operations with one machine. There is sharp reduction in requirement of labour while using a combine harvester. They are easily available on rent and are affordable to small farmers as well.

Figure 10.7: Number of machines for weeding distributed under the schemes from 2002-2022



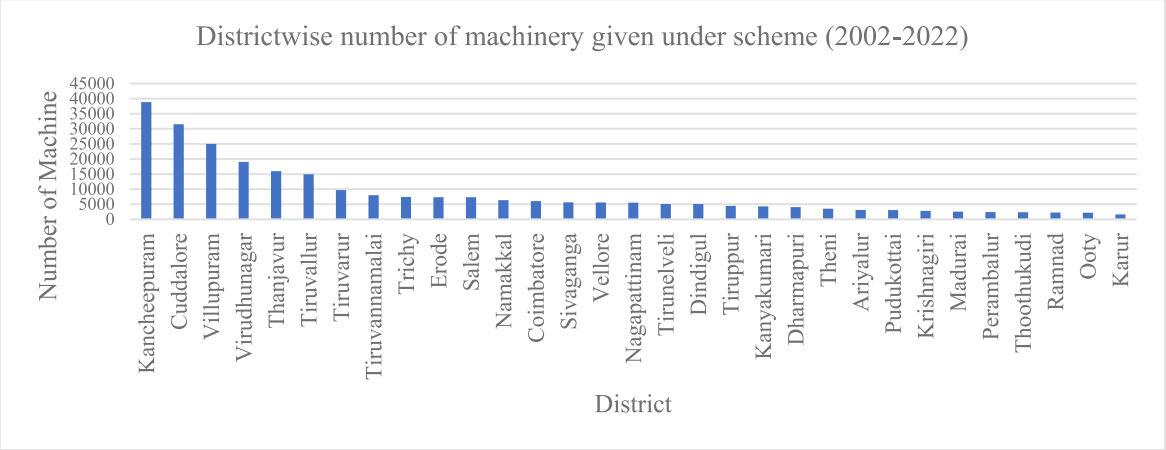
Source: *Agricultural Engineering Department, Tamil Nadu*

The figure 10.7, shows a huge demand for weeder which can be used in weeding operation. Weeding is a labour -intensive operation and the requirement of labour is high. So, if machine can be used for the weeding operation, then farmers can save on labour cost and perform weeding operation efficiently.

District level variation in mechanization

Under the scheme of Sub Mission on Agricultural Mechanization (SMAM), for the purchase of Agricultural Machinery and Implements, subsidy assistance of 50 % to SC, ST, Small, Marginal and Women farmers and 40 % to other farmers or the maximum permissible subsidy prescribed by Government whichever is given for the distribution of agricultural machinery and implements like Tractor, Power Tiller, Rotavator, Paddy Transplanter, Tractor and Power Tiller driven implements, Power Weeder, Chaff Cutter, Brush Cutter, Multi Crop Thresher, Baler, Coconut Frond Chopper, Sugarcane Detrashing Machine, Sugarcane Trash cutter and Combine Harvester etc.

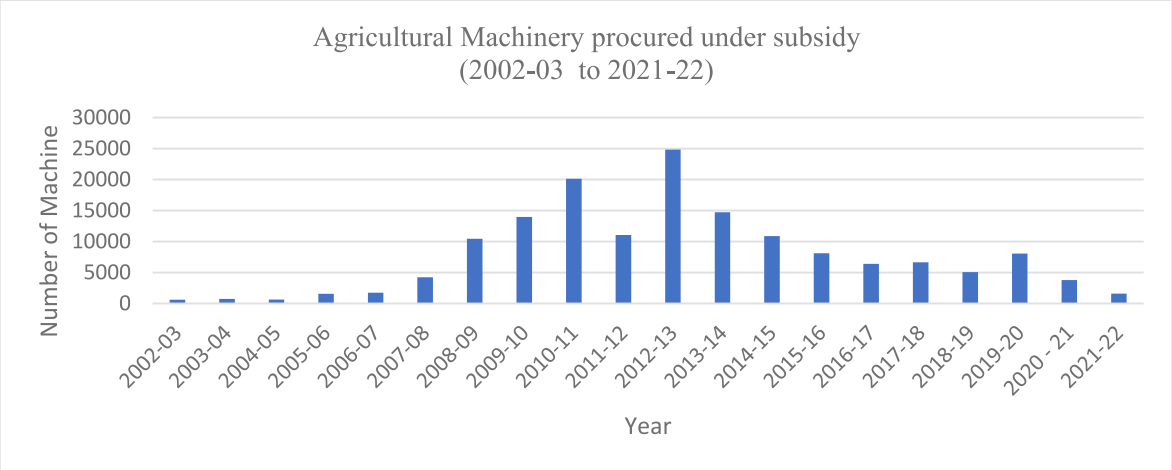
Figure 10.8: District wise distribution of machinery through various schemes during 2002-2022



Source: *Agricultural Engineering Department, Tamil Nadu*

Figure 8.10 shows the district wise achievement of individual machinery from 2002-03 to 2021-22. Kancheepuram has highest achievement followed by Cuddalore, Villupuram, Virudhunagar, Thanjavur, Tiruvallur, Tiruvarur, Tiruvannamalai, Trichy, Erode, Salem, Namakkal, Coimbatore, Sivaganga, Vellore, Nagapattinam, Tirunelveli, Dindigul, Tirupur, Kanyakumari, Dharmapuri, Theni, Ariyalur, Pudukottai, Krishnagiri, Madurai, Pereambalur, Toothukudi, Ramanand, Ooty, Kannur.

Figure 10.9: Year wise procurement of agricultural machinery in state of Tamil Nadu



Source: Agricultural Engineering Department, Tamil Nadu

Figure 10.9 shows the number of Agricultural Machinery procured under subsidy from the year 2002-03 to 2021-22.

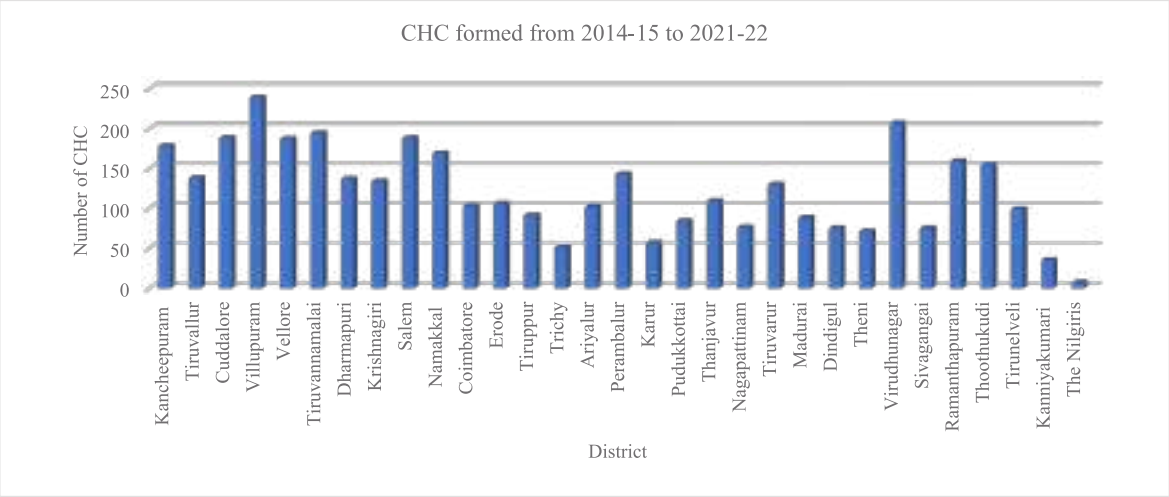
Custom Hiring Centres (CHC) and Hi-Tech Hub

With the objectives of promoting mechanization in districts and to provide hiring services for agricultural machinery, Custom Hiring Centres (CHC) were established. They have proved to be increase the net income of the farmers and reduce cost of cultivation at every stage of crop growth. As small and marginal farmers are not in position to purchase the machinery which is expensive like higher horse power tractors, threshers, harvesters, balers and other

equipment. CHCs are formed at village and block level in the state.

Under the SMAM scheme, CHC receives financial assistance of Rs. 4 lakhs to Rs.24 lakhs. During 2014-22, a total number of 3755 CHCs were established in Tamil Nadu under SMAM and NADP from 2014-15 to 2021-22. The districts like Villupuram, Virudhunagar and Salem were leading with establishment of 239, 207 and 188 respectively. These CHCs are block based, village based and sugarcane based formed under SMAM and NADP from 2014-15 to2021-22. The details of the CHCs established during 2014-22 in different districts is given below.

Figure 10.10: District wise spread of Custom Hiring Centres from 2014-2022



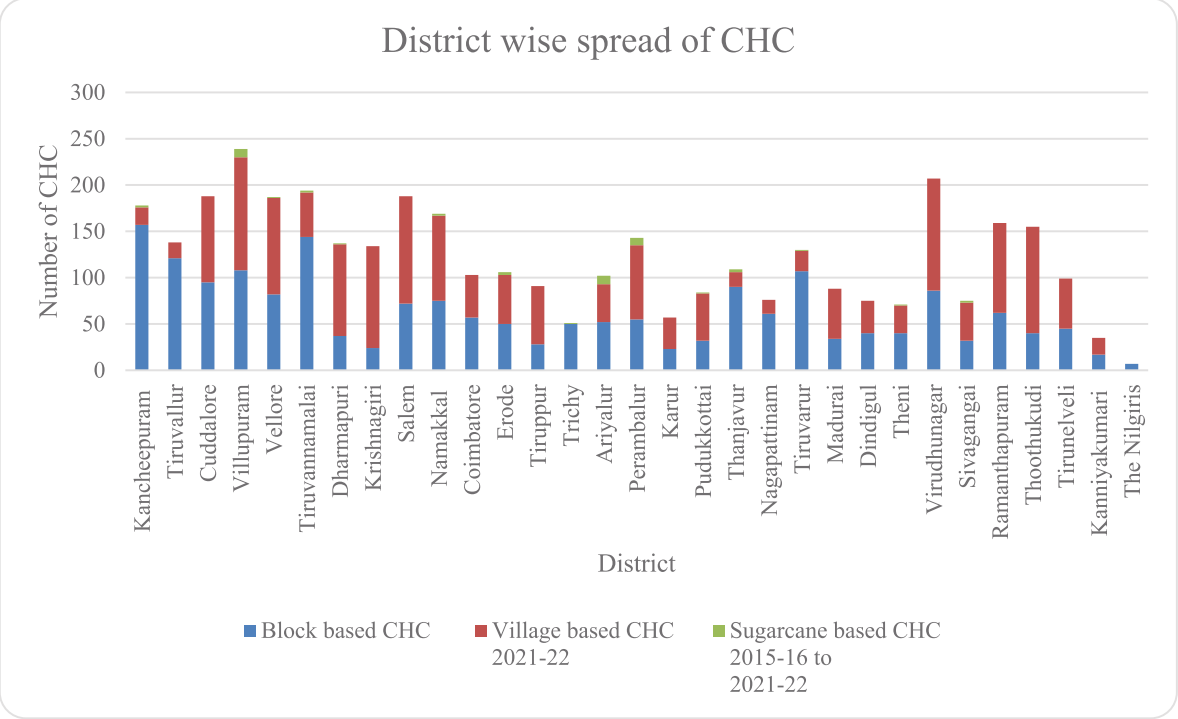
Source: *Agricultural Engineering Department, Tamil Nadu*

Block based Custom Hiring Centres: The Custom Hiring Centres are established at block level by Rural Entrepreneurs, Registered Farmers Societies and Farmer Producer Organisations with a set of agricultural machinery, implements and equipment for hiring to the farmers to meet out the agricultural machinery demand at unit cost of Rs.25 lakh. The subsidy assistance for forming Custom Hiring Centre is 40 % of the total cost or a maximum amount of Rs.10 lakh and the balance 60 % is the beneficiary contribution.

Village based Custom Hiring Centres: In order to take up the farming operations in time and to increase the net income of the farmers in the low farm power availability districts, subsidy assistance is provided for the establishment of Village level CHC to the Small and marginal farmers combined as a group like Registered Farmers Societies and Farmer Producer Organisations to purchase various types of required Agricultural machinery, implements and equipment. The cluster villages under this scheme of Chief Minister's Dry Land Development Mission are prioritised. The unit cost for forming a village based CHC is Rs.10 lakh. The subsidy assistance for a custom hiring centre is 80 % of the total cost subject to a maximum of Rupees Eight lakh. Sugarcane based Custom Hiring Centres

Sugarcane CHC: The CHCs with suitable machinery for sugarcane crop are proposed to be established at a project cost of Rs.150 lakh per centre to promote the mechanization activity in Sugarcane cultivation. These are functional through Sugar mills and Entrepreneurs with 40 % subsidy assistance to a maximum limit of Rs.60 lakh. These CHCs rent out the sugarcane cultivation machinery to the farmers. Below is the split of CHC given district wise and category wise (block, village and sugarcane).

