PRODUCTIVITY GROWTH AND ADOPTION OF FARM MACHINERY UNDER FARM MECHANIZATION IN SUPAUL DISTRICT OF NORTH BIHAR

THESIS

Submitted in partial fulfilment of the requirements for the award of the degree

Of

DOCTOR OF PHILOSOPHY

IN

FARM MACHINERY AND POWER ENGINEERING

BY

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2016

Department of Farm Machinery &Power Engineering

Vaugh School of Agriculture Engineering Technology

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ALLAHABAD, 211007, U.P. INDIA

(I.D No – 13 PH FMP101)
ABSTRACT

Agriculture is the largest private sector occupation in India as well as in Bihar. This occupation is too risky because of dependence on climatic conditions. Hence, the goal of the agricultural production system should be to maximize the income of land owning and landless rural populace to improve their livelihoods. The vulnerability to income and consumption shocks makes it inevitable to develop formal agricultural insurance mechanisms to cope up with such risks. The traditional yield insurance schemes have failed in managing the risks of the poor farmers as evident from their historically high payouts and poor penetration rates. There is a need to develop effective risk management strategies to cover potential losses in yield and hence incomes. The present investigation relates to study the productivity growth and adoption of Farm Implements under Farm Mechanization by the farmers of Supaul District of North Bihar. The purpose is to check the effect of the farm mechanization on status of the farmers of the Supaul district. Rural people of Supaul district depend upon their livelihood on agriculture and its allied activities. In pre-flood situation (before 2008) affected farmers used to raise the crops like Paddy, Wheat, Gram, Vegetables, Jute, and Sunflower etc. After flood, the land became barren due to deposition of sand silt and most of the farmers didn’t get any livelihood option. For getting employment opportunity the people migrated to Delhi, Punjab and other places. To sum up, agricultural mechanization studies had shown that farm mechanization led to increase in inputs due to higher average cropping intensity, larger area and also increased the productivity of agricultural crops. Furthermore, farm mechanization increased agricultural capacity profitability on account of timeliness of operations, better quality of work and more efficient utilization of crop inputs. Undoubtedly, farm mechanization displaced animal power from 60 to 90% but resulted in less time for farm work. Also, it led to progression in the human labour employment for the on-farm and off-farm activities as a result of manufacture, repair, servicing and sales of tractors and improved farm equipment.

The results have shown that the small and marginal farmers have also benefited by using new farm machines and their productivity rose up to a considerable height in spite of several constraints. There is need to establish farm machinery custom hiring center at Panchayat level of all the districts to achieve the main objective of mechanization and upgrade the livelihood of the small and marginal farmers.
### Questionnaire for research work in Farm Machinery

Name of Research Scholar - MRINAL VERMA  
ID No. - 13 PH FMP 101

Village…………………… District…………………………..  
State - Bihar

Name of Farmer ……………………………………………..

Please mark \( \checkmark \) in the \( \_ \) in front of the choice

#### [Part A] Demographic Data

1. Gender  
   - male  
   - female

2. Age range (excluding months)  
   - below 15 years old  
   - 16 – 20 years old  
   - 21 – 25 years old  
   - 26 – 30 years old  
   - 31 – 35 years old  
   - 36 – 40 years old  
   - 41 – 45 years old  
   - 46 – 50 years old  
   - 51 – 55 years old  
   - 56 – 60 years old  
   - over 61 years old

3. Highest education level  
   - primary school  
   - junior high school  
   - high school  
   - certificate  
   - undergraduate diploma  
   - bachelor degree  
   - master degree or higher

4. Marital status  
   - single  
   - married  
   - divorced  
   - separated

5. The number of family members  
   - 1 person  
   - 2 people  
   - 3 people  
   - 4 people  
   - 5 people  
   - more than 5 people

6. Average income (Rs. per month)  
   - less than 3000  
   - 3001 – 5000  
   - 5001 – 8000  
   - 8001 – 10000  
   - 10001 – 15000  
   - 15001 – 25000  
   - more than 25000

7. Type of agricultural activities (you can make more than 1 choice)  
   - crop grower  
   - rice  
   - sugar cane  
   - wheat  
   - corn  
   - mung bean  
   - pulses  
   - vegetable  
   - others (please specify)…………………………………………………..  
   - livestock  
   - poultry  
   - pig  
   - cow/cattle  
   - others (please specify)…………………………………………………..

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i
8. Agricultural areas
- 4 acres or less
- 5 – 10 acres
- 11 – 20 acres
- 21 – 30 acres
- 31 acres or more

9. Do you own the land?
- yes
- no (rent)
- both own and rent

[Part B] Data related to the use of information and communication (ICT) tools in agricultural sector

10. What kind of information tools do you currently use in daily life? (Can make more than 1 choice)
- TV
- radio
- CD/DVD player
- home phone
- mobile phone
- computer
- Internet
- community loud speakers’
- Newspaper

11. Which Information tools would you like to use or learn in order to improve your Agricultural productivity? Please fill in the following table for each type of tool.

<table>
<thead>
<tr>
<th>Information tools</th>
<th>Perception</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly agree</td>
</tr>
<tr>
<td>TV</td>
<td></td>
</tr>
<tr>
<td>Radio</td>
<td></td>
</tr>
<tr>
<td>CD/DVD Player</td>
<td></td>
</tr>
<tr>
<td>Home Phone</td>
<td></td>
</tr>
<tr>
<td>Mobile Phone</td>
<td></td>
</tr>
<tr>
<td>Computer</td>
<td></td>
</tr>
<tr>
<td>Internet</td>
<td></td>
</tr>
<tr>
<td>Community Loud Speakers</td>
<td></td>
</tr>
<tr>
<td>Newspaper</td>
<td></td>
</tr>
</tbody>
</table>

12. In your family, who plays the main role in conveying new agricultural information to you?
- yourself
- your children
- your spouse
- brother(s)
- sister(s)
- father
- mother
- others (please specify)

13. Other than your family, who or what are your main agricultural information providers? (can make more than 1 choice)
- neighbours
- local council
- extension workers
- private company
- sales agents
- government officers
- related web sites
- others (please specify)

14. Do you believe the following sources give you accurate information? Please fill in the following table for each source of information.

<table>
<thead>
<tr>
<th>Information sources</th>
<th>Perception</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly believe</td>
</tr>
<tr>
<td>Neighbours</td>
<td></td>
</tr>
<tr>
<td>local council</td>
<td></td>
</tr>
<tr>
<td>extension workers</td>
<td></td>
</tr>
<tr>
<td>private company</td>
<td></td>
</tr>
</tbody>
</table>
15. What type of information would you like to acquire in order to improve your productivity? (can make more than 1 choice)

- pest management
- use of fertilizer
- soil improvement
- market price
- use of insecticide
- weather forecast
- financial management
- organic farming
- others (please specify)

16. What time of the day would you like to get the new information (Hrs.)?

- 6.00 – 10.00
- 10.01 – 13.00
- 13.01 – 16.00
- 16.01 – 18.00
- 18.01 – 21.00
- 21.01 – 24.00

17. Which positive outcomes have you resulted from the information you have received from these providers? (Please tick any that apply.)

- increasing amount of productivity
- higher quality of productivity
- lower cost
- higher selling price
- others (please specify)

18. Which negative outcomes have you resulted from the information you have received from these providers? (Please tick any that apply.)

- failure of productivity
- higher cost but lower productivity
- low selling price
- complicated processes
- no follow-up process to stimulate the success
- others (please specify)

19. What kinds of current agricultural support have you used or heard about? (can make more than 1 choice)

- market prices via mobile phone services
- CD/DVD about agricultural productivity improvement
- agricultural forums/web board on the website of Department of Agriculture
- weather forecast for agricultural purpose on the website of SAU/ Meteorological Department

20. What are your expectations towards agricultural information dissemination via Information tools?

[Part C] - Data related Machinery

21. Have you received any farm machinery from Govt. /NGO on subsidy basis, if yes?

<table>
<thead>
<tr>
<th>Name of machine</th>
<th>Actual price</th>
<th>Subsidy amount</th>
<th>Actual price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
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<td>2.</td>
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<tr>
<td>4.</td>
<td></td>
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</tbody>
</table>
### 22. Machinery Inventory

<table>
<thead>
<tr>
<th>Bullock drawn machinery</th>
<th>Nos</th>
<th>Tractor drawn</th>
<th>Nos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country ploughs</td>
<td></td>
<td>Tractors</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; 35 hp</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt; 35 hp</td>
<td></td>
</tr>
<tr>
<td>Seeding Implements</td>
<td></td>
<td>Power tiller, hp</td>
<td></td>
</tr>
<tr>
<td>Blade harrow / Bakhar</td>
<td></td>
<td>MB plough</td>
<td></td>
</tr>
<tr>
<td>Bullock carts</td>
<td></td>
<td>Cultivators</td>
<td></td>
</tr>
<tr>
<td>Sprayers</td>
<td></td>
<td>Disc harrows</td>
<td></td>
</tr>
<tr>
<td>Rotavator</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any other machinery, specify</td>
<td></td>
<td>Seed-ferti-drill</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Planter</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Threshers</td>
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<tr>
<td></td>
<td></td>
<td>Chaff cutters</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Diesel pump sets, hp</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Electric pumps, hp</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Trailers</td>
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<td></td>
<td></td>
<td>Other, specify</td>
<td></td>
</tr>
</tbody>
</table>

### 23. Major crops grown

<table>
<thead>
<tr>
<th>S No.</th>
<th>Name of crops</th>
<th>Average yield, q/ha</th>
<th>Rates, Rs/q</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Kharif season</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Paddy</td>
<td></td>
<td></td>
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<tr>
<td>2</td>
<td>Soybean</td>
<td></td>
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<tr>
<td>3</td>
<td>Cotton</td>
<td></td>
<td></td>
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<td>4</td>
<td>Maize</td>
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<tr>
<td>5</td>
<td>Millet</td>
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<td></td>
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<tr>
<td>6</td>
<td>Green gram</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Black Gram</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Pigeon pea</td>
<td></td>
<td></td>
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<tr>
<td>9</td>
<td>Other</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Rabi Season</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Wheat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Gram</td>
<td></td>
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<tr>
<td>3</td>
<td>Mustard</td>
<td></td>
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<tr>
<td>4</td>
<td>Peas</td>
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</tr>
<tr>
<td>5</td>
<td>Rabi Jowar</td>
<td></td>
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</tr>
<tr>
<td>S No.</td>
<td>Crop</td>
<td>Operations</td>
<td>Existing practices</td>
</tr>
<tr>
<td>-------</td>
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<td>-------------------------------------------------</td>
</tr>
<tr>
<td>1.</td>
<td></td>
<td>Seed bed preparation</td>
<td>B.O/T.O MB plough, cultivator, disc harrow, Rotavator</td>
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<tr>
<td></td>
<td></td>
<td>Sowing/planting</td>
<td>Seed-ferti drill, planter</td>
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<td></td>
<td></td>
<td>Irrigation</td>
<td>Flood, furrow, sprinkler, Drip</td>
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<td></td>
<td></td>
<td>Weeding/interculture</td>
<td>Hand tools, animal drawn, power drawn</td>
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<tr>
<td></td>
<td></td>
<td>Plant protection</td>
<td>Knap sack, foot, power</td>
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<td></td>
<td>Harvesting</td>
<td>Sickle, chopper, reaper</td>
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<td></td>
<td>Threshing</td>
<td>Thresher, combine</td>
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<td></td>
<td>Seed bed preparation</td>
<td>B.O/T.O MB plough, cultivator, disc harrow, Rotavator</td>
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<td>Sowing/planting</td>
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<td>Irrigation</td>
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<td>Thresher, combine</td>
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<td></td>
<td>Seed bed preparation</td>
<td>B.O/T.O MB plough, cultivator, disc harrow, Rotavator</td>
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<td></td>
<td></td>
<td>Sowing/planting</td>
<td>Seed-ferti drill, planter</td>
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<td>Threshing</td>
<td>Thresher, combine</td>
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<td>4</td>
<td></td>
<td>Seed bed preparation</td>
<td>B.O/T.O MB plough, cultivator, disc harrow, Rotavator</td>
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<td></td>
<td>Sowing/planting</td>
<td>Seed-ferti drill, planter</td>
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<td>Thresher, combine</td>
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<td>5</td>
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<td>Seed bed preparation</td>
<td>B.O/T.O MB plough, cultivator, disc harrow, Rotavator</td>
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<td>Irrigation</td>
<td>Flood, furrow, sprinkler, Drip</td>
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<td></td>
<td>Weeding/Interculture</td>
<td>Hand tools, animal drawn, power drawn</td>
</tr>
</tbody>
</table>

24. Existing mechanization status

<table>
<thead>
<tr>
<th>S No.</th>
<th>Crop</th>
<th>Operations</th>
<th>Existing practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td>Seed bed preparation</td>
<td>B.O/T.O MB plough, cultivator, disc harrow, Rotavator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sowing/planting</td>
<td>Seed-ferti drill, planter</td>
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<td>Irrigation</td>
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<td>Weeding/interculture</td>
<td>Hand tools, animal drawn, power drawn</td>
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<td>Plant protection</td>
<td>Knap sack, foot, power</td>
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<td>Harvesting</td>
<td>Sickle, chopper, reaper</td>
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<td></td>
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<td>Threshing</td>
<td>Thresher, combine</td>
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<tr>
<td>Plant protection</td>
<td>Knap sack, foot, power</td>
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<td>Harvesting</td>
<td>Sickle, chopper, reaper</td>
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<td>Threshing</td>
<td>Thresher, combine</td>
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<td>Seed bed preparation</td>
<td>B.O/T.O MB plough, cultivator, disc harrow, Rotavator</td>
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<td>Sowing/planting</td>
<td>Seed-ferti drill, planter</td>
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<td>Irrigation</td>
<td>Flood, furrow, sprinkler. Drip</td>
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<tr>
<td>Weeding/interculture</td>
<td>Hand tools, animal drawn, power drawn</td>
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<td>Plant protection</td>
<td>Knap sack, foot, power</td>
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<td>Harvesting</td>
<td>Sickle, chopper, reaper</td>
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<tr>
<td>Threshing</td>
<td>Thresher, combine</td>
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</tr>
</tbody>
</table>

25. Information on prevailing custom hiring of farm machinery

<table>
<thead>
<tr>
<th>S. No</th>
<th>Name of machinery</th>
<th>Crop</th>
<th>Operation</th>
<th>Charges, Rs/h</th>
<th>Annual use, h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rs/ha</td>
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<tr>
<td>1</td>
<td></td>
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</tbody>
</table>

26. Change in production and thus livelihood in terms of using modern farm machinery
APPENDIX C
Program for the analysis of data collected from different blocks

#include<stdio.h>

int main()
{
    int count=1,year_num;
    float Rate;
    unsigned long CurrentYr;
    unsigned long NextYr;

    while (count<=1)
    {
        printf("Enter the initial egret production: ");
        scanf("%d",&CurrentYr);
        printf("Enter the rate: ");
        scanf("%f",&Rate);

        printf("Year  Production\n");
        printf("----  ----------\n");

        if ((CurrentYr>0 && CurrentYr<1000000) && (Rate>0 && Rate<4))
        {
            (float)NextYr = CurrentYr;
            for(year_num=0;year_num<=25;year_num++)
            {
                (float)NextYr = Rate * NextYr * (1-NextYr/1000000);
                printf("%4d%12d\n",year_num,NextYr);
            }
            break;
        }

        else if ((CurrentYr < 0 || CurrentYr > 1000000) || (Rate<0 || Rate>4))
        {
            printf("Invalid Input!");
            printf("Enter the initial egret production: ");
            scanf("%d",&CurrentYr);
            printf("Enter the rate: ");
            scanf("%f",&Rate);
            if ((CurrentYr>0 && CurrentYr<1000000) && (Rate>0 && Rate<4))
            {
                (float)NextYr = CurrentYr;
                for(year_num=0;year_num<=25;year_num++)
                {
                    printf("%4d%12d\n",year_num,NextYr);
                    (float)NextYr = Rate * NextYr * (1-NextYr/1000000);
                }
                break;
            }
        }
    }
}
} else {
    printf("No more chance ! Bye ! ");
}
return 0;
CERTIFICATE OF ORIGINAL WORK

This is to certify that the thesis entitled “PRODUCTIVITY GROWTH AND ADOPTION OF FARM MACHINERY UNDER FARM MECHANIZATION IN SUPAUL DISTRICT OF NORTH BIHAR” submitted by Mr. Mrinal Verma to the Sam Higginbottom Institute of Agriculture, Technology & Sciences (formerly Allahabad Agriculture Institute), Allahabad (U.P) for the award of degree of doctor of philosophy, is a record of the bonafide research work carried out by him under my supervision and guidance. He has worked on this research work for a period of about three year. The thesis in my opinion, is worthy of consideration for the award of the degree of doctor of philosophy in accordance with the regulation of the University.

Prof. (Dr.) Ashok Tripathi

Professor & Head
Department of Farm Machinery and Power Engineering
Vaugh School of Agricultural Engineering and Technology
SELF ATTESTATION

This is to certify that I have personally worked on the research project entitled “PRODUCTIVITY GROWTH AND ADOPTION OF FARM MACHINERY UNDER FARM MECHANIZATION IN SUPAUL DISTRICT OF NORTH BIHAR”. The data given in the project report has been generated during the work and are genuine. Data/ information obtained from the other agencies have been duly acknowledged. None of the findings/ information pertaining to the work has been concealed. The results embodied in this project report have not been submitted to any other university or institution for the award of any degree or diploma.

Place: Allahabad

Date:

(MRINAL VERMA)
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Acknowledgement

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Date

Place – Allahabad (MRINAL VERMA)
CHAPTER I

INTRODUCTION

Indian agriculture is characterized by overwhelmingly small holdings due to larger population density and nearly 70% of its population residing in the rural areas is coupled with irregular land fragmentation. New technology and advanced machinery enhanced the accuracy ability, efficiency and quality of the man. So, by using technology in any field the rate of production and quality automatically increases. The world amazed about unprecedented growth in farming sector which helped India to overcome from hunger to self-sufficiency in food grains by producing the food grain from 51 million tonnes to 208 million tonnes (Singh, 2009), with huge surplus for export (ICAR, 2013). The modern technological back-up by agricultural scientists, in the form of “Green Revolution” combined with farming industrial growth, liberal public funding for agricultural research, positive policy support and development and dedicated hard work of farmers contributed to the phenomenal increment in agricultural production. Use of engineering in farming sector was equally appreciated by the farmers and today they feel proud to have advanced and improved machinery from sickles to combine harvesters, Bakhars to rotavators, Dibblers to pneumatic planters, Persian wheel to drip and micro-sprinkler systems, sieve to colour sorters, kolhus to solvent extraction plants, and hand mills to roller flour mills, etc. Due to use of houses and low tunnel plastic houses technology, the farmers are not afraid of hot or cold desert and vagaries of weather as they have green to grow crops in any place at any time of the year.

