Climate Resilient Agriculture Programme in Bihar

INTERVENTIONS & IMPACT

Bihar Agricultural University, Sabour

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FOREWORD

Climate change has become a global issue of concern affecting all the fronts of human life on earth including agriculture. It is predicted that in the days to come, if not managed properly, the climate change will result in declined crop yields, emergence of new pests, diseases and reduced resource use efficiency. The small and marginal farmers are particularly more vulnerable to the negative impacts of climate change. This situation necessitates implementation of climate change mitigation strategies in a comprehensive manner.

Keeping this need in mind, the Climate Resilient Agriculture Programme was implemented under the visionary leadership of Hon'ble Chief Minister of Bihar, Shri Nitish Kumar in all the 38 districts of the state since 2019. Under this program, the climate resilient cropping systems, crop varieties, low-cost climate resilient production technologies were demonstrated and disseminated among farmers. For enhancing resource use efficiency, the precision water and nutrient management, laser land levelling, crop residue management, crop diversification etc. were promoted.

This document reflects the impact of the climate resilient technologies on the farm production process in terms of changes in cropping pattern, cropping intensity, resource use efficiency. Further crop specific impact on yield, cost of cultivation, profitability has been also well documented in this publication. The Bihar Agricultural University, Sabour is grateful to Government of Bihar and Secretary, Department of Agriculture, Govt. of Bihar for funding this project and providing valuable guidance and cooperation in implementation of Climate Resilient Agriculture Programme. I am confident that this document will be helpful for policy makers, research scholars and academicians in justifying the continued implementation of CRA programme and act as guide for formulation of future policies on climate change management.

I congratulate all the scientists and field staff who have contributed towards development this impact document.

(D.R. Singh)
Vice Chancellor

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

KVK	Krishi Vigyan Kendra
CRA	Climate Resilient Agriculture
BISA	Borlaug Institute for South Asia, Pusa
ICAR-RCER	ICAR-Research Complex for Eastern Region, Patna
DRPCAU	Dr. Rajendra Prasad Central Agricultural University, Pusa
BAU	Bihar Agricultural University, Sabour
ZT	Zero tillage
DSR	Direct Seeded Rice
AWD	Alternate wetting and drying
PTR	Puddled Transplanted Rice
COMFED	Bihar State Milk Co-Operative Federation Ltd.
CBG	Compressed Bio-Gas
GHG	Green House Gas
IRRI	International Rice Research Institute
CIP	International Potato Centre
CIMMYT	International Maize and Wheat Improvement Centre
IPNI	International Plant Nutrition Institute
mm	Millimetre
B:C ratio	Benefit Cost ratio

1. EXECUTIVE SUMMARY

EXECUTUVE SUMMARY

During 2023, a sample survey was conducted to assess the impact of Bihar government sponsored CRA programme implemented by BAU, Sabour, DRPCAU, Pusa, BISA, Pusa; ICAR-RCER, Patna and data was collected from 1725 farmers belonging to 23 districts of the state namely Araria, Arwal, Aurangabad, Banka, Bhabua, Bhagalpur, Bhojpur, Gaya, Jamui, Jehanabad, Katihar, Khagaria, Kishanganj, Lakhisarai, Madhepura, Munger, Nalanda, Patna, Purnea, Rohtas, Saharsa, Sheikhpura and Supaul.

The data was collected with respect to various indicators pertaining to impact assessment parameters. These indicators include demographic factors, cropping pattern, cropping intensity, resource utilization, crop performance, system productivity and system profitability. According to the survey, CRA had the following impacts.

As a result of this intervention, a major shift was observed in the project area in terms of cropping patterns. The area under the less productive rice-wheat cropping pattern has decreased by 58%. Similarly, the area under the Rice-mustard cropping pattern has declined by 48%; the area under Rice-Chickpea has declined by 16% and the area under Rice-Rabi maize has declined by 13%. These double crop based cropping patterns were largely replaced by triple crop based Rice-Wheat-Moong; Rice-Chickpea-Moong; Rice-Mustard-Moong; Rice-Lentil-Moong.

The overall cropping intensity has increased from 201 % during the pre-CRA period to 250 % after introduction of CRA registering an increase in cropping intensity by 48% which corresponds to 25% increment compared to pre-CRA cropping intensity.

The Rice-Wheat-Moong cropping system promoted under CRA provided 31% higher system productivity (102 q/ha) as compared to the pre-existing Rice-Wheat production system (78 q/ha). Similarly, the Maize-Wheat-Moong and Rice-Rabi Maize cropping systems also yielded maximum system productivity (i.e. above 100 q/ha).

It was observed that in case of rice crop, the average number of irrigations have reduced from 5.23 (~ 5) to 3.76 (~4). The average external water application through irrigation in rice crop has reduced from

944.74 mm to 649.68 mm registering a saving of 33.10 % (315.79 mm). It was observed that in case of wheat crop, the average number of irrigations has decreased from 3.51 (~ 4) to 2.98 (~3). The average external water application through irrigation has reduced from 507.7 mm to 446.5 mm registering a saving of 11.88 % (60.20 mm) in wheat crop.

The reduction in use of farm inputs and consequent reduction in cultivation costs has significantly contributed to an increase in net income from rice cultivation. Further, net income has also increased due to crop yield increases by 12% (i.e., from 16.09 to 18.10 q/acre). The overall net profit from rice cultivation has risen by 23% (i.e., 19197.77 to 23526.27 Rs. /acre) whereas B:C Ratio has improved by 24.85% (i.e., from 2.17 to 2.71).