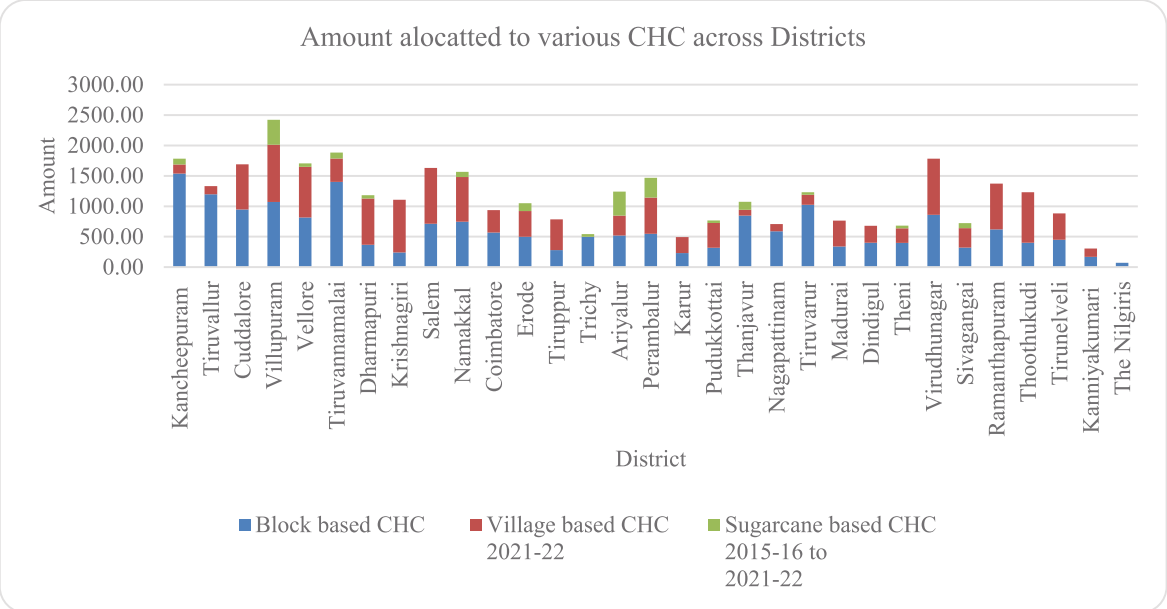
Figure 10.11: District wise number of Custom Hiring centre in Tamil Nadu



Source: *Agricultural Engineering Department, Tamil Nadu*

The figure 10.11 shows presence of CHC (in numbers) in each district under the category of block, village and sugarcane. The village based CHC are highest in number followed by block based and sugarcane based with number of 1923, 1806 and 46 respectively across Tamil Nadu. The limited number of sugarcanes based CHC is due to the inclusion of crop specific machines and expensive setup cost.

Figure 10.12: Amount allocated to various category of Custom Hiring Centre in Tamil Nadu



Source: *Agricultural Engineering Department, Tamil Nadu*

Figure 10.12 provides the distribution of amount (in Rs lakh) of CHC formed under NADP and SMAM 2014-16 to 2021-22 under each district. Even though the number of sugarcanes CHC is very limited, the amount spent is substantial. This is due to the advanced and sophisticated machines involved in sugarcane processing. The total cost of setting up a sugarcane CHC is higher than the standard CHC.

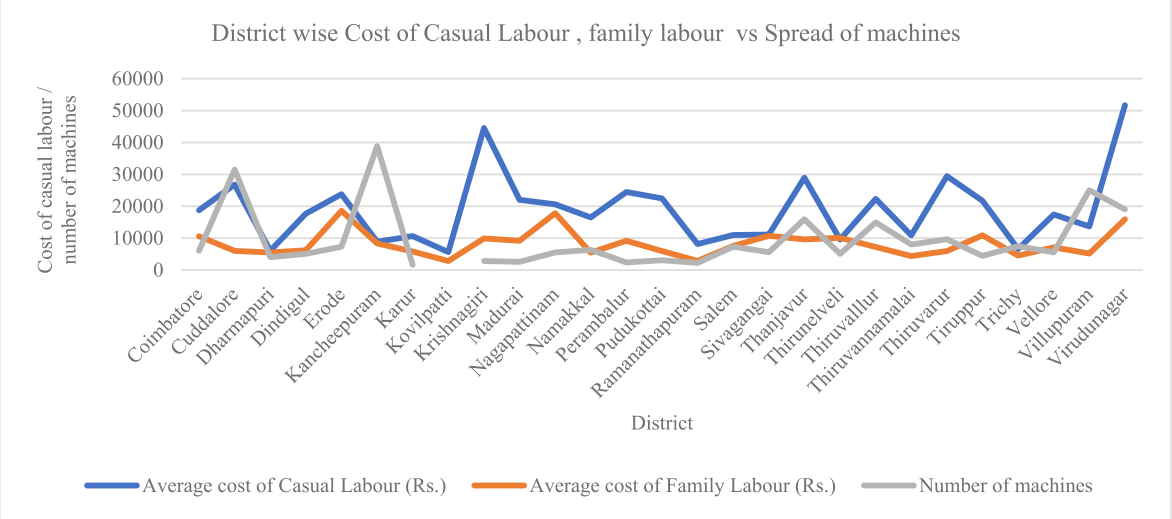
Sugarcane CHC Model

There is successful model established for sugarcane CHC model for agriculture machine rental for sugarcane crop. This model has given opportunity to entrepreneur for establish CHC with financial assistance from government and private banks. Also, involvement of sugar mills to meet the financial commitment of the CHC helps support the CHC owners to balance the expenditure of purchase of machines.

Section 3: Machine and labour dynamics in state

Labour scarcity as common in other states is also a challenge in Tamil Nadu. Farmers were facing labour issues due to various reasons including MGNREGA, migration to urban centres etc. This shortage has forced agriculture farm sector to look for mechanised operations requiring less of manpower. Comparatively cost of field operations were less in using farm machinery with manual labour. For instance, paddy transplanting requires about 10 to 15 women per acre as manual labour which extends to one day for transplanting. On the other hand, mechanized transplanter requires 1-2 hours of time to cover one acre. It saves cost, labour and as well as time. Similar trend is observed amount various crops in different operations using manual labour and machinery. This high cost and time advantage have also boosted the demand of machines in the state. In terms of farm machinery, combine harvester, tractors (mounted with rotavator, cultivator, disc plough and tailor), power tillers were predominantly used by farmers. Power weeder are not popular. For paddy transplanting, farmer have to depend mostly for manual labours because due to non-availability of transplanters. Though the government has allotted high number of transplanters, they are still out of access to small and marginal farmers in the state. Farm machinery companies like Mahindra, Swaraj, TAFE and John Deere were some of major players in Tamil Nadu.

Figure 10.13: District wise cost of casual and family labour vs spread of machines



Source: *Department of Economics and Statistics and Agriculture Engineering Department, Tamil Nadu*

The district wise cost of casual labour and family labour for Tamil Nadu has been appended from the year wise data available with Department of Economics and Statistics, Ministry of Agriculture & Farmers Welfare.[22] The figure 10.13, shows the spread of machine across districts and maps it with cost of casual and family labour. There is a positive trend observed whereas cost of labour increases also indicates higher spread of machinery in those districts.

In an innovative approach to labour issues in the state, National Rural Livelihood Mission and Kalaignar Village Integrated Agriculture Development Program, labour under MGNREGA is allowed to work in farmers field. Once a farmer registers with the Panchayat and receives the approval from panchayat president, he/she can deploy MGNREGA workers for ridge construction in between the field and as well as in field external arena. The cost of labour is covered under the MGNREGA work. The major work for the labour is related to construction and rejuvenation of water structures in farmer field. This model needs further research to draw the impact on labour and farmers and the linkage with government.

Section 4: Skill gap and access to extension services

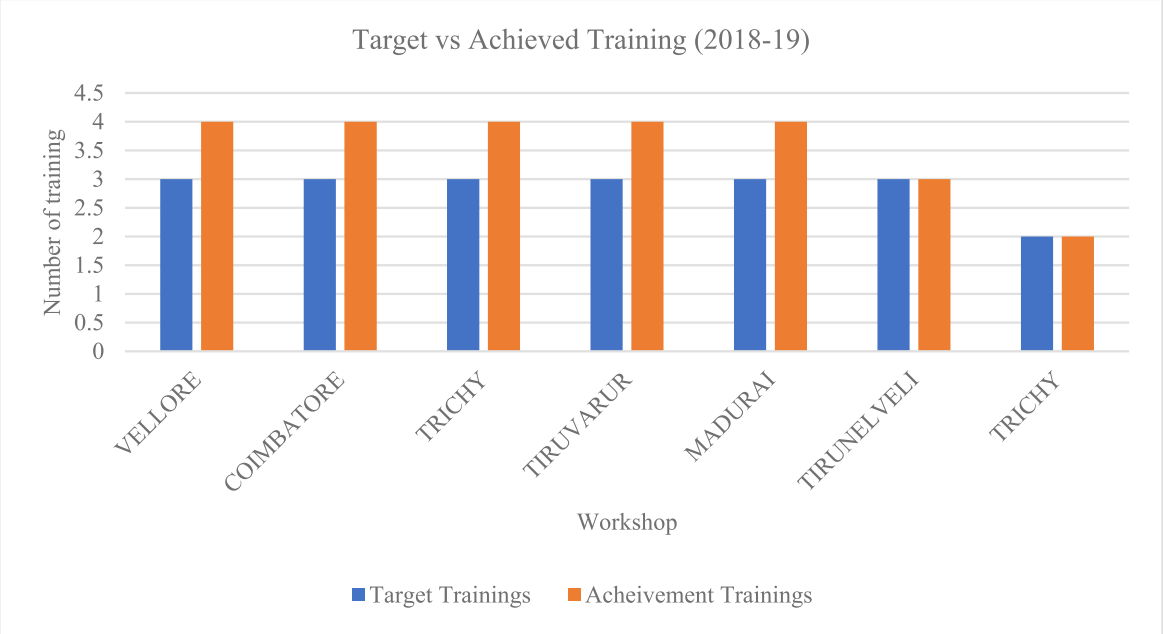
Status of Skill training

In the state, there are trainings conducted for farmers and officials through various agencies. State Agricultural Extension Management Institute (STAMIN) is responsible for trainings to the Extension personnel and Office Staff of the Department of Agriculture for equipping them with latest technologies in Agriculture, Extension, Administration, Management and Computer applications. In the year 2021-22, 1,033 departmental Officers were trained at cost of Rs.24.75 lakh. Trainings are imparted to the middle level officers of Agriculture & Allied departments. Courses like the Post Graduate Diploma in Agricultural Extension Management (PGDAEM), Diploma in Agricultural Extension Services for Input Dealers (DAESI), Certificate Course on Insecticide Management for Pesticide Dealers / Distributors, Skill Training of Rural Youth (STRY) and Certified Farm Advisor Course (CFA) are being provided. In year 2021-22, trainings for 2,282 technical officers were trained at the cost of Rs.65.14 lakh. Water Management Training Centre (WMTC) functions at Vinayagapuram, Madurai district and is responsible for

[22] http://eands.dacnet.nic.in/Cost_of_Cultivation.htm

imparting trainings on Irrigation technologies and Water Use Efficiency for field functionaries and farmers. Similarly, Skill Development Training to Rural Youth has been envisioned and functioning to impart training for rural youth. Farmers Training Centres organise training to farmers, farmer convenors, farm women and rural youth on farm management practices and new technologies through 22 Farmers Training Centres spread across the state.

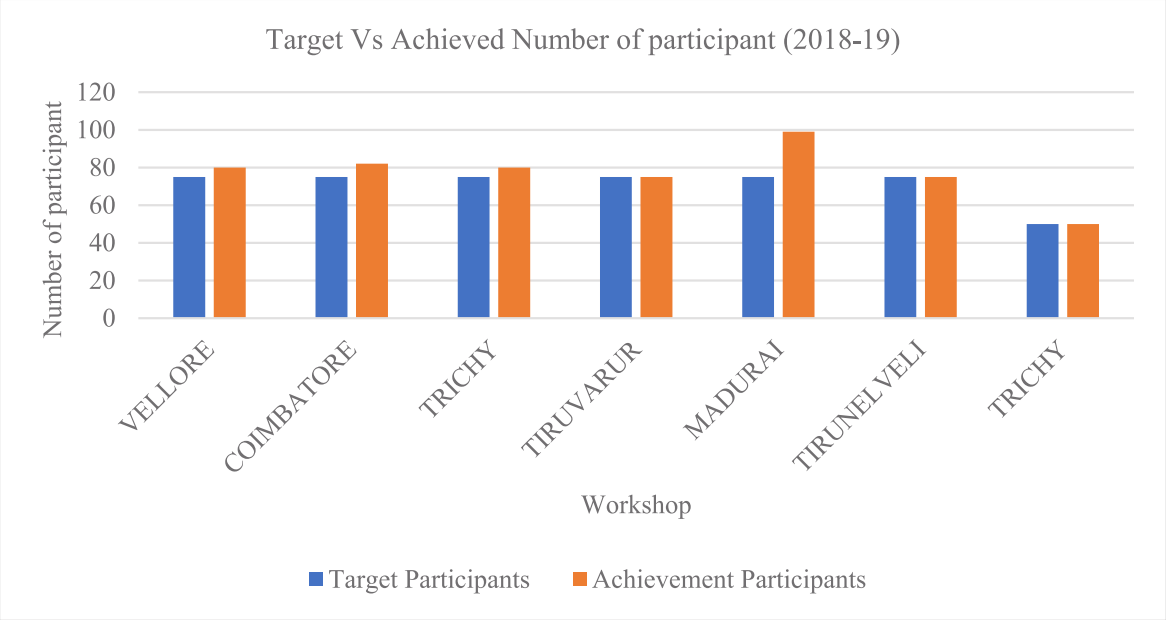
Figure 10. 14: Number of trainings conducted across workshops



Source: *Agricultural Engineering Department, Tamil Nadu*

The figure 10.14, shows the number of trainings conducted across each workshop for training of Rural Youth on Operation and Maintenance of Agricultural Machinery and implements and Solar powered pumping system under - ATMA scheme during 2018-19.