1.1 Growth of Agricultural Production

Agriculture mechanization holds effective utilization of inputs to improve the productivity of labour and land. Besides above, it helps in reducing the drudgery in farm operations. The early farm mechanization in India was mostly influenced by the technological development in UK. Tractors, irrigation pumps, chaff cutters, tillage equipment and threshers were gradually started for agriculture mechanization. The high yielding varieties with assured irrigation and higher rate of application of fertilizers gave higher returns that enabled farmers to adopt mechanization inputs, especially after Green revolution in 1960s. The development and use of power thresher in the start of sixties, with integrated Bhusa production technology
and aspirator blower and mechanical sieves for grain and straw separation, was the major achievement of Indian engineers. These threshers were widely adopted by the farmers with curiosity. Due to successful use of the threshers; gradually demand for other farm machinery such as reapers and combine harvesters also increased. Machineries for tillage, irrigation, sowing, plant protection and threshing have been widely accepted by the Indian farmers. Even poor farmers with small holdings also utilize many improved farm equipment by hiring these equipment to improve their productions and farming operations. Now these days a trend is started in agricultural mechanization for use of high capacity machines through custom hiring for reduction of economic unbalance and for contractual field operations. However, technology in plantation crops, horticulture and commercial farming is yet to be started in the country. The momentum of agriculture mechanization in the India accelerated with the manufacture of farm machines by the local body industries. With the good beginning of manufacture of tractors in sixties with the help of developed countries, today the Indian agriculture machinery industries meet the maximum of the requirement of technological inputs and also export.

1.2 Progression of Agricultural Machineries

The manufacture of farm machinery in India is quite complex due to comprising of village artisans, small-scale industries, tiny units, State Agro-Industrial Development Corporations and organized tractor, engine and processing equipment industries.

In the Indian village; traditional hand and bullock drawn tools are mostly fabricated by small-scale industries and village craftsmen (blacksmith and carpenters). These small scale industries depend upon public and private institutions for technological support. However, these industries, upgrade their designs and the processes of production with experience. While, organized sectors have manufactured of machines like engines, tractors, milling and dairying equipment.

In India, some industries have used complex production technologies, and some of them came to match international standards. Due to Govts. Help, the scope of import of technology (product designs and manufacturing process) by organized sector and entry of foreign investors is likely to accelerate exports. Since cost of production of agriculture machinery in India is more competitive due to lower labour wages, the importers from various developing Countries will find Indian agriculture equipment more useful. But the quality of tools and
machines produced by Indian farm machine industries are not matched with other countries, so it shall need improvements in quality for gaining major export growth. For this, mass production of critical and fast wearing components and their standardization would greatly help.

1.3 Overview of Bihar

Bihar state has poorest per capita income amongst the all states of India and maximum rate of persistent poverty with social structure. According to ICAR the average size of land holding in Bihar state is 0.75 hectare, while national average holding of 1.57 hectare. Small and marginal farms of the Bihar constitute about 91 % of the total land holdings which was affected the viability of agriculture. Along with this there are other constraints also available in Bihar in terms of unavailability of agricultural machineries; high input costs and lack of knowledge of advanced farming. The total geographical area of Bihar is 94163 sq km. The Bihar State is totally landlocked and it is sharing its boundary with Nepal in the north, West Bengal in the east Jharkhand in the south, and Uttar Pradesh in the west. The plains of Bihar are divided into two unequal halves by the river Ganges, which flows through the middle from west to east. The Bihar State has 38 districts, 534 blocks and 45103 villages. Total number of Gram Panchayats in Bihar is 8463. The population of the State as per 2011 Census stands at 10.38 crore. It is the most densely populated State in India with population density of 1103 persons per sq km. The sex ratio is at 916. The literacy rate is at 63.82%, with male and female literacy rates at 73.39% and 53.33% respectively. Nearly 2/3rd of the area of Bihar is flood prone. The net sown area in the State is 53.32 lakh ha with cropping intensity of 137%. Based on soil characterization, rainfall, temperature and terrain, three main agro-climatic zones in Bihar have been identified. These are: Zone – I (North West Alluvial Plain), Zone – II (North East Alluvial Plain), and Zone-III (South Bihar Alluvial Plain), each with its own potential and prospects. All these zones have Chaur, Maund, Tal and Diara lands, which are submerged during the rainy season.

According to ICAR the percentage of population employed in agricultural sector in Bihar is estimated to be 81%, which is greater than the national average. Agriculture contributes in the states GDP nearly 45 per cent of GDP of the state (20012-13) (including forestry and fishing). Maximum of population of Bihar dependent on agriculture coupled with
low yields of the major cereal crops is main reason for high poverty ratio in the state; which is about 42% of the State population while national average is of 26 percent. As urbanization in the state is still very bad, so nearly 91% of the population lives in rural areas. The State of Bihar is also poor in the national average on all socio-economic indicators such as average size of operational holding, per capita income, percentage of villages electrified, per capita cultivated land, per capita deposit, road length per thousand sq km, credit deposit ratio, per capita bank credit, male-female literacy and life expectancy etc.

The gross and net sown area in the Bihar State is estimated at 80.26 lakh ha and 56.38 lakh hectare respectively. The principal crops of the Bihar are wheat, paddy, pulses, potato, maize, oil seeds, sugarcane, tobacco, and jute. Rice, wheat and maize are the major crops. The average productivity of rice and wheat are 1.45 and 2.19 t/ha, respectively, while the production potential (experimental yields at research farm as well as realized in front line demonstration) of 4.5-5.0 tonnes per ha. Similarly, the average maize yield of the State is about 2.38 t/ha as against its yield potential of 6 t/ha. Winter maize is a success story, where the farmers have realized yield level of 6-8 tonnes per ha. Similarly, Boro Rice (summer rice) has the realization of 6-8 tonnes per ha. Even though the State is rich in soil and water resources, its average yields of Rice, Wheat, Maize and Sugarcane in the state are only about 32, 44, 40 and 38 percent of the potential yields, respectively. Sugarcane production and sugar industry hold great potential in Bihar. The state’s share in the country’s production is 4 to 4.5 percent and ranks 10th among the sugarcane producing states. However, Bihar has the lowest sugar recovery rate in the country at 9% against the national average of 10.36%. Thus, there is considerable scope to increase the productivity of these most important crops in Bihar. All these clearly reveal that Bihar has great potential to be a rich State in the field of agriculture.

1.4 Justification
Supaul district has been carved out on 14th March 1991 as a result of bifurcation of Saharsa district. It is surrounded by Nepal in north, Saharsa and Madhepura in south, Darbhanga and Madhubani in west and Araria district in East.

The landscape is monotonously flat with raised side the upland called as levee and the alternating depressions between the streams, the oxbow lakes or the low lands commonly known as "chaurs" within between medium up & low lands.

Koshi is a tributary of river Ganges traverse from west of Kanchenjunga Hills of Nepal and enters in Bihar near Bhimnagar of Supaul district. The flow of river leads to heavy sand siltation resulting in the change of the courses which results in every year devastation of one and other area of koshi zone. In year 2008 a breach occurred in the eastern embankment at 12th km from Koshi Barrage near Kusha in Nepal caused devastation of large area of cultivable land in Basantpur, Chhatapur, Triveniganj, Pratapganj and partial damage in Raghopur Block. The cultivable land became unfertile due to deposition of sand and silt up to six ft. Devastating flood created a lot of harm to the people, land, agriculture, animal husbandry, fisheries and other allied sectors.

Rural people of Supaul district depend upon their livelihood on Agriculture and its allied activities. In pre flood situation (before 2008) affected farmers used to raise the crops Paddy, Wheat, Gram, Vegetables, Jute, and Sunflower etc. After flood the land became barren due to deposition of sand, silt and most of the farmers don’t find any livelihood option. For getting employment opportunity the people migrated to Delhi, Punjab and other places.

After implementation of Farm Mechanization Program the impact is required to be evaluated in terms of productivity growth as well as financial security to the rural people of Supaul district.

1.5 Objective of the Present Study
Considering the above facts the present study was undertaken with the following objectives:-

1. Investigation of changes over time in resource endowment and productivity in connection with farm machinery adoption.

2. Identification of factors affecting utilization of farm machinery.

3. Changes in production after adoption of farm machines.

4. Change in livelihood after adoption and implementation of farm mechanization.
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<td>av</td>
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<tr>
<td>2</td>
<td>BHP</td>
<td>Brake Horse Power</td>
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<td>CCSHAU</td>
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<td>7</td>
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<td>Galvanized Iron</td>
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CHAPTER III

MATERIALS AND METHODOLOGY

This chapter describes the description of the study area that Supaul district of Bihar state. This chapter also described the materials and tools used in farm mechanization which increases the production and the livelihood of the farmers.

3.1 DESCRIPTION OF THE STUDY AREA

3.1.1 Geography

Supaul district had been the part of Mithilanchal from Vedic period well known as Matasya Kshetra. This district is situated between 86° 22΄ to 87° 90΄E longitude and 25° 37΄ to 26°32΄ N latitude. The administrative headquarter of this district is Supaul town. This district covers 2410 square km area and surrounded by Nepal to the north, Araria district to the east, Madhepura and Saharsa district to the south and Madhubani district to the west. It is a part of Koshi division. Koshi River flows through this district which is regularly affected by flood caused by the river. This district comprises of four sub division namely Supaul, Birpur, Nirmali and Triveniganj. Supaul sub division consists of four blocks namely Supaul, Kishanpur, Saraigarh Bhaptiyahi and Pipra. Birpur sub division further sub divided into three blocks namely Basantpur, Raghopur and Pratapganj. Triveniganj sub division has two blocks namely Triveniganj and Chatapur. Nirmali sub division comprises two blocks Nirmali and Maruna.

3.1.2 Demographics

As per 2011 census the total population of Supaul district is 2228397 and population density 920 per square km. Out of the total population 4.74 percent population resides in urban area of the district. A total of 105558 people lives in urban areas of which males are 55788 and females are 49770. The rural population of Supaul district is 95.26 percent. The total population living in rural areas is 2123518 out of which males and females are 1099495 and 1024023 respectively. The Sex ratio of Supaul district is 925 female for 1000 males. The urban sex ratio is 892 whereas rural sex ratio is 931. The literacy rate of this district is 72.86 percent. The rural literacy rate literacy rate is 56.89 percent. (NIC Supaul 2016)
3.1.3 Flood and Natural calamities

Every year, Supaul district faces the problem of flood. The river Koshi enters from Nepal at Bhimnagar of Supaul district in India. The river Koshi flows through the district which is considered the sorrow of this area but the construction of dam on either side of the river the severity of damage has been reduced. Tilyuga, Sursar, Balan, Kali etc. are the tributaries of it. The flow of river leads to heavy sand siltation resulting in changing in the courses which results devastation of one and other area of Koshi zone. Flow of silt every year in the river and the construction of embankment, the bed level of river becomes higher than the country side land. The entire district is vulnerable to natural calamities. This district falls under Koshi river basin and hence severely affected by flood and also prone to earthquake, cyclone and sometimes with drought too. The whole district falls under seismic zone V. but in terms of severity and frequency of hydro metrological and climatological risk, the district is recurrently ravaged by flood. Recent earthquake also affected this district.
3.1.4 Climate and ecological situation

The climate of Supaul is apparently induced by the Himalayan Terrain. Rains are very frequent here. Summer falls between April to June and the average temperature stands for 30°C. The moisture content in the air sharply decreases in summer. When the summer ends northern and southern wind replaces the western wind followed by thunders, showers and scanty rains. The monsoon enters normally in mid-June decreasing temperature in the range of 8°C-10°C and increasing humidity to 60-90 percent. The average rainfall is 1344mm. The winter is also very pleasant and continues from November to first week of March. This district is very suitable for the cultivation of cereals, cucurbits and vegetables. Two crops wheat and paddy are grown without much effort. The climate is also favorable for the cultivation of cabbage, cauliflower, carrot, radish etc. round the year. Bamboo is also grown abundantly in this area.

3.1.5 Rainfall

The rainfall trend of Supaul district indicates that there is a drastic change in rainfall pattern during four years. In the year 2015 the actual rainfall in the month of October was only 18.85mm as against the normal rainfall of 75.4 mm which is only 25 percent of the normal. The deviation in rainfall in all the five months depicted in the table indicates that there is great challenge for the farmers in future to produce crop for better productivity.
Table 3.1: Rainfall pattern of Supaul district

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Month</th>
<th>Avg Rainfall (mm)</th>
<th>Actual Rainfall (mm)</th>
<th>Percentage</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>2012</td>
<td>2013</td>
<td>2014</td>
</tr>
<tr>
<td>1</td>
<td>June</td>
<td>231.7</td>
<td>53.46</td>
<td>289.04</td>
<td>207.35</td>
</tr>
<tr>
<td>2</td>
<td>July</td>
<td>331.6</td>
<td>276.82</td>
<td>178.53</td>
<td>247.39</td>
</tr>
<tr>
<td>3</td>
<td>August</td>
<td>308.8</td>
<td>132.14</td>
<td>208.12</td>
<td>311.53</td>
</tr>
<tr>
<td>4</td>
<td>September</td>
<td>236.5</td>
<td>-</td>
<td>130.01</td>
<td>171.05</td>
</tr>
<tr>
<td>5</td>
<td>October</td>
<td>75.4</td>
<td>-</td>
<td>199.67</td>
<td>60.08</td>
</tr>
</tbody>
</table>

Source: DAO office, Supaul (Govt. of Bihar)

3.2 MECHANIZATION

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

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

3.2.1 Farm Mechanization

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

Farm mechanization is an important element of modernization of agriculture. Farm Productivity is positively correlated with the availability of farm power coupled with efficient farm implements and their judicious utilization. Agricultural mechanization not only enables efficient utilization of various inputs such as seeds, fertilizers, plant protection chemicals and water for irrigation but also it helps in poverty alleviation by making farming an attractive enterprise. Traditionally humans and animals were used for field operations and processing.
activities. As a result of introduction of mechanical powers, the process of farm mechanization began. Adoption of agricultural machinery and other implements provide technology to facilitate agriculture by efficient utilization of inputs, besides reducing drudgery. Traditionally, Indian farmers relied on equipments, which were simple and could be easily fabricated by village craftsmen. Since introduction of mechanical power, agricultural engineering started gaining importance and thus organized professional activities started. It is generally believed that the benefits of modern farm technology have been availed by large farms only. Even farmers with small holdings utilize selected improved farm equipments on custom hiring basis to improve productivity and thus, ultimate increase in quantum of production. Such use of improved farm implements and equipments is preferred with a view to reduce cost of production also.

3.2.2 Impact of Farm Mechanization in the Agriculture

Agricultural mechanization plays an increasingly important role in agricultural production in the Work. It reduces drudgery, increases the safety and comfort of the working environment; it enhances productivity, cropping intensity and production. It increases income for agricultural workers and then improves social equality and overall living standards. If properly used, it also conserves and properly utilizes natural resources and reduces the cost of production. It allows for timelier farm operations, effectively deals with climate change, produces better quality agricultural commodities, etc. It is therefore, necessary to use modern equipment in agriculture and to use modern science and technology to re-invent agriculture. The region needs to accelerate the development of agricultural mechanization. Due to green revolution gross food production increased from 51.0 million tons in 1970-1971 to 264.77 million ton in 2013-2014 and land productivity rose from 0.58 tons/ha/year to more than 2.14 tons/ha/year.

The impact of the mechanization on the agriculture can be envisaged as

- Farm mechanization led to increase in inputs on account of higher average cropping intensity and larger area and increased productivity of farm labour.
- Farm mechanization increased agricultural production and profitability on account of timeliness of operation, better quality of work done and more efficient utilization of inputs.
Farm mechanization increases on-farm human labour marginally, whereas the increase in off-farm labour such as industrial production of tractors and ancillaries was much more.

Farm mechanization replaced animal power to the extent of 50 to 100% but resulted in lesser time for farm work.

3.2.3 Impact of Farm Mechanization on the Farmers

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

Mechanization affects the coat structure of agricultural production by:

- Saving of labour
- Easing jobs
- Increasing yield
- Saving land
- Facilitating the opening up of new land
- Conserving natural resources

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

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

3.3 FACTORS AFFECTING FARM MECHANIZATION

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

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

These challenges pose a serious impediment to the growth of the industry and agriculture. The key challenges faced by the farm mechanization in India (Mehta and Pajnoo, 2013) are as follows.
(i) The average farm size in India is small (1.08 ha) as compared to the European Union (14 ha) and the United States (170 ha). Therefore, there will be little mechanization unless machines appropriate for small holdings are made available. Due to small size of land holdings, it is difficult for the farmers to own machinery. As a result, the benefits of mechanization are enjoyed by only a section of the farmers who have large farm holdings.

(ii) Mechanizing small and noncontiguous group of small farms is against ‘economies of scale’ especially for operations like land preparation and harvesting. With continued shrinkage in average farm size, more farms will fall into the adverse category thereby making individual ownership of agricultural machinery progressively more uneconomical.

(iii) The major constraint of increasing agricultural production and productivity is the inadequacy of farm power and machinery with the farmers. The average farm power availability needs to be increased to minimum 2.5 kW/ha to assure timeliness and quality in field operations, undertake heavy field operations like sub-soiling, chiseling, deep ploughing and summer ploughing.

(iv) Matching equipment for tractors, power tillers and other prime movers are either not available or farmers make inappropriate selection in the absence of proper guidance, resulting in fuel wastage and high cost of production.

(v) Almost 90 % of tractors are sold in India with the assistance of some financial institution. Sale of farm machinery is driven by factors like financial support, limit of funding (in terms of percentage of the cost), funding/financing institution and the applicant’s profile (deciding the credibility of the client).

(vi) The high cost and energy efficient farm machinery are capital intensive and majority of Indian farmers are not able to acquire these assets due to shortage of capital with them.

(vii) Cropping pattern decides the extent of mechanization required for timely operations and achieving optimum results. The scope of mechanization increases with intensive cropping pattern. Price realized by the crop is also an important factor, as it indicates the cash in hand for the farmer.
Hill agriculture, which covers about 20% of cultivated land, has little access to mechanization. This situation has to be improved by developing and promoting package of technology for mechanization of hill agriculture to achieve higher productivity.

There are wide technology gaps in meeting the needs of various cropping systems and regions. The Indian farmers have limited access to the latest equipment and technology. Further, there is little feedback from the farmers for product improvement and product acceptance.

The quality of farm implements and machinery manufactured by small scale industries in the country is generally not of desired standard resulting in poor-quality work, longer down time, low output and high operational cost. The quality of equipment has to be improved.