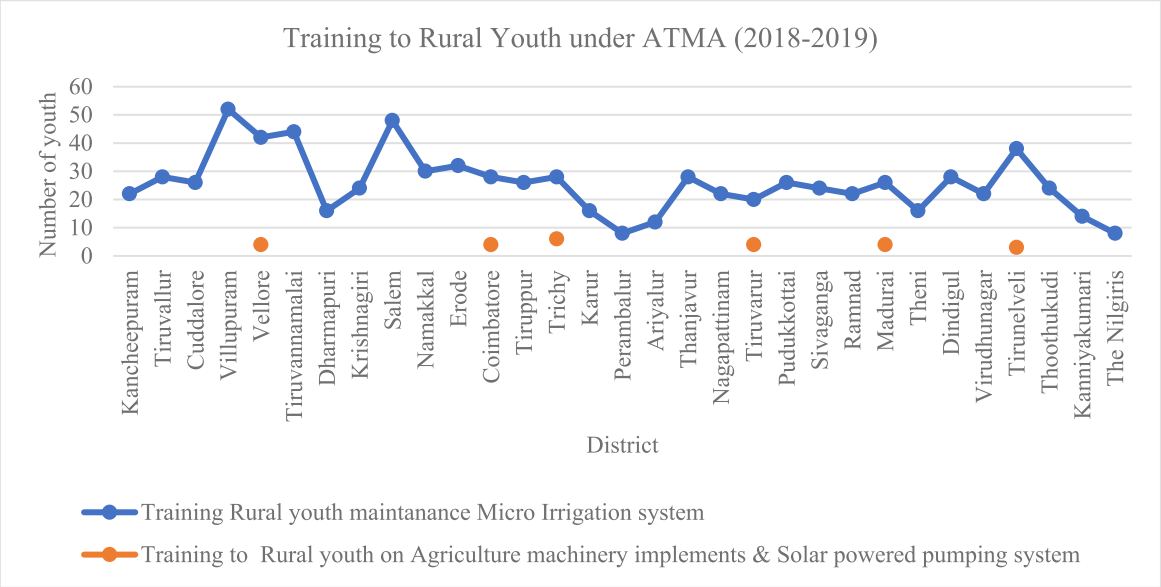
Figure 10.15: Number of participants who were trained under the workshops



Source: *Agricultural Engineering Department, Tamil Nadu*

The figure 10.15, shows the number of participants trained under the trainings conducted across each workshop for training of Rural Youth on Operation and Maintenance of Agricultural Machinery and implements and Solar powered pumping system under – ATMA scheme during 2018-19.

Figure 10.16: Number of youths trained under ATMA for micro irrigation and agricultural machinery implements



Source: *Agricultural Engineering Department, Tamil Nadu*

The figure 10.16, shows the number of youths trained for micro irrigation system and agricultural machinery implement. The training for micro irrigation systems has trained higher number of youths in all the districts in the state. The agriculture machine training is restricted only to few districts that too with very few youths being trained. The financial outlay for both the training is equivalent in spite of higher coverage in micro irrigation training. This indicated higher cost involved in conducting trainings for agricultural machinery implements and solar powered pumping system.

Access to information

Farm exhibitions related to farm machinery were organized by government departments and farmers were participating in those exhibitions with the help of KVKs. Mostly KVKs were engaged in farm extension services with the support of government department and leading farm machinery company.

State Agricultural Machinery Information Data Centre at Chennai is an 'state of art' facility developed by Agriculture Engineering Department. It has display of number of machineries for various crops and farm operations. It is hi tech knowledge centre and helpful in providing exposure to farmers under one roof. There are visits organised by KVKs to the centre where farmers participate and information is disseminated in systematic way.

Training farmers for operations, repair and maintenance of agricultural machinery

For driving farm machinery, most of the farmers/farm labours were trained by their relatives or their family members. There were only few people who have been trained by department however for using combine harvester, sugarcane harvester, power weeders dedicated demo practices are organised by the respective farm machinery companies. Because of specialised nature of this machines, they require training and hand holding. The private network has well-formed hand holding for the farmers. Some of the move by the government have been appreciated and translated in field. A clause is incorporated to train the framers on the machines while empanelment of the private companies. There is a well spread dealer network of the private companies. Farmers approach nearby dealers for repair and maintenance if local mechanics fall short on the services. Major of the issues is resolved at local mechanics but dealers' mechanics is required to attend to some of the queries. Even for spare parts, local mechanics have to order through dealer and is made available when require. To support the farmers with the machine repairs, the state is going to establish Service Centre for repair and maintenance of Agricultural Machinery and Solar Pump sets. This will enable farmers to have easy access to repairing for the machinery. Any delay in repair of machines leads to delay in the farm operation. Hence, taking these service centres close to the farmer will enable the farmer to take timely repair works in the farm itself and carry out the agricultural operation without any delay thus avoiding the damage to crops during sensitive crop growth periods. This is proposed to be established by Agricultural Engineering Department at a project cost of Rupees Eight lakh to the Rural Youth, Entrepreneur, Farmers Groups and Farmer Producer Organisation (FPO)s with 50 % subsidy assistance up to a maximum amount of Rupees Four lakh.

Section 5: Machine usage and adoption by women

Women's participation is widespread in agriculture operations. They are mainly involved in paddy transplanting, weeding, harvesting of horticulture and floriculture crops. Their involvement in paddy harvesting and threshing in limited due to high presence of combine harvesters.

Image: Women operating power tiller on left, Women labour interviewed for Labour saving technology

Women participation in the farm machinery usage is not prevalent. Most of the farm machinery were operated by men and some women reported that they need gender friendly tools and equipment. In rare case some women drive farm machinery with the help of their husband's support. Women access to extension agents is limited and hence there is no formal structure of information to reach women. Though women are highly perceptive and open to learning, only if backed up by correct information and training.

Willingness to pay for gender friendly tools

Discussion was carried out to capture observations for perception of labour-saving technologies from women who are engaged in farming operations. The women respondents were shown videos of two labour-saving technology on digital devices and their responses for both the tools were noted. The tools were selected based on their wider prevalence and usage among states and crops. Tool 1 is the hand weeder used for weeding. Tool 2 is rice transplanter used for transplanting the paddy nurseries. Details of the tools are given in the Table 10.2.

Table 10.2: Details of the gender friendly tools displayed through digital media during field interactions

	Tool 1: Hand weeder	Tool 2: Rice transplanter
Operation	Weeding	Transplanting
Usage	To remove weeds in between the two rows of the crop	To transplant the nurseries of paddy to the field
Capacity	0.015 hectare per hour	0.092 hectare per hour
Benefit	Weeding without squatting position	Transplanting without bending position
Cost	Rs 800/- to 2500/-	Rs 3600/-

As women are highly engaged in labour intensive agriculture operations, they find these tools/equipment labour saving. Labour saving tools/equipment reduced drudgery of manual labour, saves time and increases efficiency of the operations. Women perspective of these tools/equipment have been positive due to the reason of time and cost savings. The high incurrence of labour cost motivates them to adopt to the technology which can be deployed on field by themselves. Their willingness of pay for these categories of tools/equipment varied from Rs 1500- Rs 3500.

Agricultural Machine Rental through centres established by Panchayat level Federation

There is successful model established for women led agriculture machine rental. One such group is from the **Kumaravaadi village.** Kumaravaadi women farmer group started in 2021 with 13 women members. One tractor, two power weeder and three power sprayers were allotted to them under government subsidy of 80% and 20% contribution by panchayat level federation.

The group rents machinery for farmers in the village and the rental cost is pre decided for instance the rental cost for tractor is about Rs.1200 and for sprayer is Rs.200. The group has been lending for 1 year now and has generated profit of Rs 56,000.

Observation and field findings

Feedback of Financial Assistance for the Procurement of Various Agricultural Machinery and Equipment

Based on field interactions, non-beneficiaries are reluctant to apply for subsidies due to their perception of bias towards large farmers. Majority of the information about the schemes is through known leaders/progressive farmer or agriculture officials. Farmers first priority for purchase of machines is their own funds/savings. Farmers expressed that the price of machines after subsidy is similar to that of the machine available in open market, that is the price of machine on subsidy is quoted at higher side.

Operation Wise Machine Availability

Land preparation: Tractors are widely used and are cost effective. Majority of farmers irrespective of their landholding sizes have shifted to tractors and use their implements. They are easily available on rental and the market seems to be well established for this. Farmers are able to manage tractors from within the village with waiting of less than 2-3 days.

Sowing/transplanting: Seed drills are being preferred over sowing where applicable. Horticulture crops have manual sowing done by both men and women farmer. Paddy transplantation is labour intensive work and there are paddy transplanters which can be used instead. Paddy transplanter are not widespread but are highly in demand.

Weeding: Weedicides have emerged as an alternate to manual weeding. Manual weeding is time consuming and labour intensive. It is costlier than the use of chemical weedicide. The prevalence of power weeders was limited and majority resorted to manual weeding. There was limited or no information about manual weeding tools like wheel hoe which have been developed by ICAR under labour saving technology.

Fertilisers and sprayers: They are prevalent and widely used.

Harvesters: Majority of harvesting options are mechanized through multi crop threshers and combine harvesters. Machines like combine harvesters are prevalent across the state. They are available on rent and offers cost benefit to the farmers. There is high adoption because the machines reduced requirement of labour and assures timeliness of the work.

Machine Acquaintance and Training

Machines which are prevalent since many years like tractor have widespread usage. Farmers/operators have learnt operating these machines by themselves or help of the family members. There is very less instance of the operators of getting formal trainings from government institutes. Trainings for advanced machines like power tiller, sugarcane harvesters are given by private companies/dealers from where the machine is purchased. The timeline of training depends on the level of precision required for imparting the training.

Impact of Farm Machinery in Agriculture in Tamil Nadu

Based on the field interactions, use of machines has saved the input cost through reduction in seed rate. Use of seed drill and multi crop planters, seed germination rate has improved. Machines/equipment like seed cum fertilizer drill and fertilizer broadcaster has led to efficient use of fertiliser saving on the cost and also labour requirement for application. Use of rotavator, power weeder, cono weeder, garden tillers has impacted the weeding activity. Land preparation, seed and fertilizer placement, weed control, interculture operations require timely operations. The harvesting and threshing time has reduced with use of harvesters and threshers. There has been reduction in input cost and improved yields. With the stated benefits of mechanization, all state governments are focussing on promoting machine use in agriculture. This has pushed the farm power availability in the state.

Takeaways

The findings indicate effectiveness of the state in spread of machines and strengthening the ecosystem for agricultural mechanization. Field visits and interaction with various stakeholders, culminate into the following focus areas:

1. Subsidy
   - Subsidies need to enable the small and marginal farmers. Most of the farmers reported are large farmers or contact farmers who were availing subsidy.
   - Proper awareness of subsidies and the process, will help motivate the smaller farmers to apply for the subsidies. This can be imparted through village meetings and various village centres.
2. Repair and spare parts availability:
   - Spare parts availability has been a concern for few farmers.
   - Enhancing dealers connects with local mechanics and monitoring their stock will aid the farmers who visit the local mechanics.
3. Gender friendly tools
   - As women are engaged in agricultural operations, use of gender friendly tools will reduce their drudgery to higher extent.
   - If the cost economics of manual tools is shared with women farmers and labour, their adaptability will increase.
   - Inclusion of female extension agents for dealing with women farmer and labour will be highly appreciative among women community
4. Training of women on smaller machines like power weeder/tiller
   - Women of households owning smaller machines like power weeder and tiller can be trained to operate the machines
   - The ergonomics of these machines are designed for ease of men but with proper training and practice women can adapt to this highly efficient machine

CHAPTER 11

MECHANIZATION STATUS AND ASSESSMENT OF SKILL GAP ACROSS ODISHA

Section 1: State overview with secondary data

Odisha (formerly known as Orissa) is a state located in eastern India, and occupies 4.7% of India's total landmass. It is the eleventh largest state in terms of population, has more than 83% of its population living in rural areas. Odisha's economy is mainly dependent on agriculture, the share of agriculture in the gross state domestic product has decreased from around 37% in TE1992-93 to 21% in TE2017-18 while the share of industry and services has increased (CSO 2019). Despite this decline, more than 55.7% of Odisha's population is engaged in agriculture and related sectors (NSS 68th round 2014) (45% according to the Labour Bureau, 2015-16). Like many other Indian states, small and marginal farms dominate Odisha's agricultural landscape. Of the state's 48.7 lakh farm holdings, 93% fall into this category, with less than 2 hectares of land. These farms account for around 75% of the land in Odisha. The number of small and marginal farms increased by 5.6% between 2010-11 and 2015-16. Large farms, defined as those with a landholding size greater than 4 hectares, make up only 0.1% of the total number of farms, and occupy only around 2% of the state's land area according to the 2015-16 Agriculture Census.

Odisha, which has predominantly red soil, produces a wide variety of commodities, including paddy, mangoes, tomatoes, brinjal, sugarcane, jute, and poultry. Although paddy is the most cultivated crop, accounting for almost 48% of the gross cropped area, farming in the state has diversified towards high-value agriculture, such as fruits and vegetables and livestock. Nevertheless, agriculture in the state faces significant challenges due to frequent natural calamities such as floods, cyclones, and droughts.

It is important to note that agricultural policy can have a direct impact on a large proportion of the population.

Over the years, Odisha has made significant progress in agricultural growth and productivity, particularly in the production of rice, the main crop of the state. The state has adopted various measures to increase agricultural productivity, such as providing irrigation facilities, better seeds, and fertilizers, and promoting the use of modern technology in farming practices.

The Odisha government has implemented various agricultural schemes and programs to promote sustainable agricultural growth in the state. Some of the major agricultural schemes in Odisha are:

1. Krushak Assistance for Livelihood and Income Augmentation (KALIA): This is a flagship program launched by the Odisha government in 2018 to provide financial assistance to farmers for crop cultivation and animal husbandry.
2. Pradhan Mantri Fasal Bima Yojana (PMFBY): This is a centrally sponsored scheme that aims to provide insurance coverage and financial support to farmers in case of crop losses due to natural calamities.
3. Rashtriya Krishi Vikas Yojana (RKVY): This is a centrally sponsored scheme that aims to

promote agricultural development by providing financial assistance to states for various agricultural activities, such as the establishment of agricultural research and extension centres, soil testing labour stories, and market infrastructure.

4. Odisha Integrated Irrigation Project for Climate Resilient Agriculture: This project aims to provide irrigation facilities to farmers in drought-prone areas of the state and promote climate-resilient agriculture
5. National Mission on Sustainable Agriculture (NMSA): This is a centrally sponsored scheme that aims to promote sustainable agricultural practices, such as conservation of soil and water resources, and promote agroforestry and organic farming
6. Odisha Millets Mission: This is a state government initiative that aims to promote the cultivation of millets and promote their consumption as a healthy food option

The state government has also invested in building rural infrastructure, such as roads and markets, to improve the accessibility and connectivity of agricultural produce.

Table 11.1: Farm Power Availability in Odisha

Name of the District	Farm Power Availability (kW/ha)	Legend
Angul	1.414	
Balasore	2.645	
Bargarh	1.920	
Bhadrak	1.339	
Balangir	1.245	
Boudh	1.353	
Cuttack	5.812	
Deogarh	1.126	
Dhenkanal	1.267	
Gajapati	1.267	
Ganjam	1.614	
Jagatsinghpur	3.162	
Jajpur	1.721	
Jharsuguda	1.980	
Kalahandi	1.151	FPA more than 2.05 kW/ha FPA between 1.00 to 2.05 kW/ha FPA less than 1.00 kW/ha
Kendrapara	1.680	
Keonjhar	1.360	
Khordha	3.618	
Koraput	1.129	
Malkangiri	0.792	
Mayurbhanj	1.473	
Nabarangpur	1.318	
Nayagarh	1.637	
Nuapada	0.802	
Phulbani	1.853	
Puri	2.741	
Rayagada	1.358	
Sambalpur	1.738	
Sonepur	1.087	
Sundargarh	1.404	
Total	1.647	

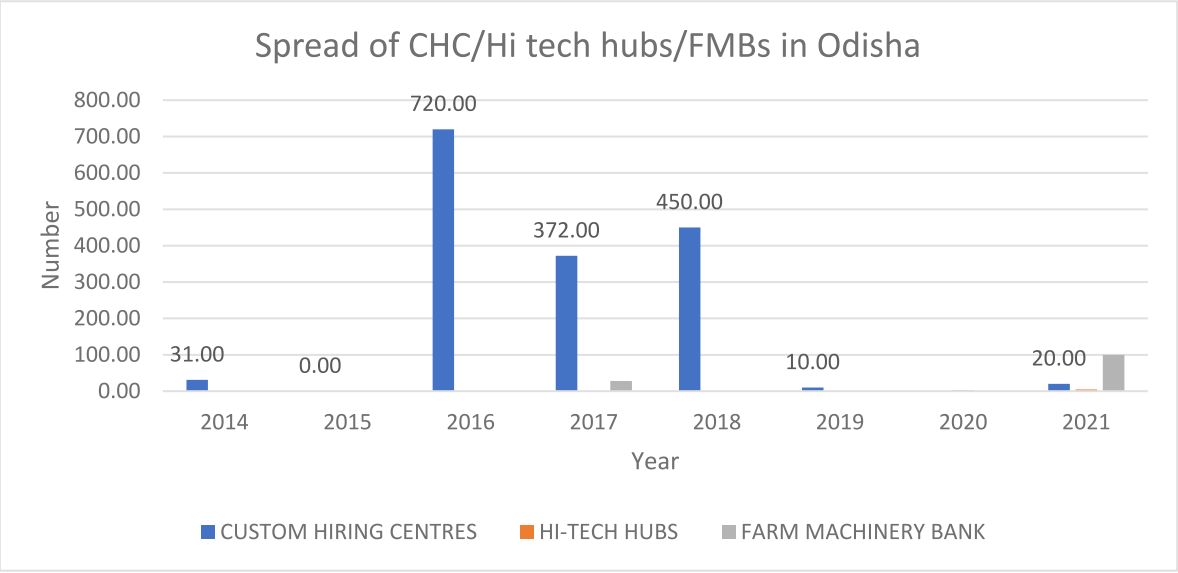
Source: *Mechanization & Technology Division, Ministry of Agriculture & Farmers Welfare*

The Government of Odisha has implemented several farm mechanization schemes to promote the use of modern agricultural machinery and equipment in farming practices. Some of the major farm mechanization schemes in Odisha are:

1. Promotion of Farm Mechanization for In-Situ Management of Crop Residue: This is a centrally sponsored scheme that aims to promote the use of machinery for crop residue management, such as crop residue shredders and balers.
2. Farm Mechanization Component under Rashtriya Krishi Vikas Yojana (RKVY): This is a centrally sponsored scheme that provides financial assistance to farmers for the purchase of various agricultural machinery, such as tractors, power tillers, and threshers
3. Sub-Mission on Agricultural Mechanization: This is a centrally sponsored scheme that aims to promote the use of agricultural machinery and equipment in various agricultural operations, such as land preparation, sowing, harvesting, and post-harvest management
4. Chief Minister's Krishi Udyog Yojana: This is a state government scheme that provides financial assistance to farmers for the purchase of various agricultural machinery and equipment, such as tractors, power tillers, and pump sets
5. National Food Security Mission (NFSM): This is a centrally sponsored scheme that promotes the use of farm machinery and equipment in various agricultural operations, such as seed treatment, sowing, and harvesting

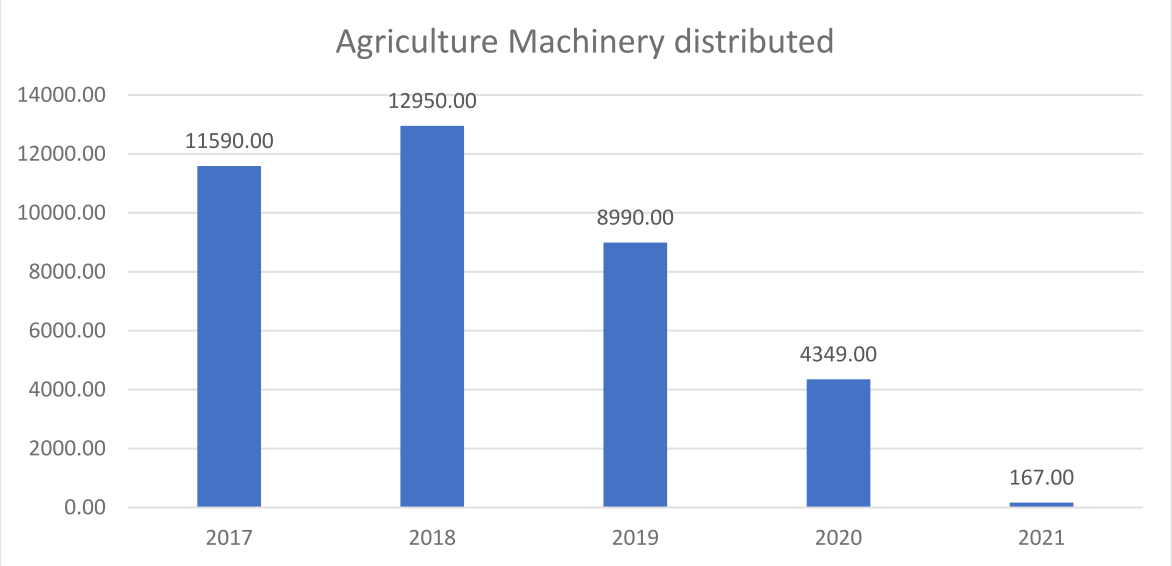
Also, a focus scheme, Popularisation of Agricultural Implements, Equipments and Diesel Pumpsets has been launched with objective to popularise use of farm machineries and equipment through providing subsidy assistance to farmers so as to facilitate timely and scientific agricultural operations and reduce cost of cultivation and drudgery of labour associated with these agricultural operations. Under this, subsidy is being extended for popularising different farm equipment. Besides, Innovative farmers who have developed/ modified some of the farm equipment's or operations depending on the prevailing situation are rewarded at district and state level under Mukhya Mantri Abhinaba Krushi Jantrapati Samman Yojana.

Figure 11.1: Spread of CHC/Hi tech hubs/FMBs in Odisha



Source: *Department of Agriculture & Farmers Welfare, Ministry of Agriculture & Farmers Welfare*

Figure 11.2: Agriculture machinery distributed in Odisha



Source: *Department of Agriculture & Farmers Welfare, Ministry of Agriculture & Farmers Welfare*

State Level Farm Machinery Training and Testing Centre, SLFMTTC, Bhubaneshwar

The Farm Machinery Training & Testing Centre started functioning since 2013-14 at the State owned OFMRDC (Odisha Farm Machinery Research & Development Centre, Bhubaneswar) with available facilities. The infrastructure consists of administrative building, training halls, Testing yard & Trainees hostel. The main activities of the office are testing of Farm Machinery developed by the SSI units, Manufacturers, Innovative Farmers of Odisha & other states, releasing of newly developed implements/machineries for farmer's use & imparting training for skill up-gradation of Farmer's, Farm Machinery owners, Unemployed youths, ITI youths, Departmental Mechanics & Engineer etc. Till date the Institute has conducted 447 of Demonstrations through a technical committee. The SLFMTTC shall impart training to the Farmers, members of SHGs, FPOS (Farmer's producer organisation), Rural youth & other entitles. The trainer are officials of State Govts, Technicians, Entrepreneur & Manufacturers. This is provision of trainees for user level courses/ crop specific machines/ Technical level courses/course on repair & overhanding & Training in Post Harvest Management Programme. For Training purposes, a sixty-bed training hostel is constructed in SLFMTTC Campus with four lecture halls. Currently, there is requirement of refreshers training of testing engineering and technical persons. Also, the training hostels need attention so that it can be functional for training.

Section 2: Village and household profiling from primary data

Socio-Economic and Farm-Level Characteristics

This section describes the socio-economic background of the households surveyed across two blocks in Orissa. Socio-economic profile indicates information on the average age, education qualification, ownership of APL/BPL card, caste, gender, occupation, family size, members involved in agriculture and non-agriculture work.

Socio-economic characteristics of sampled households

Table 11.2: Block wise list of sampled villages

District	Koraput		Puri	
Block	**Jeypore**	**Kundra**	**Delang**	**Nimapada**
Village	Mukhikhudipi	Limma	Arisal	Dalavanpur
	Panasaput Bagra	Bhasang Guda	Khandimangalapur	Haripur
	Ekomba	Khatalapadar	Beraboi	Kuanarpur
	Phampuni	Raniguda	Sujanpur	Gadapadanpur
	Dimla	Asana	Delangkothabar	Resinga

Table 11.2 shows the list of the all the villages in which the survey was conducted in different blocks of Orissa.

Table 11.3: Block wise list of sampled villages

District		Koraput		Puri		Total	
Category	**Land size**	**Jeypore**	**Kundra**	**Delang**	**Nimapada**	**Household covered for each category in the state**	**% Household covered for each category in the state**
Landless	0	0	6	2	0	8	1%
Marginal	Less than 2.5 Acres	69	49	65	65	248	41%
Small	2.5 -5 Acres	27	32	7	8	74	12%
Semi Medium	5 - 10 Acres	45	57	73	70	245	41%
Medium	10 - 25 Acres	9	5	3	7	24	4%
Large	25 Acre and above	0	1	0	0	1	0%

The household have been classified into six categories i.e., Landless, Marginal (less than 2.5 acre), Small (2.5-5 acres), Semi medium (5-10 acres), Medium (10-25 acre) and large (25 acre and above). The details of the household related to the categories have been provided in the table 11.3. The number of the household surveyed in each block is 150 including all the six categories. From the table 11.3 it is evident that marginal size land holders and semi medium size land holders together constitute 82% of the total respondents. Small size land holders cover 12% of the respondents and 1% of the respondents are landless.