The after sales service of farm machinery is the other concern in India as the majority of farmers are cost conscious. There are inadequate service centers for proper upkeep of the machinery.

3.4 FARM MECHANIZATION TOOLS

3.4.1 Tillage and Planting machinery

The traditional animal drawn country plough has low output (30-40 h/ha). Tractor drawn MB plough, harrows, cultivators and rotavator are better machinery used by the farmers. There is need for high capacity machines for custom hiring services. For precise application of seed and fertilizer, mechanically metered seed drill and seed-cum-fertilizer drill operated by animal and tractor have been developed and are being manufactured to suit specific crops and regions. Zero till drill and strip till drill have also been developed to reduce energy inputs in crop Production. CIAE has developed farm equipment like inclined plate planter and pneumatic planter for precision sowing. Following tools are used for the tillage and plantings of crops.
3.4.1.1 Ploughs
A plough is a tool (or machine) used in farming for initial cultivation of soil in preparation for sowing seed or planting to loosen or turn the soil. Ploughs are traditionally drawn by working animals such as horses or cattle, but in modern times may be drawn by tractors. A plough may be made of wood, iron, or steel frame with an attached blade or stick used to cut the earth. It has been a basic instrument for most of recorded history, although written references to the plough do not appear in English until 1100 CE at which point it is referenced frequently. The plough represents one of the major advances in agriculture. There are different types of Ploughs available to match various types of soil structures. These different types are listed below:

- Mould Board Plough
- Disc Type Plough
- Rotary Plough
- Chisel or sub surface Plough
- Sub Soiler

3.4.1.2 Rotavator
A rotavator is mechanical device with power blades attached to a spinning surface to plough soil and give optimum tillage. Different rotavator are designed to suit different agricultural purposes. A rotavator is a compact machine which can be used on any land size but is more appropriate for pulverizing the soil to insure a good seed bed.

3.4.1.3 Land levelers
Land Leveler is significant equipment that is used for farming and agriculture with a purpose to level the land. Land levelers are a great tool in any operations where there is a yard and driveways. Reversible Land Leveler, Terracer, Rear or Blade Land Leveler, Heavy Duty Land Leveler and Laser Guided Land Leveler are the examples.
3.4.1.4 Cultivators

A cultivator is a farm implement used for secondary tillage. One sense of the name refers to frames with teeth (also called shanks) that pierce the soil as they are dragged through it linearly. Another sense refers to machines that use rotary motion of disks or teeth to accomplish a similar result. Cultivators are machines in the agriculture industry that are used to break up soil. They are pulled behind tractors using either a three-point linkage or a tractor drawbar. Cultivators are generally used to till the soil and prepare it for the dispersing of seeds and can be used before and after the crops are sowed. They can provide other functions, such as removing and destroying weeds, as well as fertilizing the soil and covering seeds with soil.

Different types of cultivators are used in the India which is given below:

- Rotary Cultivator
- Disc Cultivator
- Row Crop Cultivator
- Five-tine animal drawn cultivators
- Low wheel cultivator

3.4.1.5 Harrow

Harrow is an implement that cuts the soil at shallow depth. Its purpose is to smoothen and pulverize the soil as well as cut the weeds to mix materials with soil. This implement breaks the soil clods after ploughing and collect the trash from the ploughed land. Different types of harrow used by farmers are as follows:

- Disc Harrow
- Spring tooth Harrow
- Spike tooth Harrow
- Triangular Harrow
- Blade Harrow (Bakhar)
- Zig-zag Harrow

3.4.2 Scrapers
Scrapers are the farming machines or tools which are used for the land forming. Some scrapers which are used in Indian agriculture farming are mentioned below:

- Carrier type scrapers
- Rotary scrapers
- Elevator scrapers
- Bottomless scrapers
- Land planes
- Laser controlled drag scrapers

### 3.4.3 Irrigation and Drainage Equipment

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

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

#### 3.4.3.1 Storage of water in ditches

- In the area where cucurbits are grown irrigation water facility is not properly available.
- Farmers carry water from small streams and store it in small shallow ditches dug in their field.
The ditches are duly lined with polythene.

Water is stored in the ditch and covered with straw to minimize losses due to evaporation in too hot climate.

![Figure 3.3 Storage of water in ditches](image)

### 3.4.3.2 Bamboo boring (especially for sand silted area)

- Bamboo boring is widely used in sand silted areas.
- Water table up to 30 – 40 ft.
- Major components-MS Flat ring, Bamboo stripe, Nylon net, Nylon rope, GI Steel or PVC pipe.
- The length of GI steel or PVC pipe is of 10ft and bamboo pipe is 25 – 30 ft.
- Bamboo boring structure is used well with 3 BHP pump.
- This may irrigate 2 ha of land with delivery pipe.
- The life span of this boring may go up to 10 yrs.
- The cost of boring comes to Rs 3000 to Rs 5000
3.4.4 Processing Implements & Equipment

These are used to treat or prepare farm products for use, storage & preservation. The processes included for the purpose are chaff cutting; grain grinding, grain crushing & grain drying etc. The following implements & equipments are generally used in processing of grains.

3.4.4.1 Chaff Cutter

This machine used to cutting fodder. Depending on the basis of cutting mechanism chaff cutter may be of Cylinder type and Flywheel type

- On the basis of dropping position of cut chaff it is of three types
  - Let-fall type
  - Throw-away type
  - Blow-up type
- On the basis of source of power the chaff cutter may be of
  - Manually operated
  - Animal operated
  - Power operated

Capacity of a chaff cutter can be formulated as follows

\[ C \text{ (Capacity)} = \text{Volume (V)} \text{ per unit time} \times \text{Density (d)} \]

\[ C = Vd \]
V = throat width * throat height * length of cut * revolution per minute * no. of knives

V = W * H * L * N * n

W = throat width, H = throat height, L = length of cut, N = rev/min, n = no. of knives, d = density of chaff.

C = W * H * L * N * d

A general specification of power chaff cutter machine has been shown in the table 3.2

**Table 3.2 Specifications of chaff cutter machine**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Machine</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Overall Width</td>
<td>785 mm</td>
</tr>
<tr>
<td>2</td>
<td>Overall Length</td>
<td>1400 mm</td>
</tr>
<tr>
<td>3</td>
<td>Overall Height</td>
<td>1390 mm</td>
</tr>
<tr>
<td>4</td>
<td>Wheel Diameter</td>
<td>780 mm</td>
</tr>
<tr>
<td>5</td>
<td>Motor Pulley Diameter</td>
<td>75 mm</td>
</tr>
<tr>
<td>6</td>
<td>Weight</td>
<td>142 Kg (Including Motor)</td>
</tr>
<tr>
<td>7</td>
<td>Cutting Blade</td>
<td>High Carbon Steel (2-Nos.)</td>
</tr>
<tr>
<td>8</td>
<td>Bearing Size</td>
<td>6204 &amp; 6206</td>
</tr>
<tr>
<td>9</td>
<td>Blade Size</td>
<td>510 mm</td>
</tr>
<tr>
<td>10</td>
<td>V-Belt Size</td>
<td>B-102</td>
</tr>
<tr>
<td>11</td>
<td>Electric Motor</td>
<td>1440 rpm</td>
</tr>
</tbody>
</table>

**3.4.4.2 Grain Graders**

Harvested grain (threshed / shelled / dried) needs further processing to get rid of various types of contaminations or undesirable matter, viz., inert material, common and seeds of noxious weeds, other crop/variety seed, decorticated seed, damaged seed and/or off-size seed. Cleaning and grading result in reduced bulk of the material, high value products, safe and longer storage, more out-turn of better quality milled products. The primary method of seed cleaning is the air-screen separator. It uses a combination of air, gravity, and screens to separate seed based on size, shape, and density. These widely-use units come in a variety of models with two to eight vibrating screens. In all cases, the cleaning principles are the same. The grains are fed into the hopper where they are evenly distributed by a feed roller and transferred through a controlled gate on the top sieve. In the process the grains are subjected to primary aspiration by the use of air trunk which drains off chaff, straw, dust or deceased grains. Then the material is passed through sieve layer for separation according to their width and thickness. After the
separation, the graded material is subjected to air sifter and aspiration chamber where remaining light particles are sucked off by a strong upward draught of air. The graded material and the impurities are automatically discharged in separate chutes.

### 3.4.4.3 Driers

Machines used for drying farm crops are made to a wide variety of designs and many sizes to cover the diverse requirements of different crops. The function of these machines called dryers is simply to remove excess moisture without loss of the quality of the product.

- Batch or Bin dryers
- Continuous flow type Rotary dryers
- Tray type dryers
- Spray dryers
- Freeze dryers
- Electrical dryers
- Solar dryers
- Sack dryers
- Batch or Bin driers

### 3.4.4.4 Paddy Processing machines (Rice Shellers)

Rice Sheller is an agricultural machine used to automate the process of removing the chaff (the outer husks) of grains of rice. Throughout the history, there have been numerous techniques to hull rice. Traditionally, it would be pounded using some form of mortar and pestle. An early simple machine to do this is a rice pounder. Later even more efficient machinery was developed to hull and polish rice. These machines are most widely developed and used throughout Asia where the most popular type is the Engelberg huller designed by German Brazilian engineer Evaristo Conrado Engelberg in Brazil and first patented in 1885.

### 3.4.5 Transportation Equipment

These are used to transport agricultural produce from farm / field to godown or market place, they include:
3.4.6 Sowing Machines

Seeding or sowing is the art of placing seeds in the seed bed to have good germination in the field. Common methods for sowing are as follows:-

- Broadcasting
- Dibbling
- Seed dropping behind the plough
- Drilling
- Hill dropping
- Check row planting
- Transplanting

3.4.6.1 Dibbler

Dibbling is the mechanism to place two or more seeds in holes made in the soil either by hand tools or by some implements especially used for vegetable. The equipment used for dibbling is called dibbler. It is a conical instrument used to make proper holes in the field. Some hand dibblers are made with several conical projections made in a frame. Now days different types of dibblers are available in market for maize, vegetables etc.

3.4.6.2 Seed-cum-Fertilizer drill

Seed drill is a machine for placing seeds in a continuous flow in furrow at uniform depth and at controlled depth. Such seed drill fitted with fertilizer dropping arrangement is known as seed cum fertilizer drill. It is highly accepted by farmers of Punjab, Uttar Pradesh, Uttarakhand and Bihar after harvest of rice. The seed cum fertilizer drill consists of frame, seed box, fertilizer box, seed and fertilizer metering mechanism, furrow openers, covering
devices and transport wheel. Different type of seed and fertilizer metering mechanism are available according to the seed is available.

3.4.6.3 Planters
The planters are normally used for seeds larger in size and can’t be used by usual seed drill. The function of planter is to open furrow, meter the seed, place the seed in furrow, cover the seeds and compact the soil. The planter consists of hopper, seed metering device, knock out arrangement, cut off mechanism furrow openers and furrowers for making bed.

3.4.6.4 Potato Planter
It consists of a belt cup-type of metering mechanism with 37 cups, spaced at 60 mm. The holes are provided on the frame for changing ridgers. Its hopper capacity is 140 kg. Machine’s overall dimensions are 1.98 m × 1.83 m × 1.18 and its weight is 250 kg. With this, seed spacing can be changed by changing sprockets provided with the ground-wheel. Machine can be operated with 30-hp tractor. The CCSHAU Hisar Centre had conducted trials on the planter, covering 6.2 hectares in Bhatala and Lalpura villages. The seed rate for potato (variety 222) was 3,000 kg/ha and no. of plants per 5-m length were 32.6.

3.4.6.5 Sugarcane Planter
The planting of sugarcane crop is conventionally done through country plough or ridger requiring 30-35 laborers per ha for undertaking various planting operations. These include sett cutting, furrow opening, application of fertilizers in furrows, seed treatment, dropping of cane setts in furrows, application of insecticide, soil covering over the setts in furrows and planking. Non-availability of man power in sufficient number during these days of labour crisis and also planting being a time consuming process, it poses problems before sugarcane growers having 90-92 per cent of the plant area under spring and summer planting. Two types of cutter planters i.e. ridger and disc types, are available. The ridger type cutter planter is used in a well prepared soil while disc type cutter planter can be used immediately after harvest of wheat or rabi crops enabling sugarcane planting 5-6 days earlier than the normal practices. The cutter planter not only obviate 50-60 per cent of the planting operation cost but also enhances the cane yield by 6 to 7 per cent due to proper placement of cane setts, fertilizers and insecticide in
the furrows. Impressed with the performance in terms of reduced planting cost and higher yield in the demonstrations, the demand of cutter planter among the farmers is increasing day by day. A few sugar factories particularly the D.S.M. Rauzagaon, Faizabad and Balrampur Sugar Mills, Hydergarh, Barabanki have started planting sugarcane through cutter planter in their sugar mill areas. The Institute is receiving regular supply orders for this implement from many sugar mills and farmers of the country.

3.4.6.6 Paddy Transplanter

The paddy transplanter is mainly comprised of three parts, the motor and the running gear and the transplanter device. The transplanter includes the seedling tray, the seeding tray shifter, plural pickup forks. The seeding tray is like a shed roof where mat type rice nursery is set. When the rice transplanter is brought in the field, the seedlings were fed on the seedling trays. Then the tray shifts seedlings like a carriage of typewriters as pickup forks get seedlings from the tray and put into the ground. The pickup folks act like human figures by taking seedlings from the tray and pushing them into the earth.

Table 3.3: Specifications of different Self Propelled Transplanter

<table>
<thead>
<tr>
<th>Model</th>
<th>AMS-PT-6300B</th>
<th>AMS-PT-8238B</th>
<th>AMS-PT-10238BGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension</td>
<td>2410x2132x1300 mm</td>
<td>2410x2165x1300 mm</td>
<td>2410x2645x1300 mm</td>
</tr>
<tr>
<td>Net Weight</td>
<td>300kg</td>
<td>360kg</td>
<td>410kg</td>
</tr>
<tr>
<td>Diesel engine model</td>
<td>175F Manual Start</td>
<td>175F Manual Start</td>
<td>178F Electric Start</td>
</tr>
<tr>
<td>Diesel engine power</td>
<td>3.68kw/4.93hp</td>
<td>3.68kw/4.93hp</td>
<td>4.05kw/5.5hp</td>
</tr>
<tr>
<td>Diesel engine speed</td>
<td>2600 rpm</td>
<td>2600 rpm</td>
<td>1800 rpm</td>
</tr>
<tr>
<td>Transplanting row</td>
<td>6</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Row spacing</td>
<td>300 mm</td>
<td>238 mm</td>
<td>238 mm</td>
</tr>
<tr>
<td>Seedling spacing</td>
<td>120/140 mm</td>
<td>120/140 mm</td>
<td>120/140 mm</td>
</tr>
<tr>
<td>Working efficiency</td>
<td>0.2 ha/h</td>
<td>0.27 ha/h</td>
<td>0.24-0.34 ha/h</td>
</tr>
<tr>
<td>Packing size</td>
<td>2250x1760x600 mm</td>
<td>2810x1760x600 mm</td>
<td>2810x1760x600 mm</td>
</tr>
<tr>
<td>Packing weight</td>
<td>360kg</td>
<td>420kg</td>
<td>460kg</td>
</tr>
</tbody>
</table>

3.4.7 Harvesting and Threshing Machine

Harvesting is the operation of cutting the crops in the field; it can be performed in three ways i.e. manually, using tractor driven mini-harvesters / reapers or using self propelled harvesting
combine. Threshing is the process of taking out grains from the dry crop straw. It loosens the grain and separates it from straw. The commonly used harvesting & thrashing implements (tools) and equipment are

- Sickles (manual tool)
- Mowers
- Reapers
- Straw Reapers
- Threshers (Various types)
- Combine Harvester

Sickle is the major low cost traditional tool for harvesting. Self-sharpening serrated sickle is finding adoption. CIAE walk behind and self-propelled reaper harvesters, which facilitate quick harvesting, is getting acceptance. Traditional threshing by animal treading has been almost fully replaced by power threshers operated by 5-15 hp engine or electric motor. Pedal operated paddy threshers reduce drudgery and have become popular in India. Whole paddy straw is obtained by using rasp bar type axial flow thresher. Combine harvesters are being used for harvesting wheat, paddy, soybean and gram in few states.

3.4.7.1 Small Rice Thresher
A 0.5 hp single phase electric motor powered thresher for rice has been developed suitable for small farmers, especially farmers of hilly regions. This thresher operates in hold-on mode. Such type of small thresher has threshing efficiency of 96–98% having an output of 100–150 kg/h. Labour requirement is to be 14–20 person-hours/ton. Initial cost of thresher is estimated to be Rs 8,000 (including Rs 3,000 for motor) and the cost of operation Rs 250–300/ton (including labour charges). Weighing only 45 kg (with motor), it can be easily carried by two persons in the hilly terrain.

3.4.7.2 High capacity Multicrop thresher
High capacity Multicrop thresher is popularized now days by the farmers due to three times more output than local thresher and a saving of 50% labour and time of operation. It reduced human drudgery through saving of time for the same quantum of crop compared to local
thresher. Such type of high capacity thresher cleans the grain up to 99 percent having negligible grain losses less than 2%.

3.5  
**Strategy for Mechanization of Indian Agriculture**

Agricultural mechanization should contribute to sustainable increase in productivity and cropping intensity so that the planned growth rates in agricultural production are achieved. Mechanization is capital intensive and substantial sums have been invested in our country. In the absence of good planning and direction, investment on mechanization may not yield the expected results. India adopts a policy of selective mechanization under diverse conditions, which makes the agricultural mechanization a challenging task.

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

(i) The widely fragmented and scattered land holdings in many parts of the country need to be consolidated (virtual or real) to give access for their owners to the benefits of agricultural mechanization.

(ii) There is a need to have more interaction among the farmers, research and development workers, departments of agriculture and industry to make farm machinery research and development base stronger.

(iii) To achieve higher production levels, the quality of operations like seedbed preparation, sowing, application of fertilizer, chemicals and irrigation water, weeding, harvesting and threshing will have to be improved by using precision and efficient equipment.

(iv) The rice transplanting operation can be mechanized by introduction of self-propelled walking type rice transplanter on small and medium land holdings. The riding type rice transplanter may be introduced on large size land holdings on custom hiring basis (Mehta and Pajnoo, 2013).

(v) The benefits of agricultural mechanization should be extended to all categories of farmers with due consideration to small and marginal farmers, to all cropping systems including horticultural crops and to all regions of the country especially the rainfed areas.

(vi) There is a need to innovate custom service or a rental model by institutionalization for high cost farm machinery such as combine harvester, sugarcane harvester, potato
combine, paddy transplanter, laser guided land leveller, rotavator etc. and can be adopted by private players or State or Central Organizations in major production hubs.