Figure 11.3: Age of respondent

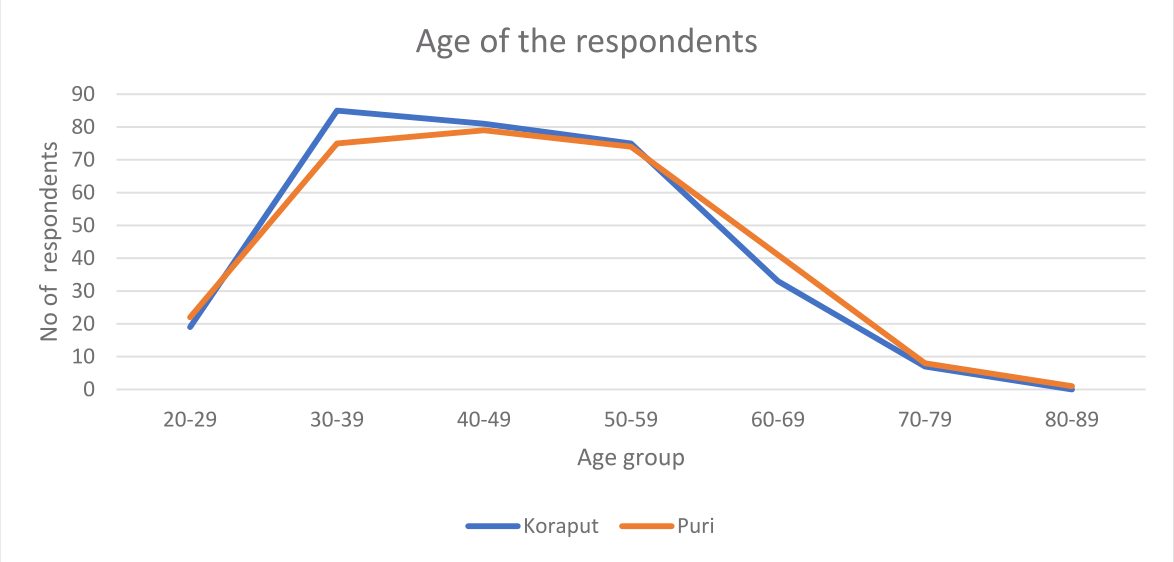


Table 11.4: Family demography and engagement in work in Orissa

	landless	Marginal Landowner (up to 2.5)	Small Landowner (2.5-5 Acre)	Medium Landowner (10-25 Acre)	Large (above 25 acres)
Average Age	45.12	45.56	45.6	46.83	49
Average number of total family members	3.5	4.67	5.04	5.2	5
Average number of children (0-5 years)	0	0.36	0.4	0.54	0
Average number of children (6-14 years)	0.75	1.1	0.98	1.04	1
Average number of Adult Male	1.62	1.63	1.82	1.79	2
Average number of adult females	1.12	1.58	1.84	1.83	2
Average number of Male in agriculture	1.62	1.63	1.82	1.79	2
Average number of females in agriculture	1.12	1.58	1.82	1.83	2
Average number of Children in agriculture	0	0	0	0	0
Average number of Male in non-agriculture	1.62	1.63	1.82	1.79	2
Average number of females in non-agriculture	1.12	1.58	1.82	1.83	2
Average number of children in non-agriculture	0	0	0	0	0

Table 11.4 indicates the family profile of the households. Generally, the trend shows that

middle aged people are more engaged in agriculture and related activities and number of family members increases with land holding size. The table 11.5 also indicate the level of male and female engagement in agriculture and non-agricultural work, and it shows all females and males in the households are participating in agricultural activities.

Table 11.5: Block wise family demography and engagement in work

		Koraput		Puri	
		Jeypore	**Kundra**	**Delang**	**Nimapada**
Landless	Average Age		38	66.5	
	Average number of total family members		3.66	3	
	Average number of children (0-5 years)		0	0	
	Average number of children (6-14 years)		0.66	1	
	Average number of Adult Male		1.83	1	
	Average number of adult females		1.16	1	
	Average number of Male in agriculture		1.83	1	
	Average number of females in agriculture		1.16	1	
	Average number of Children in agriculture		0	0	
	Average number of Male in non-agriculture		1.83	1	
	Average number of females in non-agriculture		1.16	1	
	Average number of children in non-agriculture		0	0	
Marginal Landowner (up to 2.5)	Average Age	46.08	41.1	48	45.53
	Average number of total family members	4.82	4.32	4.86	4.62
	Average number of children (0-5 years)	0.32	0.36	0.32	0.45
	Average number of children (6-14 years)	1.41	0.94	1.12	0.86
	Average number of Adult Male	1.53	1.55	1.78	1.64
	Average number of adult females	1.56	1.46	1.6	1.65
	Average number of Male in agriculture	1.53	1.55	1.78	1.64
	Average number of females in agriculture	1.56	1.46	1.61	1.65
	Average number of Children in agriculture	0	0	0	0
	Average number of Male in non-agriculture	1.53	1.55	1.78	1.64
	Average number of females in non-agriculture	1.56	1.46	1.61	1.65
	Average number of children in non-agriculture	0	0	0	0

		Koraput		Puri	
		Jeypore	Kundra	Delang	Nimapada
Small Landowner (2.5-5 Acre)	Average Age	48.11	44.4	48.13	43.32
	Average number of total family members	4.68	4.94	4.73	4.38
	Average number of children (0-5 years)	0.31	0.68	0.291	0.45
	Average number of children (6-14 years)	1.35	0.85	1.11	0.85
	Average number of Adult Male	1.62	1.74	1.73	1.61
	Average number of adult females	1.4	1.66	1.61	1.47
	Average number of Male in agriculture	1.62	1.74	1.73	1.61
	Average number of females in agriculture	1.4	1.66	1.61	1.47
	Average number of Children in agriculture	0	0	0	
	Average number of Male in non-agriculture	1.6	1.74	1.73	1.61
	Average number of females in non-agriculture	1.37	1.66	1.61	1.47
	Average number of children in non-agriculture	0	0	0	0
Semi Medium Landowner (5-10 Acre)	Average Age	48.55	43.26	51.85	40.13
	Average number of total family members	4.88	4.9	6.71	4.63
	Average number of children (0-5 years)	0.29	0.52	0	0.5
	Average number of children (6-14 years)	0.74	1.09	1.57	0.87
	Average number of Adult Male	1.92	1.67	2.43	1.62
	Average number of adult females	1.96	1.61	2.71	1.62
	Average number of Male in agriculture	1.92	1.67	2.43	1.62
	Average number of females in agriculture	1.92	1.61	2.71	1.62
	Average number of Children in agriculture	0			0
	Average number of Male in non-agriculture	1.92	1.67	2.43	1.62
	Average number of females in non-agriculture	1.92	1.61	2.71	1.62
	Average number of children in non-agriculture	0	0	0	0

		Koraput		Puri	
		Jeypore	**Kundra**	**Delang**	**Nimapada**
Medium Landowner (10-25 Acre)	Average Age	45.55	56.8	51.66	46.42
	Average number of total family members	3.66	7.8	4.33	5.71
	Average number of children (0-5 years)	0.66	0.8	0	0.42
	Average number of children (6-14 years)	0.55	1.2	1	1.57
	Average number of Adult Male	1.22	2.6	2	1.85
	Average number of adult females	1.22	3.2	1.33	1.85
	Average number of Male in agriculture	1.22	2.6	2	1.85
	Average number of females in agriculture	1.22	3.2	1.33	1.85
	Average number of Children in agriculture	0	0	0	0
	Average number of Male in non-agriculture	1.22	2.6	2	1.85
	Average number of females in non-agriculture	1.22	3.2	1.33	1.85
	Average number of children in non-agriculture	0	0	0	0

All the respondents owned the house that they are living in. All the respondents' major source of lighting at home is electricity and uses LPG for cooking purpose. Majority of the respondents in all four blocks uses keypad phone. Out of the 600 households surveyed, only 35% of them uses smart phone while 65% of them uses keypad phone.

Figure 11.4: Block wise phone usage

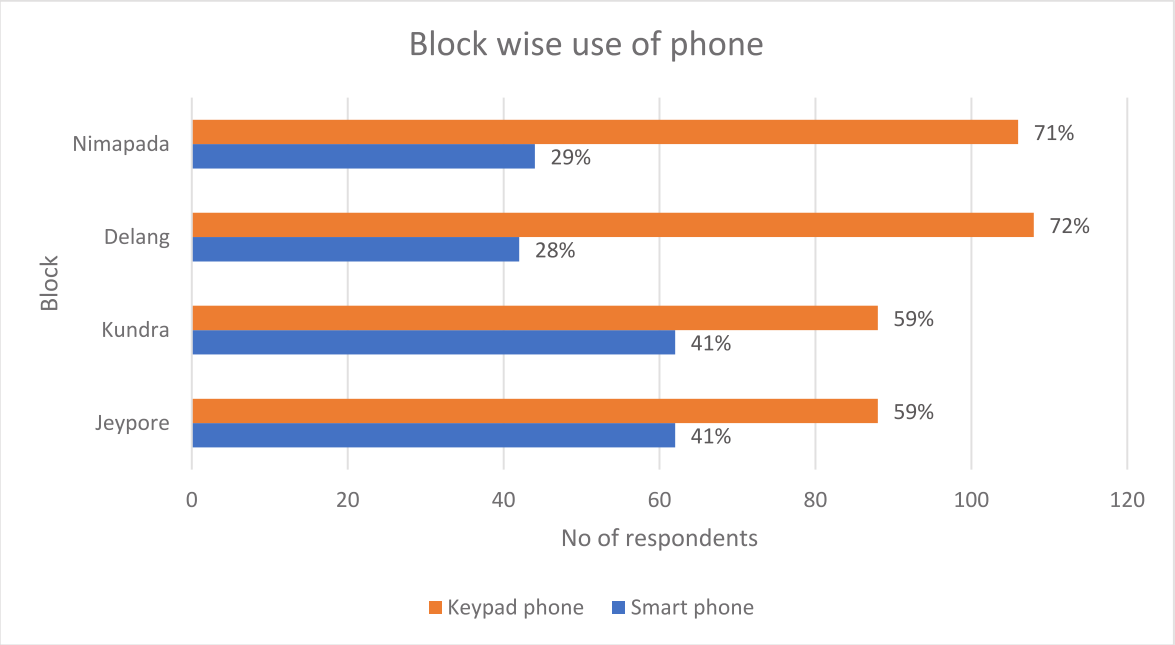


Figure 11.5: Occupation of households

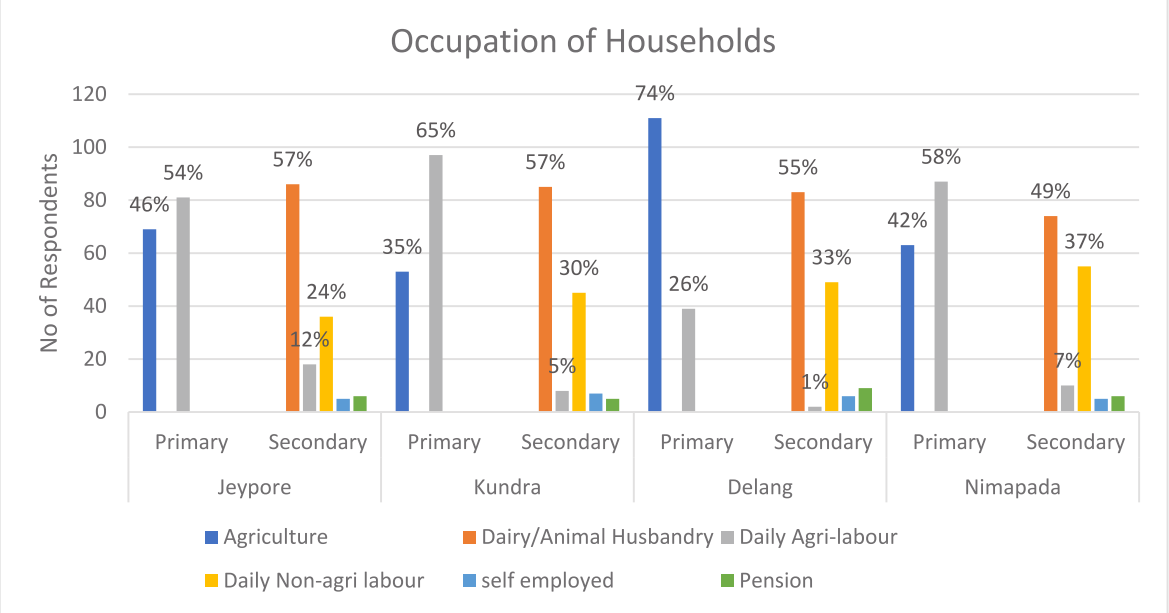


Figure 11.5 gives a sense of the proportion of households having agriculture and non-agriculture sources of income as primary and secondary occupation. The primary occupation of majority of the respondents in Jeypore, Kundra, and Nimapada blocks were daily agricultural labour followed by agriculture, while in Delang block around 74% of the respondent indulge in agriculture for primary work. Dairy and animal husbandry were the major secondary occupation for majority of the respondents followed by daily non-agricultural labour.

Table 11.6: Primary and secondary occupation

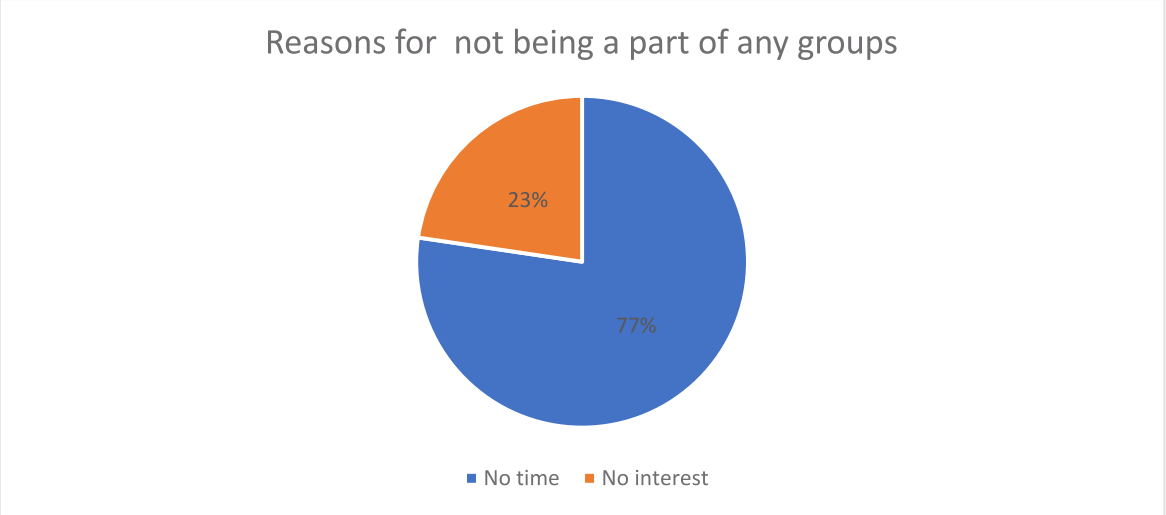
Block	Jeypore		Kundra		Delang		Nimapada	
Occupation	**Primary**	**Secondary**	**Primary**	**Secondary**	**Primary**	**Secondary**	**Primary**	**Secondary**
Agriculture	46%		35%		74%		42%	
Dairy/Animal Husbandry		57%		57%		55%		49%
Daily Agri-labour	54%	12%	65%	5%	26%	1%	58%	7%
Daily Non-agri labour		24%		30%		33%		37%
self employed		3%		5%		4%		3%
Pension		4%		3%		6%		4%

Section 3: Skill gap and access to extension services

All the respondent has bank account while no one have kisan credit card. All respondents answered that they were not a part of any community. Respondents found lack of time as the main reason for not being a part of any group and a few them responded that were not interested in communities (figure 11.6). Information regarding farming and lives stock were collected from government outlet or depot, private shops or suppliers, family members, media or radio or television or newspaper, community members or cooperative, gram sevak, kisan mitra, etc., while majority of the respondents were interested to adopt advice from private shops or suppliers followed by community members or cooperative and family members.

Every respondent visited government department for either information or studies. Average visit per respondent is 2.34 times per year. All respondents were visited KVK or other agriculture related institute. Everyone has received some benefit in the form of money from government for support.

Figure 11.6: Reasons for not being a part of any groups



All though availability of labour were easy, availability of agriculture work in the village was difficult for all respondents. Majority of the respondent felt getting agriculture work in the village was easy before 5 years and mentioned that January, June, July, august, September, October, November and December are peak season for availability of work. When there is no agriculture work available, all the respondents are ready to do non agriculture work in their village, nearby villages and nearby cities. Respondents pointed out the reasons of theirs and their family member's migration to non-agriculture work were due to lack of continuous work in agriculture, higher wages outside agriculture and city and high education qualification.

Section 4: Women adoption of machinery and labour-saving technology

This section examines the women's access to agriculture information and extension services. Age split of the women respondent is as given in the table

Table 11. 7: Percentage (%) of women respondent in the age group

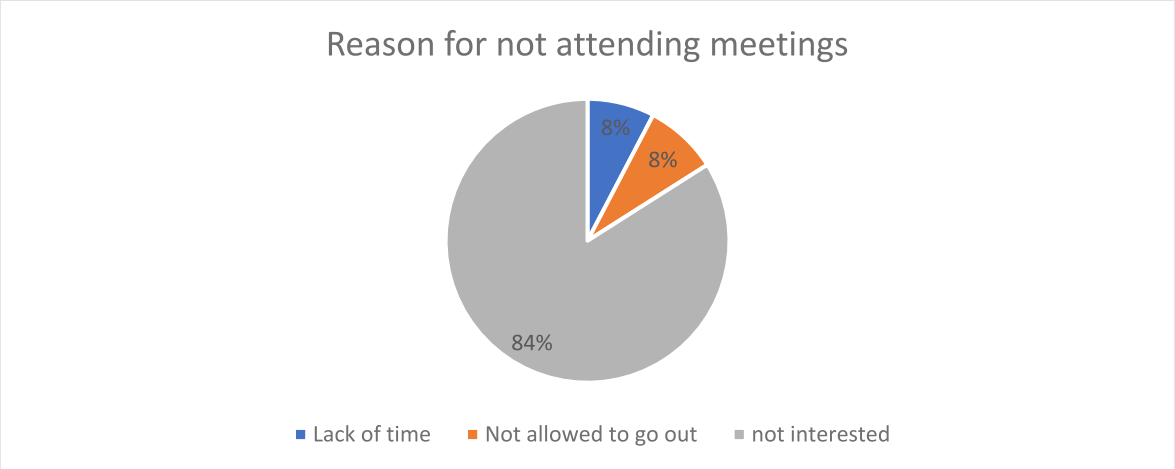
Age category	Percentage of women respondents
20-29	22
30-39	27
40-49	30
50-59	17
60-69	4
70-79	1

Table 11.8: Number of hours and days given by women in agricultural activities

	Hours	Days
Sowing/Transplanting	6-8	35-50
Weeding	6-8	18-25
Irrigation	2-5	5-10
Harvesting	6-8	18-25

Women respondents were participating in sowing and transportation, weeding, irrigation and harvesting. Table 11.8 shows that sowing/transportation engaged labourers 6 to 8 hours a day for 35 to 50 days per year. Weeding and harvesting and related works were available for 18-25 days a year and engage respondents for 6 to 8 hours a day. Respondents were engaged in irrigation for 2 to 5 hours per day for 5 to 10 days. Under the study, various reasons were explored for why women are not allowed to use machines for performing various agriculture operations and all respondents reported the reasons as machine being too expensive to be used by them, they might not be able to operate those machines and mis handle the machines. All of the respondents mentioned they were comfortable doing the job by traditional method, safety and risk issues, they do not know how to use the machines and they felt uncomfortable using the machines were the reasons for not using the machines which were allowed for them to use. All women respondents were felt the need of getting trained on operating and handling the machines and for that if needed they were all willing to travel out of their village for residential programs. They were getting information about agriculture from government outlets/depots, NGOs or NGO outlets private shops/suppliers, community members or cooperatives, family members, gram sevak, kisan mitra, KVKs and other government agencies. No women respondents have met any extension agents or never visited any KVKs or other agriculture related institutes and they were all wanted to receive agriculture related information from a female extension agent. Respondents were not interested in attending any meetings. Majority of the respondents (84%) said that they are not attending the meetings due to lack of time.

Figure 11.7: Reason for not attending meetings



CHAPTER 12

RECOMMENDATION AND CONCLUSIONS

Indian agriculture contributes to food security and generates employment. With increasing population, there is higher pressure to increase food production. Land being the limited resource, a lot of progress and innovation is being undertaken on other inputs to increase the productivity of the land. From seed innovation to fertiliser subsidies, these initiatives have helped to achieve the above objective. Agricultural mechanization plays a vital role in the agriculture sector by enhancing the efficiency and effectiveness of crop production inputs, leading to increased productivity. It also helps to reduce the labour pious nature of various farm operations. But there is a huge difference in the uptake of agriculture machines across the states and across various agricultural operations. Efforts are underway to increase the coverage of machines in all state of India.

ASSAM

The majority of respondents (87%) expressed a need for maintenance and repair training for machines. Additionally, 48% of respondents desired shorter training durations, while 39% wanted training focused on machine operation. Only 5% of respondents suggested a change in training content. Out of the 432 respondents who hired power tiller operators, only 12.5% reported easy availability of operators. The remaining 82.18% indicated that they had to bring operators from outside their village due to non-availability. Respondents reported that machine availability is not the issue; rather, the shortage of operators is hindering their cultivation operations. Some reported that their agricultural operations are delayed as they wait for operators to arrive. This is a challenge that can be addressed through collaborative efforts with KVKs in the affected blocks. The highest gap was found in Gabharu block, where 98% of respondents stated that operators had to be called from other villages, followed by Kaliapani, Titabor, and Naduar.

The Government of India introduced a scheme called Sub Mission on Agricultural Mechanization (SMAM) in 2014-15 to make farm machines accessible and affordable for small and marginal farmers. The scheme includes the establishment of Custom Hiring Centres (CHCs), creating hubs for hi-tech & high value farm equipment, and Farm Machinery Banks. The distribution of various subsidized agricultural equipment and machines to individual farmers is also part of the scheme. Custom hiring institutions provide hiring options of machines to SMFs as purchasing them is not financially feasible. The components of SMAM also include creating awareness among stakeholders through demonstration of machine operations and skill development of farmers and youth. The performance testing and certification of machines at designated testing centres located all over the country ensures farm machinery is of high quality and efficient. Under the SMAM scheme, a total of Rs.4556.93 crores have been released to States and implementing institutions from 2014-15 to 2020-21. Over 13 lakh agricultural machines have been distributed and more than 27.5 thousand Custom Hiring Institutions have been established. For the year 2021-22, the budget allocation for SMAM has been increased to Rs.1050 crore.

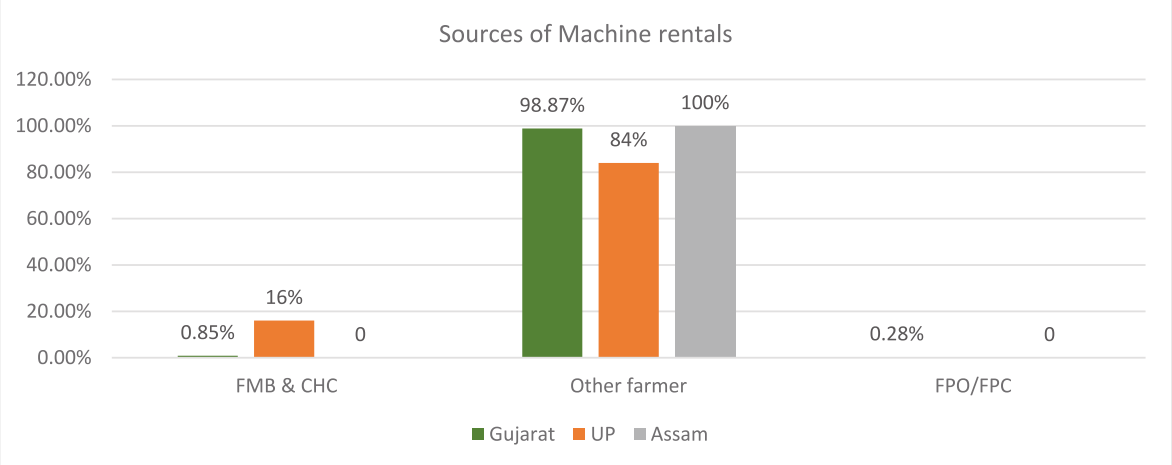
The government programs have been effective and the implementation has led to widespread usage and adoption of machines in agriculture. Even though affordability of the machines remains biggest challenge, but options like rental of machines have delivered much relief to farmers. The most prevalent rental options in villages are the farmers/owners of the machines who provide rental services to the farmers who don't own the machines. Hence, ownership of machines is not a barrier anymore for adoption. Even government system like Custom hiring centres and Farm machinery banks have been established to increase the availability of the machines.

Gujarat

Tractors are the most widely used machine, followed by cultivators, power tillers, disc ploughs, and rotavators. Joint ownership of tractors is observed. Out of all the users of tractors, 37.30% respondent owned the tractors and 62.70% rented it. Most of the rentals are from other farmers. Spread of CHCs and FMBs is not widespread. Only 3% of tractor operators were trained through private dealers and 82% receive training from their friends/relatives. Non-availability of the machine is faced during the peak agriculture time. There are issues with finding operators on time, inefficiency of the operators, inappropriate way of handling machines and higher fuel consumption. The state has mechanization in most of the activities accept weeding where proportion of adopters are very less. Working on imparting right skill set to the tractor operators and maintenance takers will not only increase the efficiency of the operations but also increase the shelf life of the tractor and its equipment.