(vii) The high capacity rice combines may be introduced to paddy growing areas on custom hiring basis. It will help in timely harvesting and better yield of paddy crop.

(viii) Medium and large scale farmers may be provided with Govt. subsidies to encourage them to buy and to apply advanced medium and high size machinery such as cotton picker, rice transplanter, and sugarcane harvester and combine harvester on their fields (Mehta and Pajnoo, 2013).

(ix) The farm machinery bank may be established for machines being manufactured elsewhere in the country and supply to users/farmers on custom hiring mode.

(x) Provision may be made for special credit support at lower interest rates to rural individuals, venturing into entrepreneurial use of farm machinery through custom hiring (Mehta and Pajnoo, 2013).

(xi) Manufacturing units that are set-up in areas with lower mechanization needs to be supported by extending tax and duty sops. This would result in easier reach of the equipment to farmers in those areas (Mehta and Pajnoo, 2013).

(xii) There is a need for quality manufacturing and after sales support for reliability of farm machinery. This may be achieved by streamlining of testing procedure, training of engineers and conducting testing of farm equipment for standardization and quality control in farm equipment manufacturing.

(xiii) There is a need for strengthening training programs at various levels and for different categories of people on operation, repair and maintenance of agricultural machinery, tractors, power tillers, rice transplanters, combines etc. and for transfer of technology.

(xiv) The quality of life and work environment of farmers/farm women need to be improved. Their work involves considerable drudgery and discomfort. Proper ergonomic designs of agricultural equipment, incorporating latest safety measures and ‘comfort features’ should be made available.

3.6 Methodology Used for Research

Agriculture is not only the source of livelihood but also it generates raw material for the agro based industries which has immense potential in the state. With a view to bring Second Green
Revolution in the eastern region of the country (particularly in Bihar) the agricultural activities being undertaken based on ‘Rain God,’ will have to be linked with science.

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

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

Under all the schemes the government provided different agricultural machineries under subsidy to the farmers for easy adoption.

Table 3.4 Subsidy available on Procurement of farm equipment (2014-15)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>General</td>
<td>SC/ST</td>
</tr>
<tr>
<td>1</td>
<td>Tractor (up to 70hp)</td>
<td>25% maximum 45,000 (up to 40hp)</td>
<td>35% maximum 67,500 (up to 40hp)</td>
</tr>
<tr>
<td>2</td>
<td>Power Tiller (8.71-15 hp)</td>
<td>50% maximum 50000</td>
<td>50% maximum 75000</td>
</tr>
<tr>
<td>3</td>
<td>Laser land leveler</td>
<td>50% maximum 100000</td>
<td>50% maximum 150000</td>
</tr>
<tr>
<td>4</td>
<td>Rotavator</td>
<td>50% maximum 20000</td>
<td>50% maximum 30000</td>
</tr>
<tr>
<td></td>
<td>Equipment Type</td>
<td>50% maximum 20000</td>
<td>50% maximum 30000</td>
</tr>
<tr>
<td>---</td>
<td>-------------------------------------</td>
<td>-------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>5</td>
<td>Reversible MB Plough</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Disc Harrow</td>
<td>50% maximum 10000</td>
<td>50% maximum 14000</td>
</tr>
<tr>
<td>7</td>
<td>Cultivator</td>
<td>50% maximum 10000</td>
<td>50% maximum 14000</td>
</tr>
<tr>
<td>8</td>
<td>Sub soiler</td>
<td>50% maximum 7500</td>
<td>50% maximum 10000</td>
</tr>
<tr>
<td>9</td>
<td>ZTD/Seed Drill/ Multicrop Planter</td>
<td>50% maximum 30000</td>
<td>50% maximum 40000</td>
</tr>
<tr>
<td>10</td>
<td>Potato Planter</td>
<td>50% maximum 20000</td>
<td>50% maximum 30000</td>
</tr>
<tr>
<td>11</td>
<td>Raised Bed Planter</td>
<td>50% maximum 20000</td>
<td>50% maximum 30000</td>
</tr>
<tr>
<td>12</td>
<td>Sugar cane cutter cum Planter</td>
<td>50% maximum 20000</td>
<td>50% maximum 30000</td>
</tr>
<tr>
<td>13</td>
<td>Paddy drum seeder</td>
<td>50% maximum 3000</td>
<td>50% maximum 3750</td>
</tr>
<tr>
<td>14</td>
<td>Seed cum fertilizer dibbler</td>
<td>50% maximum 500</td>
<td>50% maximum 750</td>
</tr>
<tr>
<td>15</td>
<td>Ridger</td>
<td>50% maximum 7500</td>
<td>50% maximum 11000</td>
</tr>
<tr>
<td>16</td>
<td>Pump set (diesel/electric) up to 10hp</td>
<td>50% maximum 10000</td>
<td>50% maximum 15000</td>
</tr>
<tr>
<td>17</td>
<td>Weeder</td>
<td>50% maximum 800</td>
<td>50% maximum 800</td>
</tr>
<tr>
<td>18</td>
<td>Power weeder</td>
<td>50% maximum 15000</td>
<td>50% maximum 20000</td>
</tr>
<tr>
<td>19</td>
<td>Combine</td>
<td>50% maximum 40000</td>
<td>50% maximum 50000</td>
</tr>
<tr>
<td>20</td>
<td>Reaper cum binder</td>
<td>50% maximum 17500</td>
<td>50% maximum 17850</td>
</tr>
<tr>
<td>21</td>
<td>Self propelled reaper</td>
<td>50% maximum 40000</td>
<td>50% maximum 60000</td>
</tr>
<tr>
<td>22</td>
<td>Tractor</td>
<td>50% maximum 20000</td>
<td>50% maximum 30000</td>
</tr>
<tr>
<td>Code</td>
<td>Machine Type</td>
<td>50% Maximum 1</td>
<td>50% Maximum 2</td>
</tr>
<tr>
<td>------</td>
<td>--------------------------</td>
<td>---------------</td>
<td>---------------</td>
</tr>
<tr>
<td>23</td>
<td>Potato digger</td>
<td>20000</td>
<td>30000</td>
</tr>
<tr>
<td>24</td>
<td>Power maize sheller</td>
<td>10000</td>
<td>15000</td>
</tr>
<tr>
<td>25</td>
<td>Power operated wheat/maize thresher</td>
<td>15000</td>
<td>20000</td>
</tr>
</tbody>
</table>

Source: Office of the Joint Director (Engg.) Agriculture Department Govt. of Bihar

3.7 RESEARCH PLAN

3.7.1 Sampling Plan

Three stage stratified random sampling has been used to draw the sample of farmers in which blocks were taken as first stage unit, village as second stage unit and farmers as final stage unit. Data were collected from 550 farming families, 50 farmers each from all 11 blocks. The data has been given in Appendix A.

3.7.2 Selection of the Farmers

The selection of farmers in all blocks was made randomly irrespective of Panchayat, the status of farmers and topography of the village. Thus the survey was conducted with the help of well designed questionnaire (Appendix-B) prepared for this purpose. The data was gathered by personnel interviews of the formers.

3.8 DATA COLLECTION OF FARM MECHANIZATION IN SUPAUL DISTRICT
The research data are collected from different blocks of the Supaul district by collecting information from the farmers of the villages by taking interviews, filling questionnaires regarding their status of farming. The collection of the data took place by introducing following steps:

3.8.1 Primary Sources:

3.8.1.1 Interview
It is a conversation carried out with a definite aim of obtaining certain information. Interview was designed to gather valid and reliable information through the responses of the interviewee to a planned sequence of questions. Interview took both structured and unstructured forms. That is though content and the procedure involved were designed in advance there were instances where follow up questions not planned for were asked for further clarification. Interview solved the problem of misunderstanding of questions in the questionnaires. This is because; the interviewer was present to explain any question that the interviewee did not understand.

It is to be stated that the interview method of collecting data was used for this research work. It provided the researcher better understanding of all issues concerning the topic under study. Interviewees practically demonstrated on other issues which were not covered by the questionnaire. For this, fifty farmers were chosen randomly from each blocks and conduct observation on them.

3.8.1.2 Questionnaire
This took the form of a list of questions given to respondents to answer with the rationale of getting data on the topic under study. The researcher chose self administered questionnaires as oppose to the postal questionnaires. The questions in the questionnaire took two forms; open ended questions and close ended questions. The close ended questions offered a set of alternative answers from which the respondents were asked to choose the one that most closely represents their view. The open ended questions on the other hand were not followed by any kind of choice. With this, the respondents’ answers were recorded in full. The respondents again answered the questions the way he or she understood them.
It is to be emphasized that questionnaire allowed respondents time to think through the questions to provide accurate answers. The researcher conducted pretesting of the draft questionnaire with few potential respondents in an informal manner before following up with the full scale questionnaire administration.

To check for accuracy, completeness of data and ensure quality, questionnaires and interview guide were numbered serially. Research assistants who retrieved completed questionnaires checked thoroughly to ensure that respondents answered questionnaires.

As an ethical consideration, permission was sought from the various bodies that were involved in the study. The purpose of the study was explained to officials and those who responded to questionnaires and interviews.

3.8.1.3 Personal observation

The personal observation through the agricultural environment of the villages was taken to examine the process of farming, use of farm technology, production of crops and living standard of the farmers who were using different inputs in terms of farm mechanization. Visit to the different villages of different blocks of the district was made and different types of technologies used in villages by the farmers were recorded for easy analysis.

3.8.2 Secondary Sources

Secondary data are data collected for some other purposes, other than the research in question. Sources of secondary data are encyclopedia, textbooks, magazines, journals, newspaper, internet, websites and articles. However, some of its shortcomings are that it may be liable to alterations, it may not be in the required state and it may also be from the wrong source. This study made use of secondary data very extensively. Some parts in chapter one, three and the whole of chapter two were from secondary data.

3.9 DATA ANALYSIS PLAN

The analysis of the data collected was done at the end of the data collection. The responses were classified and summarized on the basis of the information provided by the respondents. The analysis was done using both qualitative and quantitative tools. With the quantitative...
tools, the current version of Statistical Product and Services Solution (SPSS) data analysis Programme, Microsoft excel, absolute figures, tables, percentages, and statistical tools such as graphs, charts, maps, diagrams were used, whereas qualitative made use of descriptions, analysis of feedback from interview. The data collected from the farmers of all the 11 blocks of the Supaul District has been analyzed by computer based program which has given in the Appendix-C.

(a) Self-Propelled Reaper  
(b) Zero-Till Drill

(c) Rotavator

Fig.3.5 Different types of machines used by the farmers
REFERENCES

Agriculture Census Division, GOI, 2006

Alshi, H. R., 1981 Impact of Technological Change on Production Employment and Factor Shares in Cotton in Akola District (Maharashtra), Ph.D. Dissertation Submitted at Indian Agricultural Research Institute, New Delhi, India.


Anonymous, 2014. AICRP on Ergonomics and Safety in Agriculture (Leaflet), CIAE, Bhopal, India.


Chaudhary, M.A., 1992. Challenges and opportunities of dry land farm mechanization in Iran. Agriculture Mechanization in Asia, Africa and Latin America. 23 (2):73-76

Dash and Pradhan., 1988. Adoption of Farm Mechanization in a Developing Economy, Daya Publishing House, Delhi.


Dewangan, K.N. ,Prasanna Kumar, G.V. and Dutta, R.K., 2004. Scope of mechanization in Arunachal Pradesh – part I, traditional hand tools of shifting cultivation. *Agricultural Engineering Today.* 28(3); 60-70

Din-Sue, F., 1995. Recent developments in agricultural mechanization in Taiwan.. *Agriculture Mechanization in Asia, Africa and Latin America.* 26 (3):58-62

GOI, 2012. Annual Plan of Department of Agriculture and Sciences; Govt. of India.

Govt. of India Twelfth Five Year Plan 2014


Kumar, G. K., 2003. A Study to Measure the Technological Change in Dairy Farming in


Sagar, P., 1995. Modernisation of agriculture in India (part I)—farm mechanisation. Agricultural Situation in India, Ministry of Agriculture, New Delhi


Suligavi, B.S., 1988. Impact of Technical Change in Rainfed Cotton on Output, Employment and Factor Shares in Dharwad District, Karnataka; An Economic Analysis, An Unpublished M.Sc (Agri.) Thesis Submitted at the University of Agricultural Sciences, Dharwad, India.


VATS, 2004. Analytical Approach to Growth Dynamics of Agricultural Inputs & their Effect in Increasing Productivity in Madhya Pradesh. Agricultural Situation in India, March; pp 723-731


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CHAPTER IV

RESULTS & DISCUSSION

In this chapter, results of the studies under the productivity growth in Supaul district due to farm mechanization have been presented.

Studies on adoption of farm mechanization in Supaul district of the North Bihar was conducted in the all eleven Blocks of the District. For this purpose, fifty farmers have been taken randomly from each Block villages. The research was done during whole season (both Kharif and Rabi crops). The data obtained from the analysis during the course of investigation has been presented in this chapter and discussed in detail.

The first section explains the current position of the farmers of the Supaul Districts in terms of farm holdings, cropping sequences of major crops and the status of the farm mechanization in the district. Second section studies the factors affecting utilization of farm machinery in Supaul districts and third section analyzed the changes in production of crops and livelihood of the farmers after the adoption and implementation of farm mechanization.

4.1 Current Status of the Farmers of the Supaul District

Rural people of Supaul district depend upon their livelihood on Agriculture and its allied activities. In pre flood situation (before 2008) affected farmers used to raise the crops Paddy, Wheat, Gram, Vegetables, Jute, and Sunflower etc. After flood the land became barren due to deposition of sand silt and most of the farmers did not able to cultivate their farm field due to lack of agriculture inputs like machineries, suitable soil condition, seeds, fertilizers etc. But many farmers used different agricultural inputs and improved their productivity. The current status of the farmers has been explained as follows.

4.1.1 Status of Land Holdings of the Farmers (Block wise)

Farm mechanization is as important as any other input for increasing agricultural productivity but land is one of the most important inputs for rural households whose primary means of livelihoods is farming. Land ownership, size and quality are important factors determining agricultural production and economics participation of households. The following table
4.1 summarizes the land holdings of the households of farmers of different blocks of the Supaul district. After the survey of all the blocks of the Supaul district, it was found that maximum farmers (70%) have marginal (less than 1 ha) land holdings and approximately 15% farmers have small (1 to 4 ha) landholdings. Approximately 8.0% farmers have medium (4 to 8 ha) and 7 percent of farmers have large land holdings (greater than 8 ha). After the observation of the table it was found that 03 blocks have maximum number of large land holdings and 03 blocks have minimum number of large land holdings. Figure 4.1 explains the distribution of land holdings of Supaul district.

**Table 4.1: Distribution of Holdings by Size Class (%)**

<table>
<thead>
<tr>
<th>District/Category of farmers</th>
<th>Marginal (&lt; 1 ha)</th>
<th>Small (1-4 ha)</th>
<th>Medium(4-8 ha)</th>
<th>Large (&gt; 8 ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supaul</td>
<td>81</td>
<td>10</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Basantpur</td>
<td>63</td>
<td>14</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>Chatapur</td>
<td>72</td>
<td>11</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Marauna</td>
<td>76</td>
<td>14</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Raghaporu</td>
<td>69</td>
<td>16</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Triveniganj</td>
<td>67</td>
<td>18</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Nirmali</td>
<td>72</td>
<td>12</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Kisanpur</td>
<td>69</td>
<td>19</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Pipra</td>
<td>65</td>
<td>19</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Saraigarh</td>
<td>64</td>
<td>18</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Pratapgarh</td>
<td>69</td>
<td>16</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Averaged</td>
<td>70%</td>
<td>15%</td>
<td>8%</td>
<td>7%</td>
</tr>
</tbody>
</table>

**Figure 4.1: Distribution of Holdings by Size Class**

All the land holdings has been distributed in two categories, first one is cultivated area which is actual farming field and other one is non-cultivated area or useless farming fields.

**4.1.1.1 Cultivated area**

**Table 4.2: Distribution of cultivated and non-cultivated farming land in different blocks of Supaul district**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Block</th>
<th>Total Area(ha)</th>
<th>Cultivated</th>
<th>Non Cultivated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sl. No.</td>
<td>District</td>
<td>&lt; 4 Inch (%)</td>
<td>Up to 8 Inch (%)</td>
<td>&gt; 8 Inch (%)</td>
</tr>
<tr>
<td>--------</td>
<td>----------</td>
<td>--------------</td>
<td>-----------------</td>
<td>--------------</td>
</tr>
<tr>
<td>1.</td>
<td>Supaul</td>
<td>77486</td>
<td>7725</td>
<td>69761</td>
</tr>
<tr>
<td>2.</td>
<td>Basantpur</td>
<td>61049</td>
<td>14333</td>
<td>46716</td>
</tr>
<tr>
<td>3.</td>
<td>Chatapur</td>
<td>75657</td>
<td>24918</td>
<td>50739</td>
</tr>
<tr>
<td>4.</td>
<td>Marauna</td>
<td>43400</td>
<td>6797</td>
<td>36603</td>
</tr>
<tr>
<td>5.</td>
<td>Raghopur</td>
<td>49354</td>
<td>13069</td>
<td>36285</td>
</tr>
<tr>
<td>6.</td>
<td>Triveniganj</td>
<td>84609</td>
<td>22464</td>
<td>62145</td>
</tr>
<tr>
<td>7.</td>
<td>Nirmali</td>
<td>33579</td>
<td>9781</td>
<td>23798</td>
</tr>
<tr>
<td>8.</td>
<td>Kisanpur</td>
<td>54512</td>
<td>18353</td>
<td>36159</td>
</tr>
<tr>
<td>9.</td>
<td>Pipra</td>
<td>49559</td>
<td>13812</td>
<td>35747</td>
</tr>
<tr>
<td>10.</td>
<td>Saraigarh</td>
<td>44217</td>
<td>8814</td>
<td>35403</td>
</tr>
<tr>
<td>11.</td>
<td>Pratapganj</td>
<td>25876</td>
<td>7526</td>
<td>18350</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>599298</td>
<td>147592</td>
<td>451706</td>
</tr>
<tr>
<td></td>
<td>Block</td>
<td>Soil</td>
<td>Rainfall</td>
<td>Irrigation</td>
</tr>
<tr>
<td>---</td>
<td>----------------</td>
<td>------</td>
<td>----------</td>
<td>------------</td>
</tr>
<tr>
<td>1.</td>
<td>Supaul</td>
<td>68</td>
<td>20</td>
<td>12</td>
</tr>
<tr>
<td>2.</td>
<td>Basantpur</td>
<td>20</td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>3.</td>
<td>Chatapur</td>
<td>20</td>
<td>35</td>
<td>45</td>
</tr>
<tr>
<td>4.</td>
<td>Marauna</td>
<td>60</td>
<td>35</td>
<td>5</td>
</tr>
<tr>
<td>5.</td>
<td>Raghopur</td>
<td>65</td>
<td>30</td>
<td>5</td>
</tr>
<tr>
<td>6.</td>
<td>Triveniganj</td>
<td>68</td>
<td>22</td>
<td>10</td>
</tr>
<tr>
<td>7.</td>
<td>Nirmali</td>
<td>50</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>8.</td>
<td>Kisanpur</td>
<td>65</td>
<td>30</td>
<td>5</td>
</tr>
<tr>
<td>9.</td>
<td>Pipra</td>
<td>70</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>10.</td>
<td>Saraigarh</td>
<td>40</td>
<td>50</td>
<td>10</td>
</tr>
<tr>
<td>11.</td>
<td>Pratapganj</td>
<td>35</td>
<td>45</td>
<td>10</td>
</tr>
</tbody>
</table>

**Figure 4.3: Distribution of Soil pattern in different blocks of Supaul district**

4.1.1.3 Topography

This zone, the alluvial plains of Koshi, Mahananda and its tributaries and Ganges (narrow strip in the South) is slightly undulating to rolling landscape mixed with long stretches of nearly flat landscape with pockets of area having sub-normal relief. The area is full of streams with abandoned or dead channels of river Koshi. Its frequent and sudden change of course has left small lakes and shallow marshes. In the south, in between the natural levees of Ganga on the one hand and Koshi and Mahananda on the other, there are vast areas, which remain water logged over a considerable period of the year.