The greatest advantage which comes with rental machine is accompanying of the machine operator in most of the cases and no hassle of repair and maintenance of the machines. Most villages don't have an ecosystem of appropriate repair of machines and they have to travel for getting it repaired/service. This incurs additional cost making the ownership of machines further expensive. Mechanization of agriculture operations depends on the crop and the region where they are grown. For instance, harvesting and threshing of paddy is mechanized in Uttar Pradesh but not in Assam. Transplanting in paddy is not widely mechanised but harvesting and threshing are.

Figure 12.1: Sources of machine rentals across states



The mechanization of agricultural operations is being prioritised to provide solution for the issues of labour scarcity. With increasing urbanization and demand of labour in urban areas, there is trend of migration from rural to urban areas. Agriculture being a labour -intensive activity induces higher amount of drudgery and work in harsh conditions. There is growing inclination of population in farming to opt for newer income generating avenues apart from agriculture. Various sectors like construction, textiles, etc are generating employment and absorbing the rural population. This has put pressure on the limited labour in rural areas. With increasing labour wages, decreasing efficiency of labour and unremunerative crop

pricing, farmers are unable to cope with the agricultural profits.

The study sampled 2400 households across the five states, and these included landless, small and marginal farmers, medium and large farmers. The study covered 80 villages across 8 districts in the four states of Assam, Gujarat, Odisha and Uttar Pradesh. Qualitative study was carried out in Tamil Nadu. Various interactions were carried out with the stakeholders in the mechanisation architecture.

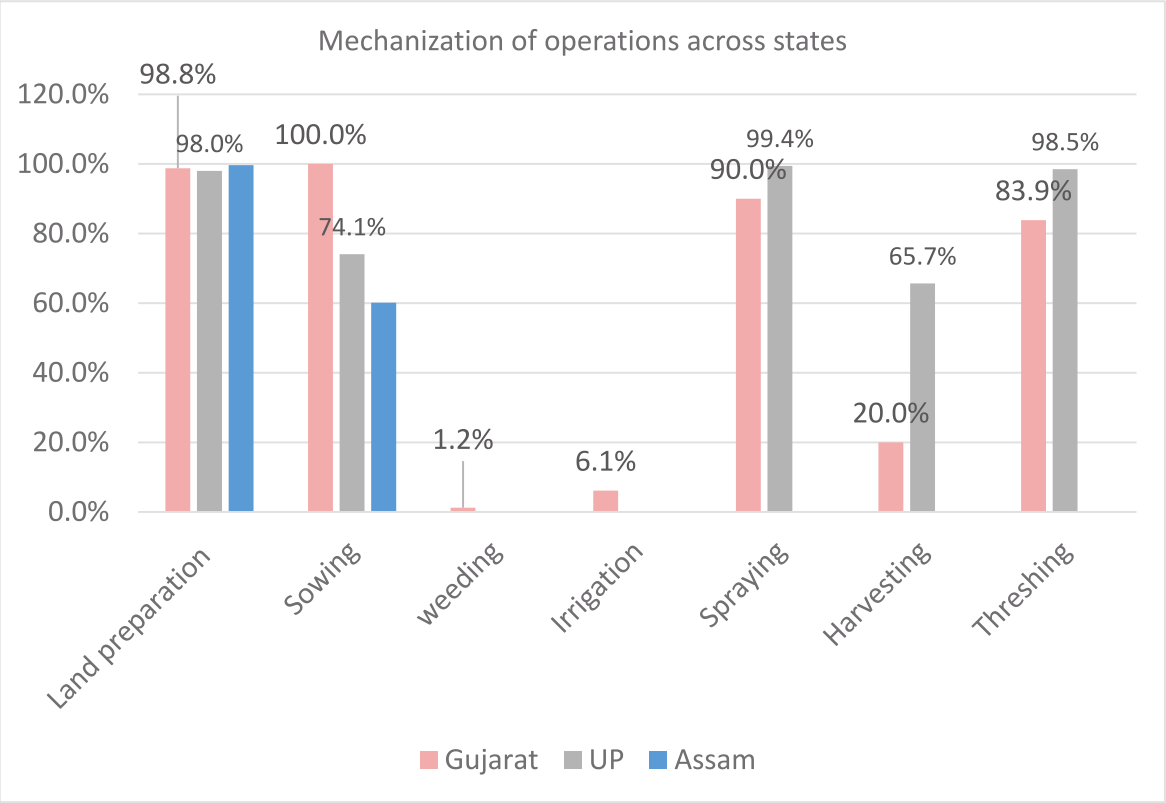
UTTAR PRADESH

Custom Hiring Centres and Farm Machinery Banks are not widely used as the majority of farmers still rent equipment from other farmers. Rental charges were found to be affordable. All of the operators learned how to drive a tractor from family members or friends and did not undergo any formal training. Out of the total tractor owners, 61% undertook maintenance at regular intervals, while only 30% did so when a breakdown occurred. Respondents are able to diagnose and repair their tractors themselves, while only 12% needed to approach a mechanic at the village level. There are issues /delays in repair services due to a lack of mechanics in the village but number of issues are resolved by self-repair. The owners of the machines did not receive any formal training but are willing to adopt innovative methods to improve the efficiency, performance, and lifespan of their machines.

It was found that land preparation is the highest mechanized operations across the states, followed by sowing, spraying, threshing, harvesting. The least mechanized activities are irrigation and weeding. Tractors are widely prevalent along with their attachments. The awareness level for tractors is high and availability along with equipment is widespread. The availability of the operators for tractor is not at all a challenge and all of them learn operating through informal sources like family members, friends or relatives. But for machines like combine harvesters, there is requirement of formal training and operators undergo trainings from training institutions. Sowing has also seen a transition from manual to machine operations. The major factor being the attachment like seed drills which can be used with tractors.

Tamil Nadu has displayed successful models of rentals for agriculture machinery by setting up Custom hiring centres and farm machinery banks with women Self-help groups. Combine harvester, tractors (mounted with rotavator, cultivator, disc plough and tailor), power tillers are predominantly used by farmers. For paddy transplanting, farmer have to depend mostly for manual labours due to non-availability of transplanters. But weeding activities are still manually done and usage of weedicides is increasing. KVKs were engaged in farm extension services with the support of government department and leading farm machinery company. State has come up with Hi tech knowledge centre for works knowledge dissemination among farmers. Any delay in repair of machines leads to delay in the farm operation. Hence, taking these service centres close to the farmer will enable the farmer to take timely repair. Even with robust mechanization ecosystem, women operations are still manual as they are involved in paddy transplanting, weeding, harvesting of horticulture and floriculture crops. Their involvement in paddy harvesting and threshing is limited due to high presence of combine harvesters.

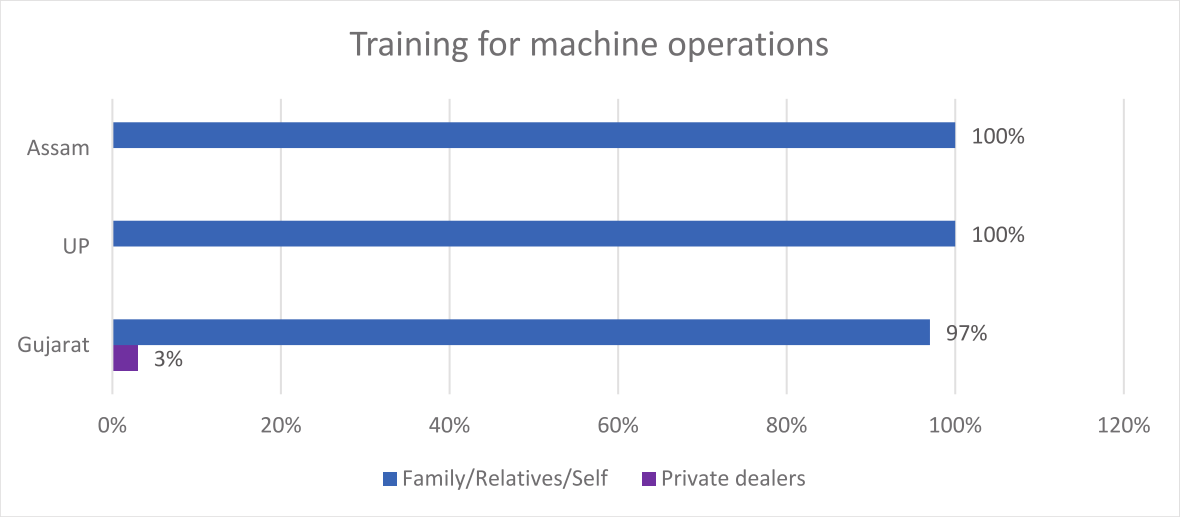
Figure 12.2: Mechanization level of operations across states



Source: *compiled by Authors*

Weeding is the least mechanised activity. The major reason being non availability of appropriate weeding machines, lack of awareness of weeding tools and availability of labour which is cheaper than the weeding machines. Power weeder are now gaining popularity but it will be a gradual process. Mostly women engaged in weeding operations as it is more labour intensive and less power intensive.

Figure 12.3: Training for machine operators



In all the states under study, there was a very small proportion of machine operators who have been trained formally. Most of the operators had learn to operate machine through their

network of family and friends. As tractors are prevalent in all the villages and their easy access allows operators to learn them in the village. Other machines like combine harvester, paddy transplanter, sugarcane cutters are more advanced and new machines. They are not easily accessible hence it hinders the learning process of the potential operators. In Tamil Nadu, it was found that the trainer from the private dealer who the sugarcane cutter is purchased trains the operators for perfection. The skill which is imparted through formal network is appropriate and increase the knowledge of the operator. Technical know-how helps operator to efficiently use the machines also ensuring a long life of the machines. The formal skill also imparts the operator with basic maintenance and repair of machine for minor troubleshooting. Even though the tractor operator can operate the machine without receiving the formal training, their score on tractor assessment is not that great indicating a lack of sound technical knowledge. The highlights the need of skill training among the operators.

Recommendations:

- With uneven mechanization across agriculture operations, it is imperative to understand the penetration of machines across the operations.
- With very low penetration of mechanization this study suggests the need for introducing and popularizing power operated weeders for narrow and wider row crops, as well as high clearance tractors with narrow tires for intercultural operations.
- Rice transplanters are required owing to the drudgery during transplanting. But the lack of confidence in the effectiveness of the transplanter is a barrier. Demonstration is important for technology adoption. Farmers adopt when they see the technology repetitively.
- For adoption of innovative and new machines like rice transplanters, power weeder/tillers and other tools, it is important to follow 3 As framework and focus on creating machine awareness, accessibility, and affordability.
    1. *Awareness:* Setting up of a data centre where all the machineries which are applicable for all the crops grown in the state are displayed. This will be one institute for creating awareness about all the machines including demonstrations and taking care of the training needs in the state. The inspiration for this model should be taken from the state of Tamil Nadu where they have created 'State Agricultural Machinery Information Data Centre' and displayed all the machines for creating awareness amongst the farmers. In collaboration with Krishi Vigyan Kendra, other non-government agency, farmers exposure visit should be organised.
    2. *Accessibility:* Along with CHCs and FMBs, presence of machines/tools in villages shall be ensured through various collaborative rental models like women SHG groups, farmer/ youth entrepreneurs in the village. Availability of machines/tools for purchase also leads to adoption. After receiving the information of the new technology, if farmers want to see it physically or undergo demonstration, the availability at nearby marketplace is of utmost important.
    3. *Affordability:* Rentals have been popular and affordable amongst farmers. If the increase in demand of machines is matched with the supply of machines, affordability can be ensured.
- Self-help groups should be involved in renting of smaller machines like power weeder/ tiller and other labour-saving tools like manual weeder etc. These groups should be imparted training for efficient use of these equipment.
- Labour displacement/ labour scarcity areas should be mapped and targeted for promoting manual technology. Efforts should be focussed on areas where there is lack of labour and farmers want to shift to manual yet sophisticated tools.

- There is difference in ergonomics of manual tools and power operated tools. If women use power operated tools, ergonomics won't matter much. But if its manually operated tool, then it will matter.
- Labour saving manual weeders shall be promoted for timely weeding operations. Timely operations will ensure that there is no loss of nutrient from soil due to weeds. This approach needs to be targeted especially in areas with low farm power availability like tribal belts etc. Manual tools will deliver drudgery less operations for women.
- Use of labour-saving weeding tool will also ensure non usage of weedicides and herbicides which are chemicals. Incidence of chemical farming is increasing due to menace of weeds. This approach should be especially targeted in vegetable and horticulture crops where lot of chemicals are used. Focus should be on use of labour-saving tools as part of promoting organic/natural farming by Government of India.
- LSTs may be included in Farm machinery bank or Custom hiring centres. This will lead to awareness of the LSTs and hence, increasing chances of adoption.
- Agri clinic and business centres should be allotted LSTs for promotion and marketing. Bringing visibility about this equipment is required.
- Female extension agents should be focussed for promotion of technologies specifically made for women. Especially, female extension agents should be made part of the tool demonstration where women can be guided on the using the tools.
- It is observed that local artisans can make the tools at cheaper cost. Krishi Vigyan Kendras can be tied up with local artisans. There is already a training course for local artisan with KVKs. With financial support for raw materials and designs, local artisans can manufacture LSTs. Local artisan/blacksmiths are prevalent at block level and in some villages. This will help in easy awareness of the tools along with ensuring availability. There are Blacksmith and agri tool cluster which can be leveraged to promote labour saving tools across villages.
- With focus on farm power availability, attentions should also be paid to introducing the gender friendly tools/ LSTs in the districts with low power availability. Hilly areas, tribal belts etc are easier to penetrate with these tools as they are cheaper, require manual efforts. Focus should be in particular areas to increase the reach of these tools and benefit women. For g: tribal areas have smaller land holdings, tractors are not efficient there (low farm power availability). They work manually and hence advanced manual tools like LSTs would be most beneficial to them.