4.1.2 Education Status of the Farmers

Literacy rate of the Bihar state is very poor due to this the education status of the farmers of the Supaul district is also not good. Approximately 8% of the farmers of the Supaul districts are educated below fifth standard while 4% of the farmers are educated from 5th to 8th standard. Approximately 8% of the farmers of the Supaul districts are educated from 8th to high school standard and 30% of farmers are educated from high school to 11th standard while 30 % of farmers are educated up to Intermediate class. 15% of the farmers are Graduate while only 5% of them are post graduate. Education standard of the farmers of Supaul district are shown in the table 4.4 and figure 4.4.
Table 4.4: Educational standard of farmers in different blocks of Supaul district (%)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Block</th>
<th>&lt; 5&lt;sup&gt;th&lt;/sup&gt; Standard</th>
<th>5&lt;sup&gt;th&lt;/sup&gt; Standard</th>
<th>8&lt;sup&gt;th&lt;/sup&gt; Standard</th>
<th>High School</th>
<th>12&lt;sup&gt;th&lt;/sup&gt; Standard</th>
<th>Graduate</th>
<th>Post Graduate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Supaul</td>
<td>9</td>
<td>4</td>
<td>8</td>
<td>32</td>
<td>30</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>2.</td>
<td>Basantpur</td>
<td>8</td>
<td>5</td>
<td>8</td>
<td>30</td>
<td>29</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>3.</td>
<td>Chatapur</td>
<td>8</td>
<td>6</td>
<td>7</td>
<td>29</td>
<td>30</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>Marauna</td>
<td>7</td>
<td>3</td>
<td>6</td>
<td>30</td>
<td>28</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>5.</td>
<td>Raghopur</td>
<td>6</td>
<td>5</td>
<td>10</td>
<td>28</td>
<td>31</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>6.</td>
<td>Triveniganj</td>
<td>10</td>
<td>4</td>
<td>6</td>
<td>31</td>
<td>28</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>Nirmali</td>
<td>6</td>
<td>3</td>
<td>7</td>
<td>28</td>
<td>29</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>8.</td>
<td>Kisanpur</td>
<td>7</td>
<td>6</td>
<td>8</td>
<td>29</td>
<td>30</td>
<td>17</td>
<td>4</td>
</tr>
<tr>
<td>9.</td>
<td>Pipra</td>
<td>8</td>
<td>4</td>
<td>6</td>
<td>30</td>
<td>30</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>10.</td>
<td>Saraigarh</td>
<td>6</td>
<td>5</td>
<td>9</td>
<td>30</td>
<td>29</td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td>11.</td>
<td>Pratapganj</td>
<td>9</td>
<td>3</td>
<td>9</td>
<td>29</td>
<td>31</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>12.</td>
<td>Averaged</td>
<td>8</td>
<td>4</td>
<td>8</td>
<td>30</td>
<td>30</td>
<td>15</td>
<td>5</td>
</tr>
</tbody>
</table>

Figure 4.4: Education status of the farmers

4.1.3 Cropping Sequence

Block wise cropping sequence of major crops of the Supaul district has shown in the Table 4.5. The major crops grown in Supaul district were maize, moong and paddy during Kharif and Wheat during Rabi, which covered an area of 17, 15, 65 and 76 percent of cultivated field respectively. The observation of the cropping sequence of the crops shows that maximum farmers were growing paddy in Kharif and wheat in the Rabi. The observations have shown in the table 4.5 and figure 4.5 and figure 4.6

Table 4.5: Block wise cropping sequence of major crops of the Supaul district (%) in cultivated land
4.1.4 Crop Yields

The yields of the major crops in all the eleven blocks of the Supaul districts has been shown in the Table 4.6 and the observation of the yields of different crops has been presented in the Figure 4.7.

Table 4.6 Block wise productivity (q/ha) of major crops of the Supaul district

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Block</th>
<th>Garma</th>
<th>Kharif</th>
<th>Rabi</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Moong</td>
<td>Maize</td>
<td>Paddy</td>
</tr>
<tr>
<td>1</td>
<td>Supaul</td>
<td>4.5</td>
<td>42</td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td>Basantpur</td>
<td>4.6</td>
<td>32</td>
<td>22</td>
</tr>
<tr>
<td>3</td>
<td>Chatapur</td>
<td>4.5</td>
<td>30</td>
<td>22</td>
</tr>
<tr>
<td>4</td>
<td>Marauna</td>
<td>4.5</td>
<td>38</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Block Name</td>
<td>Maize Yield</td>
<td>Paddy Yield</td>
<td>Moong Yield</td>
</tr>
<tr>
<td>---</td>
<td>------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td>5</td>
<td>Raghopur</td>
<td>4.6</td>
<td>41</td>
<td>24</td>
</tr>
<tr>
<td>6</td>
<td>Triveniganj</td>
<td>4.5</td>
<td>42</td>
<td>22</td>
</tr>
<tr>
<td>7</td>
<td>Nirmali</td>
<td>4.5</td>
<td>38</td>
<td>26</td>
</tr>
<tr>
<td>8</td>
<td>Kisanpur</td>
<td>4.6</td>
<td>38</td>
<td>27</td>
</tr>
<tr>
<td>9</td>
<td>Pipra</td>
<td>4.5</td>
<td>34</td>
<td>28</td>
</tr>
<tr>
<td>10</td>
<td>Saraigarh</td>
<td>4.4</td>
<td>28</td>
<td>25</td>
</tr>
<tr>
<td>11</td>
<td>Pratapganj</td>
<td>4.3</td>
<td>30</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>4.5</td>
<td>36.0</td>
<td>22.27</td>
</tr>
</tbody>
</table>

**Figure 4.7 Block wise yield of major crops of the Supaul district**

The average yield of the crops i.e. maize, paddy, moong and wheat was 36.00, 22.27, 4.50 and 28.48 quintal per hectare respectively in the Supaul district.

From the observation of the table, it was found that the overall yield of maize was good (42 q/ha) in Supaul and Triveniganj, 41 q/ha in Raghopur and Marauna, Nirmali and Kishanpur has yield of 38 q/ha. Saraigarh block has poor (28q/ha) yield. The overall yield of paddy was good (28 q/ha) in the Pipra block while Marauna block has poor (21 q/ha) yield. The overall yield of moong was good (4.6 q/ha) in the Basantpur, Raghopur and Kishanpur block while Pratapganj block has poor (4.3 q/ha) yield and the overall yield of wheat was good (31 q/ha) in Kishanpur block while Saraigarh block has poor (24 q/ha) yield.

**4.1.5 Availability of Farm Machines**

Mechanization of farming activities depends much upon the crops grown in the study region and crop-specific requirements of machines in various farming activities. In a state like Bihar, where majority of farmers are marginal and crops are grown in fragmented and scattered pattern, extent of use of machines is highly restricted. The economic status, soil quality, etc. also influence the adoption and use of farm machinery. In the Supaul district, most of the farmers did not have their own machinery equipment. They use to hire the farm machinery and other equipment from the other farmers for their required purpose.

Four major operations such as tillage, weeding, irrigation, harvesting and threshing were identified. After the observation, it found that the farmers of different blocks had almost all useful machines available such as ploughs, cultivators, land levelers, rotavator, sickle,
threshers, low cost hand operated sprayers and dusters, diesel and electric pump sets and disc harrows.

### 4.1.5.1 Machines available by own

Supaul district of Bihar state have suffered by floods of different rivers every year, due to this the financial condition of them was not good. Hence, after the observation of the Supaul district in terms of ownership of machinery by the farmers. The use of the farm machines in various operations reveals that as much as 15 to 20% farmers own animal operated machines for ploughing operations, while 50% farmers own animal operated machines for transportation and marketing. Land preparation, plant protection, harvesting and threshing operations were carried out mostly by manually operated machines and some were use tractor operated machines, which were owned by 9, 40, 90 and 10% farmers respectively. While irrigation operations are entirely carried out using electrical or diesel operated pump sets, such machines were owned by only 10% farmers. It should be noted here that only 3% of the farmers own tractors or any other type of machines, though it was found that about 45% of farmers hire tractors for farming purpose. This was particularly because of the fact that owning a tractor requires huge capital investment, which was largely beyond the financially affordable limits of the resource-poor farmers.

The observation of the various farm machines by own by farmers of different blocks of the Supaul district has shown in the Tables 4.8.

### 4.1.5.2 Utilization of farm machines

It thus comes out that though ownership of expensive machines was fairly restricted among the farmers owing to scarcity of investible finance; they extensively hire-in the machines to perform various farming operations. As such, ownership and use of machinery was two completely different aspects, especially in case of a highly marginalized economy like Bihar.

In case of time-use of machinery in farming operations, it was observed that human power has consumed the maximum time, especially in harvesting operations of wheat (300 man hours) for one hectare. This is followed by manually operated machines, which consumed more than 317 hours in total on an average, especially in harvesting operations. However, electric
powered machines like the tube wells and tractors have consumed very little time as compared to the animal operated and manually operated machines. In particular, while electric tube wells have consumed about 26 hours of usage on an average, the tractors are operated only 6 hours for ploughing and 5 hours for transportation and marketing. In percentage terms, it can be observed that in case of ploughing activity 95 percent of time spent on ploughing is consumed by animal operated machines; while tractor operated machines consume only 5 percent of total time allotted for ploughing. Similarly, in case of transportation and marketing, about 92 percent of total time allotted has been devoted to animal operated machines, while similar tasks are performed by tractor operated machines only in about 8 hours. Now, we have seen earlier that costs on account of animal operated machines and tractor operated machines are comparable and constitute the largest cost components in costs of mechanization.

The utilization of the farm machines in various farm operations have shown in Table 4.7 and the figure 4.7 to Figure 4.18.

### Table 4.7 Utilization of farm machines in the Supaul district (percentage)

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Equipment</th>
<th>Kharif</th>
<th>Rabi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land preparation</td>
<td>Desi Plough</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Rotavator</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Cultivators</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Cultivators and Rotavator</td>
<td>55</td>
<td>50</td>
</tr>
<tr>
<td>Harvesting</td>
<td>Sickle</td>
<td>95</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>Reaper</td>
<td>05</td>
<td>30</td>
</tr>
<tr>
<td>Threshing</td>
<td>Threshers</td>
<td>05</td>
<td>100</td>
</tr>
<tr>
<td>Sowing</td>
<td>Manual</td>
<td>100</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>Seed drill and ZTD</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Spraying</td>
<td>Knapsack/ Gator</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Irrigation</td>
<td>Diesel and electric pump sets</td>
<td>70</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Micro irrigation systems</td>
<td>00</td>
<td>00</td>
</tr>
</tbody>
</table>
Figure 4.8 Farm Machinery utilization for land preparation in Kharif

Figure 4.9 Farm Machinery utilization for land preparation in Rabi

Figure 4.10 Farm Machinery utilization for sowing in Kharif

Figure 4.11 Farm Machinery utilization for sowing in Rabi

Figure 4.12 Harvesting of crops in Kharif

Figure 4.13 Harvesting of crops in Rabi

Figure 4.14 Threshing of crops in Kharif

Figure 4.15 Threshing of crops in Rabi
4.2 Factor Affecting Utilization of Farm Machinery in Supaul District

As increasing demand for industrialization, urbanization, housing and infrastructure is forcing conversion of agricultural land to non-agricultural uses. The scope for expansion of the area available for cultivation is limited. According to agriculture census 2014-15, small and marginal holdings of less than 2 hectare account for 87 % of the total operational holdings and 47 % of the total operated area. The average size of holding for all operational classes (small and marginal, medium and large) has declined over the years and has come down to 1.06 hectare in 2014-15 from 2.82 hectare in 1970-71 (Anonymous, 2015).

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

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

Every year, Bihar faces the vagaries of flood and waterlogging. After bifurcation of the State, Bihar has become the most flood prone area in the country. Total flood prone area of the State was 68.80 lakh hectares which was 73.06 percent of its total geographical area and 17.2 percent of the total flood prone area in the country. Flood situation was most severe in northern plains of Bihar. This was because almost all the major rivers in the State enter Bihar from Nepal in this region. Bed slope of these rivers was very sharp in the Nepal and they usually enter the State on plain lands. Because of a sudden drop in bed slope, silt brought by the flow of these rivers gets deposited at their base to cause recurring floods.

Due to, the rivers in the Supaul district enter district from Nepal in this region that’s why farmers of the district have suffered most by the flood and the farming operations of them was affected by it. So mechanization of the agriculture in Supaul district was majorly affected by floods.

4.2.2 Unawareness of farmers towards farm machineries

The literacy rate of the Supaul district was measured only 58.9% in the census 2011. So mostly farmers are illiterate and due to this they were unaware towards the farm machineries. They have used only old tradition and unaware toward new methods of farming. Matching equipment for tractors, power tillers and other prime movers are either not available or farmers make inappropriate selection in the absence of proper guidance, resulting in fuel wastage and high cost of production. So, unawareness of the farmers towards farm machineries is also a major factor which is retarded the farm mechanization growth.

4.2.3 Repair and Maintenance of farm machineries

In the Supaul district very few farmers have advanced farm machines but the unawareness of the maintenance workshops and the operation of the repair and maintenance they could not maintain their machines. Hence the life and performance of the farm machines would be reduced and it affects the productivity of the crops.

4.2.4 Poor Economic status of the farmers
The economic status of the farmers of the Supaul district is very poor because almost 46.8% of rural population of the Supaul district was living in below poverty line. So they cannot afford the expensive farm machines and also they have not much agriculture fields that’s why they only hire the farm machines when it needed. So farm mechanization is also affected by poor economic condition of the farmers.

4.3 Analysis of the Changes in Production of Crops and Livelihood of the Farmers after the Adoption and Implementation of Farm Mechanization.

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

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

4.3.1 Change in economic status of the farmers

After the use of proper farm machines for the different crops by the farmers of the Supaul district, the production of the crops increases by 10-15% and due to this the economic status of the farmers would be improved.
Table 4.8: Economics of different crops grown in Supaul district

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Name of the crop</th>
<th>Yield (q/ha)</th>
<th>Cost of cultivation (Rs)</th>
<th>Gross return (Rs)</th>
<th>Net return (Rs)</th>
<th>B:C Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Paddy</td>
<td>22.27</td>
<td>23600</td>
<td>36178</td>
<td>12578</td>
<td>1.53</td>
</tr>
<tr>
<td>2</td>
<td>Maize</td>
<td>36.00</td>
<td>32600</td>
<td>56400</td>
<td>23800</td>
<td>1.73</td>
</tr>
<tr>
<td>3</td>
<td>Wheat</td>
<td>28.48</td>
<td>25200</td>
<td>45448</td>
<td>20248</td>
<td>1.80</td>
</tr>
<tr>
<td>4</td>
<td>Moong</td>
<td>4.5</td>
<td>18500</td>
<td>29250</td>
<td>10750</td>
<td>1.58</td>
</tr>
</tbody>
</table>
CHAPTER II
REVIEW OF LITERATURE

This chapter compiles the work done and studies by several authors on mechanization with reference to the status, growth and impact on agricultural system in increasing the agricultural and labour productivity. In this chapter relevant literature have been reviewed and presented in brief under the different heads.

2.1- Technological changes in agriculture system
2.2- Growth of farm mechanization in World and India
2.3- Status of farm mechanization
2.4- Effect of farm mechanization on the agriculture system
2.5- Growth of farm mechanization in Bihar
2.6- Constraints of farm mechanization.

2.1 Technological Changes in Agricultural System

Hicks (1932) classified technical change as a neutral and non-neutral and stated that technical change was neutral, if the marginal rate of substitution between inputs was not affected. Non-neutral technical change is generally described as either labor-saving (capital using) or capital-saving (labour-using). Technical change is said to be labour saving if the marginal product of capital rises relative to marginal product of labour.

Solow (1957) defined technical change as a “catch-all "expression for any kind of shift in production function assuming returns to scale, homogeneous inputs and competitive equilibrium. According to him, any increase in output not explained by increase in capital and labour is assigned to technical change.

Ruttan (1960) stated that technological change has traditionally been defined in terms of changes in the parameters of a production function or the creation of new production function. The traditional procedure has been to use a partial productivity index (average output per unit of labour/capital) or total productivity index (output per unit of total input) as a measure of the impact of technological change. It was also defined that production function of crops was
another approach. The increase in the current level of output over the level of projection from the base period production function was attributed to technological change. Comparisons have been made between the level of output that would have been produced using the current level of inputs with production function of same base period and the level of output obtained with the same inputs currently.

Schmookler (1966) defined technological change to denote the art or producing new knowledge and technical change to incorporation of this knowledge in the production process of firms. In the literature no much distinction seems to be kept in view.

Srivastava et al., (1975) stated that the technological innovations in agriculture can be divided into two broad types, viz., Biological and Mechanical. Biological innovations refer mainly to inputs that increase the productivity of a given land base. High yielding plant varieties and fertilizer are the examples. Biological innovations are found to raise total farm cost. Mechanical innovations mainly are those that cause a reduction in total costs, while biological innovations are labour saving. Green revolution is frequently described as a seed-fertilizer technology. In a sense it falls in the class of biological innovations.

Bisaliah (1977) discussed the growth per acre wheat output in Punjab into its sources. He found that technical change contributed 15 per cent and increase in the use of labour, fertilizer and capital per acre under Mexican wheat contributed about 25.5 per cent to increased output (40.5 per cent). Individual contribution of labour, fertilizer and capital were 2 per cent, 15 per cent and 8 per cent respectively.