Skill Demand and skill gap Analysis:

Using the approach for skill assessment discussed in chapter 4, analysis is presented along with following recommendations:

- It is observed that majority of machine operators have been learning to operate the machines by their own/family/friends. They have basic training of how to operate the machine but primary surveys and discussions have highlighted the challenges like inefficiency of operators, rough usage of machine resulting in high maintenance cost and high fuel consumption while operations are undertaken.
- There is a huge dearth of mechanics at village level. At times farmers can self- repair for basic issues but then they have to travel to block level for getting other repairs done.
- Machines like combine harvesters require more skills to operate. There need will increase in future and hence to match the supply of operator, more training is required.
- Innovative machines like paddy transplanter, power tiller and power weeder are not prevalent and hence their limited access limits farmers to learn its's operations. The major

challenge is with any faulty operation resulting in crop loss if operated in ineffectively.

- FMTTIs are national level institutions which are located in four locations in India. This restricts the reach of the farmers to institute of such importance in agriculture sector.
- FMTTIs are effective to achieve high training targets but the quality of training may be hindered. With increased targets of training to be undertaken by FMTTIs, the effectiveness of trainings is compromised.
- Leadership at the state institutes needs to be ensured. With short term period of personnel as head of the institute disrupts the progress and effective actions. This disruption was observed at a state level training institute with a great infrastructure and resource availability.
- Certification process should be streamlined with one apex body certifying. The training institutes can be aligned to the apex agency for certification. For farmers, the benefits after receiving the training and its certificate.
- Inclusion of small tools and equipment along with other agri inputs will increase the tool visibility and hence, adoption. The inclusion will enable farmers to acquire small machines with their Kisan card etc. The trust on government cooperative societies for fertilizer is well established. This network can be leveraged for promotion of smaller machines and tools for larger benefits to the farming community.

Policy recommendations based on analysis:

- An advance training shall be imparted to the operators who are not formally trained but can operate the machines. They should be imparted with knowledge of maintenance and efficient functioning of the machines. This can be incentivised for long life and efficiency of the machines.
- Each village should be identified with entrepreneurs who can be trained for after sale and repair work. A mobile van unit for repairs can be devised which can function on schedule basis in villages.
- Block level training should be organized with the operators to disseminate the knowledge about how to increase the efficiency of the machines and basic repairs. The operator trainings will make the machine functioning efficient in order to deliver better results.
- Formal training programs to acquaint the farmers/operators with the operational aspects of not so popular but effective machines will push for usage.
- It is found that decentralised training institutes would be better for increasing the reach for training. District wise training institute will give options for farmers to approach these institutes and demand training. Smaller units will help to reach more people and achieve the training numbers. These units can be at district level government offices and hence no need of new infrastructure.
- In order to have a better training quality, resources are required to maintain manpower, trainers and infrastructure. Training targets should be mapped across the resources available with the training institutes.
- Continuous leadership is mandatory at the level of state training institutes for efficient working. These institutes have great infrastructure and can be leveraged for better training and display of machines.

Figure 12.4: Skill gap assessment

Skill Demand and gap Analysis	Policy Recommendations
Operators have basic training of how to operate the machine. Without formal training, the challenges like inefficiency of operators, rough usage of machine, high maintenance cost and high fuel consumption arise.	An advance training shall be imparted to the operators who are not formally train but can operate the machines. Knowledge of maintenance and efficient functioning of the machines can lead to long life of machine and efficient operations.
Lack of mechanics at village level forces machine owner to self repair for basic issues and travel to block level for getting other repairs done	Each village should be identified with entrepreneurs who can be trained for after sale and repair work. A mobile van unit for repairs can be devised which can function on schedule basis in villages.
Machines like combine harvesters require more skills to operate. There need will increase in future	To match the supply of operators, block level training should be organized with the operators to disseminate the knowledge about how to efficiently operate the machines
Innovative machines like paddy transplanter, power tiller and power weeder are not prevalent and hence their limited access limits farmers to learn its's operations. Any faulty operation will result in crop loss	Formal training programs to acquaint the farmers/operators with the operational aspects of not so popular but effective machines will push for usage.
FMTTIs are national level institutions which are located in four locations in India. This restricts the reach of the farmers to institute of such importance in agriculture sector.	Decentralised training institutes would be better for increasing the reach for training. District wise training institute will give options for farmers to approach these institutes and demand training.
With increased targets of training to be undertaken by FMTTIs, the effectiveness of trainings is compromised.	In order to have a better training quality, resources are required to maintain manpower, trainers and infrastructure. Training targets should be mapped across the resources available
With short term period of personnel as head of the institute disrupts the progress and effective actions.	These institutes have great infrastructure and can be leveraged for better training and display of machines with a continuous and strong leadership

Source: *Compiled by Authors*

Rationalization of agricultural schemes in India

The Government of India has initiated various agricultural schemes to boost the agriculture sector in the country, including the Pradhan Mantri Fasal Bima Yojana (PMFBY), Pradhan Mantri Krishi Sinchai Yojana (PMKSY), the Rashtriya Krishi Vikas Yojana (RKVY) and many others. There are number of schemes mentioned in earlier sections which focus on promotion of machines and implements in agriculture. This is potentially cause for duplication of efforts, makes the schemes inaccessible to farmers, and hinders the effectiveness of the agricultural initiatives. Rationalizing these schemes would involve streamlining and consolidating them into a single comprehensive scheme that addresses the various issues and challenges faced by farmers across the country. The Government of India has taken steps towards rationalizing agricultural schemes, including merging the PMKSY and the Accelerated Irrigation Benefit Programme (AIBP) into a single scheme called the PMKSY-AIBP. Overall, rationalizing agricultural schemes could lead to more efficient and effective use of resources, better coordination among different initiatives, and ultimately, improved outcomes for farmers and the agriculture sector as a whole.

Rationalization of data available for spread of machines in Agriculture

The rationalization of data available for the spread of machines in agriculture refers to the process of organizing and optimizing the use of data to improve the deployment and adoption of agricultural machinery in farming operations. Currently, there are number of schemes and varying formats in which data is stored. Collecting this data is also tedious because it

is scattered over multiple platforms in non-standard format. Bringing together all machine related data under one umbrella and standardising the format for all districts and states will create a robust data system. The spread of machines in agriculture has the potential to significantly improve farm productivity, reduce labour requirements, and enhance the efficiency of agricultural operations. However, the effective deployment of machines requires accurate data on factors such as existing machines, requirement of machines, crop types, soil conditions, weather patterns, and farm size, among others. By rationalizing data available for the spread of machines in agriculture, stakeholders can better identify the areas where machines are needed and determine the most appropriate types of machinery for specific applications. This could involve collecting and integrating data from different sources, such as satellite imagery, weather sensors, soil sensors, and yield monitoring systems, among others. With a more rationalized approach to data, stakeholders can make more informed decisions about the deployment of machines in agriculture, such as which crops to plant, when to plant them, and which machines to use for planting, harvesting, and other tasks. This can help optimize farm operations, reduce waste and costs, and increase profitability Overall, the rationalization of data available for the spread of machines in agriculture can play a crucial role in the ongoing digital transformation of the agriculture industry, enabling farmers to leverage the power of technology to improve their operations and meet the growing demand for food in a sustainable manner.

REFERENCES

DAC&FW, GOI. (2022, 03 17). PMKSY. Retrieved from pmksy.gov.in: https://pmksy.gov.in/

Department of Agriculture & Cooperation. (2014, April). MIDH Operational guidelines. Retrieved from midh.gov.in: http://midh.gov.in/PDF/MIDH_Guidelines(final).pdf

Dept. of Agriculture and Coperation, M. (2015, January). BGREI, Operational Guidelines. Retrieved from agriportal.cg.nic.in: http://agriportal.cg.nic.in/beejnigam/Pdf/BGREI.pdf

District wise agriculture census. ; https://agcensus.dacnet.nic.in/stateholdingsizeclass.aspx

Economic Times. (2020, Feb 03). PM-KUSUM scheme expansion a boost for agri sector, job prospects: Renewable energy players. Retrieved from https://economictimes.indiatimes.com/small-biz/productline/power-generation/pm-kusum-scheme-expansion-a-boost-for-agri-sector-job-prospects-renewable-energy-players/articleshow/73897086.cms

FAO. 2014b. A regional strategy for sustainable agricultural mechanization: Sustainable mechanization across agri-food chains in Asia and the Pacific region. G. Mrema, P. Soni & R. Rolle. FAO Regional Office for Asia and the Pacific Publication 2014/24. 74 pp.

Houmy, K., Clarke, L. J., Ashburner, J. E., & Kienzle, J. (2013). *Agricultural mechanization in sub-Saharan Africa: guidelines for preparing a strategy* (Vol. 22). Food and Agriculture Organization of the United Nations (FAO).
https://www.indiafilings.com/learn/bringing-green-revolution-to-eastern-india-bgrei/

https://agrimachinery.nic.in/GraphReport/SMAMFmtti/SMAMFmtti.aspx

Kishtwaria, J., & Rana, A. (2012). Ergonomic interventions in weeding operations for drudgery reduction of hill farm women of India. Work, 41(Supplement 1), 4349-4355.

MIDH, G. (2022, April 6). MIDH FAQ. Retrieved from midh.gov.in: https://midh.gov.in/

Ministry of Agriculture, G. (2007, August). Guidelines for National Agriculture Development Programme (NADP) Rashtriya Krishi Vikas Yojana . Retrieved from agricoop.nic.in: https://agricoop.nic.in/sites/default/files/rkvyfinal-1.pdf

Ministry of New and Renewable Energy, G.O.I. (2019, JULY 22). about-scheme. Retrieved from https://pmkusum.mnre.gov.in/: https://pmkusum.mnre.gov.in/about-scheme/8065c8f7b9614c5ab2e8a7e30dfc29d5.pdf

MoAC&FW, GOI. (2020). REvised Guidelines of In-situ crop residue management scheme. Retrieved from agricoop.nic.in https://agricoop.nic.in/sites/default/files/Guideline%20of%20CRM%20scheme%20-2020%20.pdf

MoN&RE, G. (n.d.). PM-KUSUM documents. Retrieved from mnre.gov.in: https://mnre.gov.in/img/documents/uploads/file_f-1632204688401.pdf

MoN&RE, G.O.I. (2021, March). pm-kusum-pradhan-mantri-kisan-urja-suraksha-evam-utthaan-mahabhiyan-scheme. Retrieved from India.gov.in: https://www.india.gov.in/spotlight/pm-kusum-pradhan-mantri-kisan-urja-suraksha-evam-utthaan-mahabhiyan-scheme

National Seminar on Women Farmer – NSWF February Organized by – Junagadh Agricultural University, Junagadh (Gujarat), Vigyan Parisar, Department of Science and Technology, Noida (UP) and National Council for Climate Change, Sustainable Development and Public Leadership, Ahmedabad (Gujarat), 2014.

Operational guidelines of Mission For Integrated Development Of Horticulture

PIB, Delhi. (2021, AUG 18). Cabinet approves implementation of National Mission on Edible Oils – Oil Palm. Retrieved from pib.gov..in: https://www.pib.gov.in/PressReleasePage.aspx?PRID=1746942#:~:text=8%2C844%20crore%20is%20the%20Government,of%2010%20lakh%20hectares%20ultimately .

Press Information Bureau, GOI. (2021, MAR 23). Press Information Bureau, GOI Ministry of Agriculture & Farmers Welfare. Retrieved from https://pib.gov.in/: https://pib.gov.in/Pressreleaseshare.aspx?PRID=1707021

Rashtriya Krishi Vikas Yojna (2020), http://www.rkvy.nic.in/static/Statements/RKVY_Allocation_2019-20.pdf

Pinzke, S., & Lavesson, L. (2018). Ergonomic conditions in manual harvesting in Swedish outdoor cultivation. *Annals of Agricultural and Environmental Medicine, 25(3).*

Pingali, P. (2007). Chapter 54 Agricultural Mechanization: Adoption Patterns and Economic Impact. Handbook of Agricultural Economics.

Quick Estimates as per Statistical Diary Uttar Pradesh 2020 published by Economic and Statistics Division, State Planning Institute, Planning Department, Uttar Pradesh.

Selected State-wise Number of Beneficiaries under Sub Mission on Agricultural Mechanization (SMAM) in India (2017-2018, 2018-2019, 2020-2021 and 2021-2022), https://agrimachinery.nic.in/GraphReport/SMAMFmtti/SMAMFmtti.aspx

Sarkar, A. (2020). Agricultural Mechanization in India: A Study on the Ownership and Investment in Farm Machinery by Cultivator Households across Agro-ecological Regions. Millennial Asia, 11(2), 160–186. https://doi.org/10.1177/0976399620925440

Som, H. (2010). World programme for the census of agriculture 2010.

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