Kunnal (1978) studied the effect of introduction of new technology on output growth in Hubli taluk of Karnataka state by using output decomposition model. He observed that a new technology farm produced about 72 per cent more output than an old technology farm of which, 33 per cent was due to technical change and 38 per cent was due to the increase in input levels.

Shaw (1979) defined a technological innovation as concrete identifiable new factor of production material as well as non-material to which the increase in production is attributed and which is not explained by the traditional factors of production. The discovery of high
yielding variety of seeds, the package of practices for realizing their production potential, mechanization of agriculture are regarded as technological innovations in agriculture. There are technological innovations in farm mechanization, postharvest technology, milk and poultry production, frozen semen technology.

Nair (1980) defined technical progress, as those changes in the production processes which reduce the marginal cost of output. This change can occur either employing the existing inputs but in different composition (a change in technique) or by introducing new factors of production either for replacing old ones or simply as additional inputs (technological innovation). Thus the technological change in either case is associated with a shift in the production function which describes the technical relation between output and inputs. Shifting production functions with rising marginal productivities are more appropriate in a dynamic situation.

Alshi (1981) studied the impact of technical change on output in cotton economy in Akola district of Maharashtra state. The per hectare production on American cotton and hybrid cotton farms was more by 43 per cent and 306 per cent than the deshi cotton farms. The contribution of technical change to this output growth was 27.77 per cent and 110.57 per cent, respectively. Increased use of labour, fertilizer, FYM and capital per hectare contributed 16.4 per cent in American cotton and 199.87 per cent in hybrid cotton. Among the various inputs, capital turn out to be an important source of output growth.

Gundu Rao et al., (1985) fitted the Cobb-Douglas production function to ragi data on both local and improved varieties in Bangalore. The authors found out a positive productivity differential (14 per cent), which emerged with the introduction of transplanting method into broadcasting local variety of ragi. About 45 per cent positive productivity differential has been generated with the introduction of new varieties of ragi to local variety farms, following the transplanting method. New technology (improved variety of ragi) contributed about 32 per cent more output over the local technology (TLV). Another dominant factor to the productivity differential (15 per cent) has been identified to be capital.
Umesh and Bisaliah (1987) using output decomposition model examined the impact of technical change in paddy production in Karnataka. They observed that HYV paddy variety Sona masuri yielded 34 per cent more than masuri variety, of which technical change contributed 17 per cent and increased input levels of labour and plant nutrients contributed 17 per cent.

Suligavi (1988) examined the impact of technological change in rainfed cotton in Dharwad district using output decomposition model. He observed that hybrid DCH-32 cotton variety (new technology) produced 115 per cent more output per farm than local cotton variety Jayadhar (old technology). To the 115 per cent more output, new technology contributed 82 per cent and increased level of inputs contributed 35 per cent. The individual input contribution of seed plus fertilizer was 19 per cent, plant protection chemicals 3 per cent and capital 13 per cent. The results indicated that the technical change was a major source of output growth in cotton technology.

Hiremath (1989) employed the Cobb-Douglas production function through restricted UOP profit function with constant returns to scale. The structural break was observed (Chow test) in A-2 and A-119 bidi tobacco varieties (new technology) over S-20 (old technology). The estimated total growth in output of A-2 over S-20 was 105 per cent of which, the contribution due to technical change was 72 per cent and of total inputs was 33 per cent. The estimated total growth in output of A-119 over S-20 was higher by 154 per cent, to which technical change contributed 90 per cent and changes in the level of inputs contributed 64 per cent. In both technologies the new seed technology, fertilizer and labour were identified as the major sources of growth in tobacco output.

Hiremath and Murthy (1991) studied the impact of technical change on factor shares in the production of beedi tobacco in Karnataka. They found that the actual factor shares under old technology variety S20 for land, labour, fertilizer, capital and manure were 0.5641, 0.01708, 0.0511, 0.1360 and 0.0437, respectively. They were not significantly different from the estimated factor shares of the corresponding factors which implied that all the inputs were paid their due share under old technology. Similar pattern was evident under new technology.
varieties like A-2 and A-119. Per acre absolute actual income has increased by 78% and 204% under new technology varieties (A-2 and A-I 19).

Suligavi and Murthy (1991) studied the impact of technological change on employment and production relationship in cotton in Dharwad district, Karnataka. The study was based on a stratified random sample of 135 farms of which 72 farmers grew high yielding varieties (HYVs) and 63 farmers grew local cotton. It was observed that the input and output mean levels differed significantly between technology levels. The HYV technology was better by as many as three times as that of local technology. The new technology was not only high yielding, but also input use intensive in respect of inputs.

Deoghare (1993) used the Cobb-Douglas production function through restricted UOP profit function with constant returns to scale studied the effects of technical change in cotton crop in Maharashtra state during 1989-90. The structural break was observed in LRA 5166, H-4 and AHH 468 cotton hybrids (new technology) over AKH 4 (old technology). The estimated total growth in output of LRA 5166, H-4 and AHH 468 over AKH 4 was 69.52 per cent, 60.37 per cent and 103.97 per cent respectively. The contribution due to technical change was 40.24 per cent, 22.02 per cent and 51.89 per cent respectively for the above cotton hybrids. The total change due to human labour, bullock labour, fertilizer and capital inputs was 29.28 per cent, 38.37 per cent and 52.08 per cent for LRA 5166, H-4 and AHH 468 over AKH 4 cotton variety respectively.

Thakur and Sinha (1994) examined the impact of technical change in rice production in Bihar agriculture. He observed that the contribution of new rice production technology is more pronounced in southern region as compared to northern region of the state. New rice production technology produced 43.47 per cent and 47.77 per cent higher yield in northern and southern regions, respectively. The technological bias with respect to factor inputs in rice production was estimated as land and labour saving as well as fertilizer and capital using in northern region. Whereas, it was estimated as labour saves as well as fertilizer and capital using and land saving in southern region.
Singh and Singh (1995) analyzed the impact of technological change on investment pattern and resource structure in Kangra and Kullu districts of Himachal Pradesh. The investment in capital assets for productive purpose increased with the farm size. The average investment per farm in crop farming in case of adopted farmers was Rs. 17,571.53, Rs. 17,699.21 and Rs. 23,716.99 on small, medium and large categories, respectively. Whereas in case of non-adopted farmers, it was Rs 7,867.36, Rs 8,262.28 and Rs. 12,275.40 on small, medium and large categories. The study pointed out that due to implementation of various development programs, the investment on productive assets, cropping intensity and productivity increased more on adopted group of farmers. The study also revealed that adoption of new technology i.e. growing of high yielding varieties was significantly and positively related to farm size, education level of farmer, availability of family labour and technical knowledge.

Mattigatti and Iyengar (1997) conducted a study to evaluate and compare the resource use efficiencies on sericulture and non-sericulture farms in the Hassan district of Karnataka. The results revealed that both sericulture and non-sericulture farms had significantly different production functions. Sericulture farms used less fertilizers and a higher amount of farmyard manure (FYM). Labour had a significant contribution in the case of sericulture farms and gave more scope for additional use of labour. Non-sericulture farms inefficiently used the labour. The gross profit of sericulture farms (Rs. 5,981.16 per acre) was comparatively higher than that of the non-sericulture farms (Rs. 4,066.62 per acre). The neutral technological efficiency for sericulture farms was 25.46% more than for non-sericulture farms. Labour (92.69%) and chemicals (18.44%) while fertilizers indicated the non-neutral technological efficiency more and FYM showed technological inefficiency. The overall non-neutral technological efficiency was positive (7.28%). The gain in gross profits of sericulture farms as a result of change in quantity of input use was comparatively less i.e. 5.84%, out of which FYM contributed 6.45% and labour 2.29 %, respectively. Other inputs like fertilizers and chemicals contributed negatively. The total gain in gross profits of sericulture farms was 38.58% more than that of non-sericulture farms per acre.

Kumar Singh, W. (1999) evaluated the effect of change in rice production technology on functional income distribution and determined the extent of change in the effects of factor specific technical bias on functional income distribution. The results revealed that the new
agricultural technology introduced in Manipur was biased towards the more use of labour and fertilizer and the saving of pesticide and insecticide in own holdings. Technical bias with respect to land was neutral and its estimated factor share remained unaltered under new technology.

**Badal and Singh (2001)** studied the technological change in maize production in Samastipur, Vaishali and Hazaribagh districts in Bihar. A test of structural break between production functions for local varietal technology and high yielding varietal technology of maize revealed that shift in production function of HYV technology was due to change in slope as well as shift in the intercept, implying thereby the existence of neutral as well as non-neutral technological change. The total differences in the productivities per hectare between local or traditional varieties and HYVs of maize were estimated to be 69 per cent in kharif and 80 per cent in rabi.

**Kunal et al., (2002)** studied that the impact of new technology on output, factor shares and employment in Bengal gram production in Karnataka. Growing of high yielding varieties of Bengal gram (technical change) resulted in about 25 per cent of additional output. To this increased output, the technology (HYV) component accounted for 10.76 per cent, while increased use of inputs accounted for 14 per cent. All the inputs stood to gain with the introduction of new technology in Bengal gram production.

**Mattigatti et al., (2002)** evaluated the technological change in the management of small-scale to large-scale irrigated sericulture farming by employing Cobb-Douglas production function and the technological decomposition model. The technological gap between different scales of farming was found to be significant. The shifts in technology from small-scale to medium-scale and medium-scale to large-scale have proved their efficiency in attaining higher profitability with 54.96% and 82.97% efficiency, respectively. The shift from small-scale to large-scale ultimately proved efficiency to the extent of 137.93%.

**Kumar (2003)** measured the technological change in dairy farming in Tamil Nadu with the view to formulate some guidelines for increasing the growth in milk production. The total gain in per day milk yield due to shift in technology was found to be 44.42 per cent, of which,
36.55 per cent occurred due to technological change and 7.82 per cent was due to the difference in the level of input use.

Kumaresan et al., (2005) studied the nature of technological changes in silk cocoon production through the measurement of productivity differences between new bivoltine sericulture (CSR hybrid) technologies and the conventional multi-voltine sericulture (Cross Breed) technologies and analyzed the constituent sources of such differences. The production function analysis indicated that farm yard manure, chemical fertilizer and cocoon feed ratio were the important variables that significantly influenced the CSR hybrid cocoon production. The total gain in cocoon production due to the shift from cross breed to CSR hybrid was found to be 35.22 per cent, which was mainly due to the difference in the levels of input use. The results indicated the adoption of CSR hybrids in place of cross breeds would bring an upward shift in the cocoon yield. The positive contribution of neutral technological change (15.40 per cent) was offset by the negative contribution of non-neutral technological change (14.28 per cent) resulting in meager yield gain due to technological change. The yield gain due to changes in input use was significant with 34.10 per cent.

Basavaraja et al., (2008) studied the technological change in paddy production in Andhra Pradesh by comparing the profitability of SRI (System of Rice Intensification) method of rice cultivation with the traditional methods. The yield realized in traditional method was 6.07 ton per hectare, while it was 8.51 ton under SRI method. The production functions for SRI and traditional methods were also estimated separately. Using the decomposition model, the productivity difference between the SRI and traditional method was decomposed into its constituent sources.

2.2- Growth of farm mechanization in India and World

Sahota (1968) carried out the multi-dimensional analysis of resource allocation and concluded that there were few significant inefficiencies of resource allocation in Indian Agriculture. Farm management data covering three cross sections, eight farm size groups and six regions of India were used for this purpose. Along with the important inputs taken as explanatory variables, the year, size and region dummies were introduced in the regression equation with a view to
account for the specific characteristics of individual units of the time periods and various cross sections.

**Radhakrishna (1969)** made the classification of a set of farmers into efficient and inefficient farmers on the bases of a number of efficiency norms through Discriminant Analysis. The issue of determination of efficient farmers arose in the context of formulation of a price policy for agricultural commodities which had to take into account, inter-alia, and the cost of production of crops. The determination of efficient farmers was attempted only as the basis of measures of economic efficiency. The data were obtained from the studies in the “Economics of farm management in Andhra Pradesh” and related to ninety three farmers who had grown irrigated paddy in the first season. The variables considered for determining efficient farmers were:

i. Efficiency criteria namely yield of paddy per acre,

ii. Cost of production of paddy per maund (cost c); and

iii. The ratio of value of output to cost.

The Discriminant Analysis demarcated the farmers into efficient and inefficient ones. The average yield per acre and the average cost per unit of produce for all the ninety three farmers were calculated. Of these, whoever had the output-cost ratio more than unity was considered to be an efficient farmer.

**Saini (1969)** evaluated the efficiency with which farmers in the States of Uttar Pradesh and Punjab used their resources to achieve the highest net returns from crop production. The investigation showed that farmers were quite rational in terms of their response to economic opportunities and made adjustments in resources use. This rationality, however, did not imply that farmers always succeed in operating their farm business at economically optimum levels. The unexploited economic margins as indicated by the existence of an excess of marginal value product over factor costs in the two states suggested that farmers were not always efficient as allocators of resources in exploiting fully the economic opportunities available to them.
Ketkar (1975) determined the potential impact of new technology on Indian Agriculture through programming model. Any shortfall of actual output from program results was termed inefficiency. These were differentiated on the basis of amounts of N, P, K used as well as the use of irrigation and high yielding seeds in dry and wet season of the year 1968-69.

Singh and Kahlon (1975) examined the resources use efficiency on sample farms in the Central Plains of Punjab, comprising two general types of farming area viz. Non- Bet and Bet. The farmers were classified into different groups on the basis of source of irrigation and source of draught power. The production elasticity of land and human labour were positive and statistically significant in case of six out of eight farm classifications. The elasticity of production with respect to working expenses was the highest. The production elasticity of expenditure on irrigation, on bullock operated, tube well plus canal irrigated farms was positive, but that of expenditure on draught power was negative in the Non-Bet area. But because of large holdings in the Bet area, the elasticity of draught power was positive for bullock-operated, tube well irrigated farms. The analysis also indicated increasing returns to size as well as the rationality of resource use.

Chamak and Singh (1979) examined the resource use efficiency in Punjab Agriculture. They concluded that land, labour and working capital were the significant variables explaining changes in output. As regards fixed capital, its production elasticity was found to be negative but non-significant in all the cases. The marginal value product (MVP) of land was the highest on the small farms followed by the large and medium sized categories. The comparison of MVP of different factors with their respective factor costs indicated significant inefficiencies in resource use for almost all the input factors on all the farm categories and also on the overall farms.

Sharma and Tiwari (1985) studied eight villages along the embankment of river Sutlej. All the cultivators of the selected villages were stratified into categories ‘A’ (<1.5 ha) and ‘B’ (> 1.5 ha). On the category ‘A’ farms, the ratios of MVPs of human and bullock labour to their respective acquisition costs were found significantly less than unity and indicated the excessive use of these resources. In case of fertilizers and manures and expenditure on fixed assets, the ratios were significantly greater than unity implying that production on average
farm of category ‘A’ could have been increased significantly by using more of these factors. Land and seed in this category had been used efficiently. On category ‘B’ farms, most of the ratios except bullock labour were not significantly different from one and hence indicated that these resources had been used efficiently. But the bullock labour was excessively used on category ‘B’ farms.

**Moorti et al., (1986)** studied the allocative efficiency of farm resources in Kangra district of Himachal Pradesh. They tried the production function for different enterprises on different sizes of farms, viz. marginal, small and large. Paddy and maize in the kharif season and wheat and oilseeds in rabi season were important crops in the study area. The higher cropping intensity on small farms showed more rational use of land on these farms.

Expenditure on human labour per farm was the highest on all farms followed by bullock labour, F.Y.M, fertilizer and chemicals. The marginal farms were more human labour intensive than for other inputs. Returns to scale on different sized farms showed that productivity could be increased through additional use of inputs other than human labour.

**Banerjee and Santra (1988)** analyzed the farm size, productivity and resource use efficiency in agriculture of the Nadia district of West Bengal. The results from the regression model relating input to farm size demonstrated a decreasing intensity of input use per farm as the farm size increased. There was a positive correlation between farm size and productivity. However, the inverse relationship between farm size and productivity was not a confirmed phenomenon. It was observed that the elasticity of input use with respect to farm size was less than unity for each factor input. Further, the elasticity of labour use with respect to farm size was much higher than the elasticity of any other input with respect to farm size.

**Datta and Joshi (1992)** measured the existing economic efficiencies in agriculture to find the cost and production potential of reclaiming salt affected soils and proposed investment priorities to increase agricultural production. Aligarh district in Uttar Pradesh was purposely selected. The district was endowed with 70 per cent of the farm land irrigated and had about 20,000 hectares of salt affected soils. Sikandrarao tehsil of the district was chosen because of having about 60 per cent of the salt affected area, largely alkali soils and 93 per cent of the area irrigated. Four villages and 120 farm households were randomly selected and the data on
the important aspects of crop production for the year 1990-91 were collected. Wheat and paddy crops were taken up for the analysis. Log-linear production function for these crops was employed and deterministic frontier function estimated using the linear programming technique. The most important determinants of wheat yield were phosphate fertilizer, hired labour and variable defined as ‘other expenses’ consisting of cost of seeds, chemicals, etc. Their coefficients were significant at one per cent probability level. So, was the case for nitrogenous fertilizer in determining paddy yield. The analysis concluded that

i. Yields on normal soils could be increased by about 29 per cent for wheat, 46 per cent for paddy by reducing the gap between best adopted and average level of technology;

ii. Salt-affected soils had also enough production potential with the available technology. At the moderate level of input use, the yield of wheat ranged from 1,140 to 1,370 Kg and paddy from 2,430 to 3.470 kg per hectare;

iii. The cost of producing additional output was significantly lower on normal soils by achieving economic efficiencies in comparison to the salt-affected soils. The future investment priorities could be developed accordingly.

Grover et al., (1992) examined the impact of farm mechanization on input-use efficiency in Bathinda district of Punjab. The analysis using the Cobb-Douglas function brought out that there was no marked difference in the resource use efficiency among the farms having different levels of mechanization. But, in a broader sense, the intensity of input use increased as the level of mechanization increased, particularly so in the case of human labour and fertilizers. The irrigation resource was found to be over-used on non-mechanized, partially mechanized with tube wells and fully mechanized farm situations. But, it was underused on partially mechanized farm with tractors but no tube wells. The MVP of irrigation (2.05) which was statistically significant indicated the possibility for increasing the expenditure on this category of farms. Also, the MVP of expenditure on insecticides and pesticides (3.66) on the partially mechanized farms turned out to be significant which implied that the expenditure on plant protection could profitably be enhanced.
**Grover et al., (1992)** studied resource productivity of rapeseed and mustard in Punjab. The data were taken from the ‘Farm Management Study in Bathinda District of Punjab’ for the year 1987-88 by using the two-stages stratified random sampling design with village as the primary and operational holding as the ultimate unit of selection. The farm size groups were identified by pooling all the operational holdings raising rabi oilseeds (rapeseed and mustard crops) in the sample villages. Three farm size-groups were thus identified and categorized into small (less than 5.97 ha), medium (5.97 to 12.25 ha) and large (12.25 ha and above) with an overall sample of 389 holdings. Regression analysis was employed to bring out the contribution of farm size and investment in human labour, bullock labour, manures and fertilizers, plant protection and irrigation to gross income from rapeseed and mustard. The findings showed that though the rapeseed and mustard crop competed favorably with the major crops of the region, yet it was more prone to insect-pests and diseases. It was also pointed out that plant protection was the most important factor which highly contributed to the gross income of the oilseed growers of all sizes of farms. Similarly, investment in human labour for producing rapeseed and mustard also had high potential for increasing returns.

**Kaur and Singh (1992)** examined the resource productivity and use-efficiency in agriculture across different agro-climatic zones of Punjab. The study indicated the prevalence of constant returns to scale in all the zones. The MVP for fertilizers was the highest in Zone I and the lowest in Zone VI. The MVP for insecticides was the highest in Zone II and the lowest in Zone IV. Whereas, for labour it was the highest in Zone IV and the lowest and negative in Zone III. The MVP of expenditure on diesel engine was found negative in Zones V and VI. It was observed that with the optimum use of resources, returns could be increased considerably in all the zones.

**Singh et al., (1992)** investigated the resource use efficiency for unirrigated and irrigated wheat grown in the watershed areas of Kandi region of Punjab. The important variables viz. crop area, human labour; bullock labour and fertilizer were regressed against the gross returns from wheat. The coefficient of multiple determination indicated that about 57 per cent to 79 per cent of the variation in the value of output from unirrigated and irrigated wheat respectively was explained by these variables. It was seen that under rainfed conditions, fertilizer application was not only essential to get higher yields but was highly remunerative too. The use of human
and bullock labour was rather excessive for both the irrigated and unirrigated wheat with negative MVPs thus indicating the need for a look at reducing/ rationalizing their use.

Sagar (1995) investigated the response of fertilizer use in Indian Agriculture. The study was an attempt to verify the findings that showed the diminishing marginal physical product of fertilizer in the major cereals viz; paddy and wheat. He used the data related to fertilizer use under field conditions as well as that of experimental and semi-experimental responses from various sources. These included state level crop-cutting experiments, cost of cultivation of principal crops and All India Coordinated Agronomic Research Project. He employed linear and non-linear response functions and also brought out derived fertilizer responses and took up three technological inputs namely, HYV, irrigation and fertilizers.

Singh (1996) made an investigation on “Efficiency of Input Use in Indian Agriculture”. He found that the growth rate of aggregate agricultural productivity in India during 1980-81 to 1994-95 had been lower than the growth rate of fertilizer use, power consumption and institutional credit, but more than the growth in irrigation water. The share of modern inputs increased from less than three per cent in pre-green revolution period to more than 33 per cent in 1990s’.

Singh (1997) estimated the field level response for important crops and examined the changes in response overtime as well as the extent of variation in the use of important inputs and their overall impact on productivity. The crop cutting experiments’ data regarding the principal crops of the Punjab State i.e. wheat, paddy and cotton at two points of time viz; 1980-81 and 1992-93 were collected from the State Department of Agriculture. The analysis was done for three zones of the State separately and for the State as a whole.

Haque (2006) studied on “Resource Use Efficiency in Indian Agriculture” highlighted farmers’ tendency to maximize physical productivity per unit of land. It might lead to over-exploitation and degradation of farm resources. He emphasized economic as well as environmental aspects of resource use efficiency. It was observed that the factor productivity in agriculture overtime showed a deceleration. The productivity of major crops such as paddy, wheat, sugarcane and cotton faced this situation in the major growing areas. There was found a
scope for raising the crop productivity through improved management practices. As evidenced from the cost of cultivation statistics, there were inter-regional and inter-farm variations in factor productivity. Among the factors influencing crop productivity, such factors of production as irrigation for cotton, seeds in paddy, wheat and cotton were found to possess negative elasticity in major crop growing states. The other factors enlisted include erratic weather, small size of holdings and insecure land tenancies.

**Kumar et al., (2008)** worked out the technical efficiency of paddy farmers in Punjab. The cross-section data relating to the various inputs and output for paddy cultivation were taken from the project “Comprehensive Scheme to Study the Cost of Cultivation of Principal Crops” in operation at Punjab Agricultural University. The normal agricultural years 1985-86 and 2002-2003 were chosen for this investigation.

### 2.3 Status of Farm Mechanization

**Chung and Kim (1990)** discussed progress of farm mechanization during the last 25 years in rural areas with an emphasis on its directional shift and the problems and their solution in countered act different phases of the progress. Farm mechanization was conceived as successful accomplishment as far as rice production is concerned because the number of power tillers has increased by more than 2.5 times, tractors 9.2 times, transplanter 7.6 times and combined about 21 times from 1982 to 1988.

**Zeren and Isik (1991)** studied the relation between agricultural inputs, mechanization and employment in Turkey. They observed that human and animal were the major source of power until 1970 when tractor power started to became popular. Between 1975 to 1987, manual and animal power sources declined to a very low level in contrast to farm tractors, which were supplying over 90% of the total farm power. In terms of farm mechanization level, this has increased from 0.04 kW/ha in 1960 to 0.97 kW/h in 1984. They found that tractors and agricultural machinery that affected increase in production have an important role among the production technologies. Tractors and agricultural machinery manufacturing sectors have also an important place in employment.
Khan (1992) studied farm mechanization in the Rajasthan (India) and observed that farm mechanization started in 1940’s when some progressive farmers moved a little forward to test the improved agriculture machines and the results were very encouraging. However it gained momentum only in the post green revolution era (1966-1967). In 1988, about 87000 tractors were on the farms as compared with only 15 in 1945. In just 16 years (1972-1988), the population of tractors, tillage implements, mechanical seeders, pump sets and power threshers increased by about 7, 6, 10 and 25 times respectively. The major constraint in farm mechanization was financial resources of farmers. Repair and maintenance of tractors and equipment was another constraint in farm mechanization.

Mirdha (1993) studied the prospects of agriculture mechanization in Tonga and indicated that traditionally, most farmers perform farm activities with the use of bush knife, fork, spade, hoe and axe. For transportation of their products, they use cart. Due to lack of appropriate technology in the production system, crops yield are low. Although in the fourth five year development plan (1985-1990) the government gave more emphasis in acquiring more tractors and implements, still the number of tractors was not sufficient to meet the demand. The acquisition of the tractors and necessary implements was very costly and beyond the farmers purchasing capacity. In addition, most of the farmers were not technically trained in the operation, care, maintenance and repair of highly technical, powerful and costly tractors, other machines and equipment.

Verma and Singh (1994) discussed the needs and prospects of mechanizing Indian agriculture. They found that Indian farmers were slowly picking up modern techniques of crop production and management such as improved seeds, fertilizers, pests and weed control methods for increasing production. Although efforts have been made since the last two decades to mechanize agriculture, only marginal success has been achieved.

Khatiwada and Sharma (1995) analyzed the status of agricultural mechanization in Nepal. The agriculture system was still found labour intensive and common manual tools were sickle, spade, khurpi and hand hoe. Although the level of mechanization in this country was low but there is a brighter scope of power operated machines such as power tilles, single axle tractors, water lifting devices etc in hilly regions. They suggested that for this purpose a master plan for
agricultural mechanization should be prepared and implemented keeping in view of long term objective of agricultural development of the country.

Din (1995) studied the recent developments in the agricultural mechanization in Taiwan. It was found that almost all the farm operations, from land preparation to harvesting have reached a level of mechanization by 95% in rice production. This was made possible through the custom hiring services and rice nursery centers, which were widely set up throughout the island and constituted a complete service network for the most of the farmers, replacing lots of the farm labour.

Makanga and Singh (1997) studied the status of agricultural mechanization in Kenya. Low level of mechanization was observed particularly with the small scale farming community, where the use of hand tools was very common.

Tsheko and Mahapatra (2003) studied the status of agriculture mechanization in Botswana and observed that the human power contributes 6240 kW which was about 6.2% of total power available for agriculture. Draft animal power availability was 14200kW and mostly used for ploughing and transport to collect water. Tractor power available for agriculture was 80,000 kW. Minimum power requirement was 217,944 kW for total crop land area of 290,592 ha for effective agricultural by assuming 0.75 kW/ha, which leads to a deficiency of 117,504 kW i.e. 54% of the total requirement.

Vatsa (2004) studies the prospects of small tools and equipment’s for hill farming and observed that lack of improved tools and implements its hampering the agricultural productivity in hill farming. Improved tools and implements such as maize cob Sheller, serrated sickle, V-shaped plough, paddy thresher and grader for hilly region had great impact in drudgery reduction. Power tiller was also identified as prominent farm equipment foe hilly region.

2.4 Effect of farm mechanization on the agriculture system

Bisaliah (1977) estimated the value of additional resources required to produce the new technology level of output by old technology as Rs.67 per acre. The farm firms in Ferozepur
district (Punjab) would have required additional resources valued at Rs.67 per acre to produce the new technology level of output during the year 1967-68 in the absence of new technology using old technology. For the entire state of Punjab, the total value of resources saved was estimated to be Rs. 10.6 crores and for all India Rs.48.7 crores for the year 1967-68.

Singh (1977) estimated the Cobb-Douglas production functions based on the cross district and time series data for the pre-technology (1960-65) and post technology (1969-72) periods for Punjab and estimated growth in output to be 33 per cent. He opined that every rupee spent on research in Punjab has yielded a return of Rs.28.64.

Alshi (1981) estimated the gross value of inputs saved as a result of development of new varieties of cotton to be Rs.163.5 million for Akola district, and Rs.1202.2 million for entire state of Maharashtra for the year 1979-80. Also, the additional quantity of cotton output with no extra cost was estimated at 36.17 thousand ton for the Akola district and 265.80 thousand ton for the Maharashtra state during the year 1979-80 at the existing level of adoption of new cotton seed technology.

Hiremath (1989) estimated the gross value of inputs saved as a result of development of new varieties of tobacco to be Rs.7.31 crores for Belgaum district and Rs.7.97 crores for the entire state of Karnataka during the year 1983-84. During the same year due to the adoption of new technology in tobacco, additional output gained was estimated at 9.159 million kg for Belgaum district and 10.44 million kg for Karnataka state.

Kumaresan et al. (2005) stated that it was inferred that, between the technological and input use differentials, which together contributed to the total productivity difference of the order of 33.72 per cent, the former alone accounted for 31.61 per cent. This implied that paddy productivity could be increased by about 31.61 per cent if the farmers could switch over to from traditional method to SRI method with the same level of resource use as in traditional method. However, the contribution of differences in input use between SRI method and traditional method of paddy cultivation to the productivity difference was meager at 2.10 per cent.
Based on the decomposition analysis carried out for assessing the total difference in income from cocoon production between the large-scale and the small scale sericulture farmers carried out by author was found to be 31.08 per cent. Among the different sources contributing to the income difference, the technology or the management practices contributed maximum (25.01 per cent) to the income gap for the large-scale farmers compared to the small-scale farmers. Among the components of technical change, the contribution of neutral technical change in the income reduction was estimated to be 25.72 per cent in contrast to the positive contribution of 0.72 per cent by the non-neutral technological change towards the net income in cocoon production.

Singh (2006) studied on the estimation of a mechanization index and its impact on production and economic factors of India. Author stated that mechanization index based on the ratio of cost of use of machinery to the total cost of use of human labour, draught animals and machinery has been suggested for estimation. For the assessment of the mechanization index, and to study its impact on yield, cost of cultivation and deployment of human and animal power, crop-wise secondary data have been adopted from the cost of cultivation of principal crops in India. The analysis revealed that, even though 78.5% farm power was contributed by mechanical and electrical power sources the mechanization index at an all-India level was only 14.5%, and it varied from 8.2% in sorghum and paddy to a highest value of 29.00% in wheat. It also revealed that the states having higher crop yields have adopted higher levels of mechanization to ensure timeliness and to reduce the cost of cultivation on a yield basis as observed in the state of Punjab. The analysis has further revealed that as a consequence of adoption of mechanization reduction in the use of human labour has not been significant, but the use of draught animals has reduced at a negative annual growth rate of 6.22%, during 1971–72 to 1996–97.

The level of mechanization index in the country is very low in other crops viz. paddy, sugarcane, groundnut etc. and therefore, plenty of scope exists to introduce mechanically operated equipment. Inputs for mechanization require long-term investment for creating support services infrastructure for manufacture, marketing, after-sale service network, training, demonstration, and credit support. The Government of India is conscious of these facts and has
taken adequate measures to promote mechanization by providing financial incentives to the farmers and to the farm machinery industries to manufacture quality farm machinery.

**Tewari (2012)** studied the farm mechanization status of West Bengal. Author stated that a suitable cropping pattern of crops like paddy, potato helps to increase the productivity of the crop yield in the State. It was noted that introduction of implements and machinery would definitely increase the present status of crops for the State. Human resources were inadequate in most of the regions in State to complete transplanting and harvesting operations in paddy and sowing and digging in potato crop. This indicated the needs of transplanted and harvester machineries for these operations in paddy and automatic potato planter and potato digger in potato crop. Major cost contributions come from initial machinery and prime moves cost in the mechanization options. Technological advancement of tractor and allied machinery manufacturing, policy incentives to encourage manufacturing of quality machinery and some social changes of farm machinery operation through custom hiring and off field works (to increase annual use) would reduce the operational cost. Banks provide term finance to farmers for development purposes and short term loans for production purposes. Author also suggest a need to finance farmers for purchasing machinery, implements to expand new activities like custom hiring service, agro-service center and make existing small and marginal units economically viable.

**Mehta (2013)** defined the agricultural scenario of the India. Author elaborated the reason of the poor condition of the agriculture in India. The main factors were the Poor utilization efficiency of critical inputs like water, seeds, fertilizers, chemicals and energy. Benefits of engineering R&D not reaching the farmers expeditiously and very high postharvest losses in grains and perishables and only 10% of produce is processed in the country as against 40-60% in other South Asian countries while very low value-addition in production catchments Nutritional insecurity of rural population.

**Nagaraj et al., (2013)** conducted a study to know the knowledge and adoption level of paddy growers of Raichur district about farm mechanization practices. The study was conducted in Sindhanur and Manvi taluks of Raichur district comprising 120 respondents from six villages. The result showed that nearly half of the respondents (45.00%) belonged to medium level of overall knowledge category about farm mechanization practices. Majority of the respondents
had complete knowledge i.e., mode of operation, frequency of use and specification of the implements such as mould board plough, harrow, cultivator, power tiller, cage wheel, puddler, sprayer, combine harvester and thresher. Further, less than half of the respondents (42.50%) belonged to medium level of adoption category. As in case of knowledge level, large majority of farmers used the implements viz, Mould board plough, harrow, puddler, cultivator, cage wheel, power tiller, sprayer, combine harvester and thresher. However, only 15.00% of the paddy growers possessed skill in the use of paddy transplanter due to its recent introduction.

Konduru et al., (2013) analyzed the impact of mechanical harvesting of cotton by pickers on the net income of Indian cotton farmers. Authors have used information collected from focus group discussions of farmers in top two cotton growing states of India and the information about trials on mechanized harvesting from representatives of equipment and input manufacturers. The results demonstrate that the net income of the cotton farmers represented from this study group will increase considerably with the mechanization of cotton harvesting. The results also show that the probability of earning a lower net income decreases, whereas the probability of earning a higher net income increases when harvesting is done by cotton pickers. But adoption of mechanical harvesting through cotton pickers by Indian farmers is not dependent upon just the availability of suitable harvesters, but also depends upon availability of appropriate cotton varieties, changing some of the agronomic practices like the seed rate, nutrient and defoliant application, pre-cleaning of cotton before sending it to cotton gins, and finally its economic feasibility in India. In order for the change in agronomic practices adopted by Indian farmers, the government extension agencies should play an active role in educating the farmers. The equipment manufacturers should come out with suitable equipment for Indian conditions like small land holdings and pre-cleaners suitable for cleaning cotton before sending them to cotton gins. Efforts also should be made by credit agencies to offer suitable credit facilities for farmers wanted to adopt mechanical harvesting and support should be also offered for establishing custom service providers. With the help of all the above public and private agencies, the adoption of mechanical harvesting of cotton by Indian cotton farmers can be successfully achieved. The mechanized harvesting of cotton in India may lead to increase in yields in Indian cotton farms and thereby the total cotton production in India. In this scenario, the international cotton markets may see more of cotton from India which may impact the
prices of cotton. But, further research needs to be done in order to understand the time line of adoption of mechanized harvesting in India.

**GOI (Twelfth Five Year Plan 2014)** stated the guidelines of sub-mission on agricultural mechanization operations. The main objectives of this mission were to increasing the reach of farm mechanization to small and marginal farmers and to the regions where availability of farm power is low; to promoting ‘Custom Hiring Centers’ to offset the adverse economies of scale arising due to small landholding and high cost of individual ownership; to creating hubs for hi-tech & high value farm equipment; to creating awareness among stakeholders through demonstration and capacity building activities and ensuring performance testing and certification at designated testing centers located all over the country.

**Mehta et al., (2014)** studied about status, challenges and strategies for farm mechanization in India. The production and productivity in Indian agriculture could not enhanced by primitive and traditional practices of farming. The average farm size in India is 1.16 ha and mechanizing small and non-contiguous group of small farms is against ‘economies of scale’ especially for operations like land preparation and harvesting. With continued shrinkage in average farm size, more farms will fall into the adverse category thereby making individual ownership of agricultural machinery progressively more uneconomical. The combine share of agricultural workers and draught animals in total farm power availability in India reduced from 60.8 % in 1971-72 to 10.1 % in 2012-13. The average farm power availability needs to be increased from 1.84 to 2.5 kW/ha by 2025 to assure timeliness and quality in field operations. Therefore, India adopts a policy of selective mechanization under diverse conditions, which makes the agricultural mechanization a challenging task. The widely fragmented and scattered land holdings in many parts of the country need to be consolidated to give access for their owners to the benefits of agricultural mechanization.

The small farms can be mechanized by use of improved manual tools and animal drawn farm equipment on individual ownership basis or high capacity farm machinery on custom hiring basis. Medium and large scale farmers may be provided with Govt. subsidies to encourage them to buy and to apply advanced medium and high capacity machinery such as cotton picker, rice transplanter, and sugar cane harvester and combine harvester on their fields. The farm machinery bank may be established in low farm power availability region for machines.
being manufactured elsewhere in the country. There is a need to innovate custom service or a rental model by institutionalization for high cost farm machinery and can be adopted by private players or Governmental organizations in major production hubs. The quality manufacturing and after sales support for farm machinery are also needed for reliability of farm machinery.

2.5 Growth of Farm Mechanization in Bihar

Majumdar (2000) studied the status and few strategies of farm mechanization in Bihar, India. To meet the future growing food requirement, production has to be increased to a growth rate of 3.7% per year (Yadav, 1999). Farm mechanization is an answer in this regard to get full efficient utilization of the inputs. Though much emphasize has been giving on farm mechanization since '70s, satisfactory breakthrough has not been achieved in most of the states of India; virtually the technology could not been percolated from the research stations to the farmers field. It was reviewed that in Bihar, mechanization in agriculture is not up to the mark because of the problems which are mostly social, economic and technical in nature. Efforts have been made in this paper to study the status in regard to mechanization and to suggest various recommendations to overcome these problems.

Agriculture Census Division, GOI (2006) this report stated and explained about the status of agriculture in Bihar. Report stated that agriculture in Bihar had crucially dependent on monsoon. Although around 57 percent of its gross cultivated area was irrigated, irrigation itself was crucially dependent on monsoon as it largely depended on the use of surface water. According to the soil quality and climatic conditions of the relevant areas, Bihar has been classified in 3 agro-climatic zones: North-West Alluvial Plane (Zone1), North-East Alluvial Plane (Zone 2), and South Alluvial Plane (Zone 3), the last zone being further classified in two sub-zones 3A and 3B. Monsoon arrives earliest in the northeastern Zone2, which also receives the highest rainfall among all three zones. Zone 3 receives monsoon showers last of all three zones and also the least amount. Total irrigated area in the State is 45.67 lakh hectares, of which nearly 30 percent is fed by canal water. This highlights the monsoon dependence of even irrigated lands as catchment areas of nearly all the major rivers in the State are outside the state.
Shambhu (2007) stated that the pace of farm mechanization was very slow in Bihar state as compared to many advanced states of the country. A study was undertaken to identify the status of farm mechanization in Nalanda District of Bihar. A survey was conducted in three blocks of the district having different geographical areas. The only manually operated improved equipment were sprayers, dusters and chaff cutters numbering 27, 9 and 470 per thousand hectare, respectively. In the case of bullock drawn equipment, cultivator, bullock carts and cane crushers were 103, 22 and 9 units per thousand hectares, respectively. The average number of tractors per thousand hectare area was 17 which were higher than other districts of the state. Only cultivators and trailers were used with the tractor. The number of tractor operated thresher were eight whereas other power operated thresher were 203 per thousand hectare area. The bottleneck in mechanization was due to lack of extension programs, availability of equipment, farm roads and consolidation of land holdings.

Jha et al., (2008) stated that Bihar agriculture has the potential to grow rapidly so as to meet the existing shortages and assume primacy in the national agricultural economy. The State has immense agricultural resources, to facilitate a Second Green Revolution in the Country. Bihar must aim at an annual agricultural rate of 5-6%. However, despite the strength of the agriculture sector, it is a paradox that this sector is growing at a snail’s pace. The rate of growth has been below its potential. There has been a conspicuous failure to exploit those resources to the desired level. This study has endeavored to identify the factors behind the dismal performance of the sector. A micro level analysis of the data shows that there are wide productivity differences among different regions in the State. From among the crop sector, yields of maize, gram and sunflower were higher than all India average. But area under all these crops is very small. The country at present suffers from a severe shortage of pulses and oils. Because of the development of poultry, demand for maize is also rising fast. The study has found that due to an appreciable increase in the irrigated area, there is likelihood of an increase of over 2 million hectares in the gross cropped area. If so, a major chunk of this area should be allocated to these crops to meet the national requirements and help bring sustained food security of the country.

Shambhu and Chaudhary (2012) stated that farm mechanization was a very important input in agricultural production. The number of tractors has increased rapidly and population of draft
animals has been decreasing in Bihar in recent years. A study was undertaken to find the tractor utilization pattern and their economics in Nalanda District of Bihar. The average annual use of farm tractors was 1,772.62 hours, in which about 70.47% were used in custom hiring and only 29.53% used for personal work. Maximum use of the farm tractor was 54% in transportation. The average cost of operation of a tractor was Rs. 145.20 per hour for an 18.65 kW tractor and Rs. 168.15 per hour for a 26.11 kW tractor. The cost of operation decreased with the increase in annual use of the tractor. Also, the total operational cost per hour increased with the increase in size of the tractor. The annual use of tractors in tillage, threshing, agricultural purpose transportation, custom use and miscellaneous use was 14.69, 1.18, 5.59, 70.47 and 8.06% of total annual use, respectively. The average Break-Even Point (BEP) of a tractor was about 596.42 h/year for an 18.65 kW tractor and 685.20 h/year for a 26.11 kW tractor. Average annual use in each case was higher than their break even points, indicating that their purchase and use in the study area was profitable.

GOI (2012) stated the agriculture condition of the Bihar state. Bihar has a total geographical area of 93.60 lakh hectares on which it houses a population of 82.9 million, thereby generating a population density of 880 persons per sq. km (Census 2001). Gross sown area in the State is 79.46 lakh hectares, while net sown area is 56.03 lakh hectares. There are around 1.04 crore landholdings in the State of which around 83 percent are marginal holdings of size less than 1 hectare. With around 90 percent of the total population living in rural areas, agriculture as the primary feeder of rural economy continues to operate not only on margins of land but also on the margins of human enterprise, its productivity being among the lowest in the country. Without increasing returns to these margins, not much can be done realistically to develop the agricultural sector. Thus, agriculture continues to define both the potentialities and constraints to development in Bihar.

Ingole (2014) examined the impact of mechanization on productivity. Mechanization in Indian agriculture started with the establishment of the Central Tractor Organization (CTO) mainly for land reclamation and development, mechanical cultivation. The production of irrigation pumps and diesel engines started during 1930s. The manufacture of tractors and power tillers started in 1960. Since then by the virtue of its inherent edge over the conventional means of farming, agricultural mechanization has been gaining popularity. The present study was
conducted in Akola district of Vidarbha region for the period 2012-2013. From Akola district 5 tehsil were selected randomly i.e. Patur, Balapur, Akola, Akot and Murtizapur. For this study 6 villages were selected from each tehsil of Akola district, i.e. total 30 villages selected. The mechanization development level changed in all selected villages over the study period i.e. on an average the composite index of mechanization in 1990 was 0.6757 and in 2013 it was 0.4430. The total contribution explained by mechanization was 10.70 percent in explaining crops productivity. It indicated that the indicators of mechanization contributed 10.70 per cent the productivity of crops.

2.6 Constraints of Farm Mechanization

Dash and Pradhan (1988) studied to identify the constraints in the use of agricultural implements and machinery in the state of Orissa. It was observed that the mechanization in agriculture is not up to the mark because of the problems which were mostly social, economic, and technical in nature. Various suggestions have been recommended to overcome these problems where a systematic planning on mechanization among the farmers to adopt the system.

Kamble et al., (1990) presented the result of a study aimed at identifying the constraints faced by groundnut growing in adoption of production technology. A sample of 125 farmers selected from different villages of Dhule district of Maharashtra suggested that there was unavailability of improved implements and skilled labours. The cost of tractor for production where excessive and there was a lack of capital as well as timely application of inputs. It was believed that credit facilities can help to overcome these drawbacks especially if extended with farm inputs through cooperatives.

Razzaq et al., (1990) studied and analyzed the problems in promoting agricultural mechanization in Pakistan. They observed that tractorization predominated over full mechanization. The previously developed manual and bullock power were prevailing to ease and speed up the operation. The farmers mainly owned and used cultivator, scraping blade, trolley and thresher with tractor despite the high level of awareness about improved agricultural machinery. Financial constraint was the major impediment in the promotion of agricultural mechanization in Pakistan.
Kumar and Sharma (1991) studied the constraints on the use of agricultural implements and machineries in the state of Rajasthan. There were mainly social, economic and technical constraints prevailing among the farmers. Several recommendations as to how these problems might be overcome were made. Following steps were suggested to promote mechanization:

i. To develop state policy on agricultural machinery

ii. To establish training center for imparting training on selection, operation and maintenance of agricultural machinery

iii. To enforce established code for agricultural machinery

iv. To encourage custom hiring for agriculture machinery

v. To accelerate the popularization of agricultural machinery by strengthening extension agencies.

Sidhu and Grewal (1991) studied and analyzed human labour employment in Punjab based on data collected for agriculture year 1981-1982 under different level of mechanization namely bullock operated farm, tractor operated farm and tractor plus combine harvester farm. The study revealed that tractorization didn’t replace human labour. There was no significant difference in human labour use on tractor operated farms and bullock operated farms. The introduction of combine harvester, however significantly reduces the use of human labour on the farm.

Sahay (1992) mentioned that the main hindrance in farm mechanization in India were small land holding, less investment capacity of farmers, availability of agricultural laborers, adequate availability of drought animals, lack of suitable farm machineries for different operations, lack of repair and servicing facilities for farm machineries, lack of skilled man power, high cost of machines and inadequate quality control of machines.

Chaudhary (1992) discussed challenges and opportunities of dry land farm mechanization in Iran. The average crop yields from dry land areas were as low as 750 and 850 kg/ha for wheat and barley respectively. The major constraints to increase yields were soil moisture deficit, inadequate cultural practices and lack of drought resistant seed varieties. There was an urgent
need for developing and popularizing soil moisture conservation equipment such as chisel plough, sweep type cultivators, ridgers and seed cum fertilizer drill for improvement in crop establishment and fertilizer use efficiency.

Iqbal et al., (1992) discussed in their study, the implication of Farm Mechanization and future strategies for adopting mechanical technology for increasing agricultural production. In their study it was observed that tractor and farm labour population increased and subsequently the bullock power decreased. Fragmentation of farm land in to small pieces has been found to be a major limitation in the adoption of mechanization.

Ampratwum (1994) studied about mechanization inputs such as mechanization extension, machinery manufacturers, sales and services, mechanization manpower development and mechanization research & development in agriculture in Oman. It was suggested that mechanization in agriculture has to be included in the development plans of the Sultanate because farm machinery provides a strong link between agriculture, industrial and service sector of the economy. National Committee on Mechanization in Agriculture and related fields was requested to formulate a mechanization policy and coordinate agricultural mechanization planning and support in the context of the overall development plans.

Pariyar and Singh (1995) studied the policy implications and development constraints with farm mechanization in Nepal. They concluded that the country could achieve the objective of higher production and increased employment through selective mechanization. They also concluded that the improved manual tools and animal drawn implements for the hilly region and mechanical power for terrain plains had to be important inputs to increase the output with the existing cultivable land. In view diminishing feed resources and low productivity of drought animals, the agriculture sector was likely to face severe energy constraints in future.

Sidahmed and Betru (1999) studied the problems and prospect of agricultural mechanization in Lebanon. It was found that 92 percent of the farmers used tractors. However only 32 percent farmers owned tractors and the rest depend upon custom hiring. The result of the study indicated the following need:

i. To establishment of a mechanization section.
ii. To develop an extensive technical extension program to help farmers with machinery management.

iii. To revive the agricultural cooperatives to provide tractor and machinery services.

iv. To encourage local manufacturers for simple and modern machines.

vi. To establish institutional linkage between farmers, farm machinery dealers, manufacturers and training institutes.

**Dewangan et al., (2004)** discussed the scope of mechanization in Arunachal Pradesh, which has mountainous physiography with irregular and rugged topography. The farmers mostly used low capacity locally made hand tools for various cultivation practices and these were leading to human drudgery. Thus, there was felt a need to modify the hand tools for implementation of mechanization strategies.
5.1 SUMMARY

This chapter deals with the description of summary and conclusion used to accomplished the experimental work done to attained the desired objectives of the study entitled, “Productivity Growth and adoption of Farm Implements under Farm Mechanization in Supaul District of North Bihar” in the Department of Farm Machinery Engineering, Sam Higginbottom Institute of Agriculture, Technology and Sciences (Formerly Allahabad Agricultural Institute, Deemed University, Allahabad -211007, U.P. (India).

Studies on adoption of farm mechanization in Supaul district of the North Bihar was conducted in the all eleven Blocks of the District. For this purpose, fifty farmers have been taken randomly from each Block villages. The research was done during whole season (both Kharif and Rabi crops). The research is a descriptive research. It made use of both qualitative and quantitative tools in analyzing the data gathered through questionnaire, interview etc.

Three stage stratified random sampling has been used to draw the sample of farmers in which blocks were taken as first stage unit, village as second stage unit and farmers as final stage unit. Data were collected from 550 farming families, 50 farmers each from all 11 blocks. The selection of farmers in all blocks was made randomly irrespective of Panchayat, the status of farmers and topography of the village. Thus the survey was conducted with the help of well-designed questionnaire (Appendix-B) prepared for this purpose. The data was gathered by personnel interviews of the formers.

A self-administered questionnaire was chosen for the study and proper information was gathered from the respondents. The questions in the questionnaire took two forms; open ended questions and close ended questions. The close ended questions offered a set of alternative answers from which the respondents were asked to choose the one that most closely represents their view. The open ended questions on the other hand were not followed by any kind of choice. With this, the respondents’ answers were recorded in full. The respondents again answered the questions the way he or she understood them.
It is to be emphasized that questionnaire allowed respondents time to think through the questions to provide accurate answers. The researcher conducted pretesting of the draft questionnaire with few potential respondents in an informal manner before following up with the full scale questionnaire administration. To check for accuracy, completeness of data and ensure quality, questionnaires and interview guide were numbered serially.

As an ethical consideration, permission was sought from the various bodies that were involved in the study. The purpose of the study was explained to officials and those who responded to questionnaires and interviews.

The analysis of the data collected was done at the end of the data collection. The responses were classified and summarized on the basis of the information provided by the respondents. The analysis was done using both qualitative and quantitative tools. With the quantitative tools, the current version of Statistical Product and Services Solution (SPSS) data analysis programme, Microsoft excel, absolute figures, tables, percentages, and statistical tools such as charts, maps, diagrams were used, whereas qualitative made use of descriptions, analysis of feedback from interview. The data collected from the farmers of all the 11 blocks of the Supaul District has been analyzed by computer based program which has given in the Appendix- C.

After the survey of all the blocks of the Supaul district, it was found that maximum farmers (70%) have marginal (less than 1 ha) land holdings and approximately 15% farmers have small (1 to 4 ha) land holdings. Approximately 8.0 % farmers have medium (4 to 8 ha) and 7 percent of farmers have large land holdings (greater than 8 ha).

All the eleven blocks of Supaul district has sandy soil due to frequent occurrence of flood every year changing soil characteristics. But the quality of the sandy soil has measured in terms of depth of sand deposits in the soil. Depth of sand deposits in the soil has been categorized in three categories i.e. less than 4 inch, 4 inch to 8 inch and more than 8 inch. After the observation of the soil pattern of the soil of different blocks, it was found that Pipra block has maximum (70%) area of less than 4 inch depth of sand deposit while Saraigarh block’s soil has maximum (50%) area of up to 8 inch depth of sand deposit. Basantpur block soil has maximum (60%) area of greater than 8 inch depth of sand deposit.

Approximately 8% of the farmers of the Supaul districts are educated below fifth standard while 4% of the farmers are educated from 5th to 8th standard. Approximately 8% of the
farmers of the Supaul districts are educated from 8th to high school standard and 30% of farmers are educated from high school to 11th standard while 30% of farmers are educated up to Intermediate class. 15% of the farmers are Graduate while only 5% of them are post graduate.

The average yield of the crops i.e. maize, paddy, moong and wheat was 36.00, 22.27, 4.50 and 28.48 quintal per hectare respectively in the Supaul district.

The use of the farm machines in various operations reveals that as much as 20% farmers own animal operated machines for ploughing operations, while 80% farmers use tractor operated tillage tools in Kharif season. Similarly in rabi 15% farmers use animal drawn tillage tool and rest 85% use tractor operated tillage machinery. While irrigation operations are entirely carried out using electrical or diesel operated pump sets. It should be noted here that only 3% of the farmers own tractors or any other type of machines.

In case of time-use of machinery in farming operations, it was observed that human power has consumed the maximum time, especially in harvesting operations of wheat (300 man hours) for one hectare. This is followed by manually operated machines, which consumed more than 317 hours in total on an average, especially in harvesting operations.

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

After the use of proper farm machines for the different crops by the farmers of the Supaul district, the production of the crops increases by 10-15% and due to this the economic status of the farmers would be improved.

5.2 CONCLUSION

Bihar agriculture has the potential to grow rapidly so as to meet the existing shortages and assume primacy in the national agricultural economy. The State has immense agricultural resources, to facilitate a Second Green Revolution in the Country. Bihar must aim at an annual agricultural rate of 5-6%. However, despite the strength of the agriculture sector, it is a
paradox that this sector is growing at a snail’s pace. The rate of growth has been below its potential. After the observation of the results, it concluded that the present status of the farm mechanization in the Supaul district of the Bihar states is little bit behind from the average availability of the farm machines in the Bihar state and in the India. But After the use of the farm machines, it found that the average productivity of the farmers had increased up to 10 to 15% and the quality of the crops also improved. The economic status of the farmers also improved due to good productivity and less human efforts.

5.3 SCOPE OF FUTURE WORK

After this study it was felt that there is a good scope for the future work in this field. Such study should be carried out in all the districts to cope up with the poor rate of productivity in the field of agriculture. Further, it may be suggested that after collection of data, various steps should be induced along with the government to overcome the low productivity of the different crops.
VITA

The author was born on 09\textsuperscript{th} January 1966 at Muzaffarpur district in Bihar. He passed his high School in 1981 from DAV High School, Gopalganj, Bihar with 72.50 percent marks and Intermediate in 1983 from Langat Singh College, Muzaffarpur with 57.00 percent of marks. He obtained his B. Tech. in Agricultural Engineering degree from Rajendra Agricultural University, Pusa, Samastipur in 1991 with 8.284 CGPA. He did his M. Tech. in Agricultural Engineering with major in Farm machinery and Power Engineering from Rajendra Agricultural University, Pusa, Samastipur in 1997 with 8.571 CGPA (Gold Medal). He joined as Subject Matter Specialist at Rajendra Agricultural University, Pusa in 2007 which is now under Bihar Agricultural University, Sabour. After getting opportunity to get PhD under Faculty Development Programme of the university and joined the Doctor in Philosophy programme in Agricultural Engineering with major in Farm Machinery and Power Engineering at Sam Higginbottom Institute of Agriculture, Technology & Sciences (Formerly Allahabad Agricultural Institute) (Deemed to be University), Allahabad in the year 2013.
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