It was observed that the wheat crop yield had increased by 13% (i.e., from 14.03 to 15.88 q/acre). Coupled with the yield increase, the reduction in cultivation costs has resulted in a 21% (i.e., from 16157 to 19478 Rs. /acre) increment in net income from wheat cultivation. While the B:C ratio has increased by 33% (i.e., from 1.96 to 2.61).

There is considerable improvement in grain yield (13.99%) (i.e., from 31.02 to 35.6 q/acre) consequently we also observed improvement in net income and B:C ratio by 48.13% and 31.78%, (i.e., from 27571.6 to 40842.65 Rs./acre) respectively.

The zero-till cultivation of lentil has not only reduced the cost of cultivation but also was able to increase the crop yield, net income and B:C ratio by 15.13% (i.e., from 4.41 to 5.07 q/acre), 30.85% (i.e., from 16098 to 21064.44 Rs. /acre) and 32.94% (i.e., from 2.47 to 3.28) respectively. The overall cost of cultivation has reduced by 15.62% (i.e., from 11554.89 to 9750 Rs./acre).

Farmers in the project area realized better crop performance owing to reduction in cultivation costs, early sowing of crops and reduced irrigation needs. It was observed that mustard crop yield has increased by 13.15% (i.e., from 3.82 to 4.33 q/acre) and cultivation cost has decreased by 19.6% (i.e., from 7411 to 5958.79 Rs./acre). The net income from mustard cultivation has increased by 31.61% (i.e., from 16898 to 22239.26 Rs./acre).

2. INTRODUCTION

INTRODUCTION

Agriculture is one of the highly sensitive and vulnerable sectors to climate change. Events such as floods and drought, as well as long-term changes in climatic conditions such as rainfall and temperature can lead to reductions in yields and shifts in cropping patterns in the region. Besides affecting crops and cropping patterns, climate change also has potential to alter insect population dynamics. This could result in the emergence of new pests, the transformation of minor crop pests into major ones. Due to climate change, small and marginal farmers will be particularly affected by declining yield trends, the emergence of new pests and diseases, as well as the reduction in resource efficiency. As a result of climate change, small and marginal farmers will be particularly affected.

It is well known that the large majority of farmers in India, particularly in Bihar are small and marginal. It is estimated that more than 84% of the farmers in the Bihar operate small and marginal holdings. Further, the state exhibits large diversity in climate change vulnerability. For instance, the southern part of the state is largely dependent on rainfed farming with limited water availability and occurrence of frequent droughts. In contrast, the northern part of the state is a water excess region and experiences flood and excessive moisture conditions after the receding of floods. In order to mitigate the impact of climate change on agriculture, it is necessary to develop a long-term strategy.

Keeping this need in mind, the Bihar government has decided to promote climate resilient agriculture in the state. Climate-resilient agriculture is a multi-pronged approach to transforming and reorienting agricultural development under the new realisms of climate change. It may be defined as "agriculture that sustainably increases productivity, enhances resilience (adaptation), reduces/removes GHGs (mitigation) where possible, and enhances

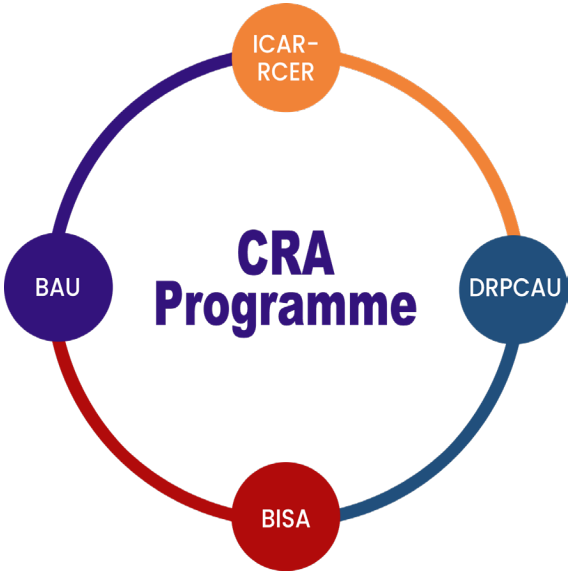

Fig. 1 *Name of Partners in CRA Programme*

national food security and development goals". Climate resilient agriculture aims at transforming the current systems and has a wider perspective of developing eco-friendly sustainable food production systems.

2.1 Genesis of Climate Resilient Agriculture (CRA) in Bihar:

The CRA Program is a Government of Bihar funded collaborative project. CRA in Bihar was conceptualized in 2016 after Shri Nitish Kumar, the Hon'ble Chief Minister of Bihar, visited the Borlaug Institute for South Asia (BISA), Pusa, Samastipur. Later on upon the direction of Hon'ble Chief Minister, Bihar the proposal was developed for dissemination of climate resilient technologies and practices among farmers in the state of Bihar. The project is being implemented in network mode since 2019 by the Bihar Agricultural University (BAU), Sabour; Dr. Rajendra Prasad Central Agricultural University (DRPCAU), Pusa-Samastipur; ICAR-Research Complex for Eastern Region (ICAR-RCER), Patna and Borlaug Institute for South Asia (BISA), Pusa. After realizing the benefits of the project in the eight districts of the state on a pilot basis, the project was upscaled in all the 38 districts of Bihar during 2020 for 5 years. In each district, climate resilient technologies were demonstrated in five villages. The project was implemented in 38 districts by Krishi Vigyan Kendra.

2.2 Program Goal:

To develop and introduce evidence-based response strategies for addressing the principal climate-based threats to the productivity and resilience of staple crop production systems in Bihar.

2.3 General Objectives:

To achieve the program goal, climate resilient agriculture practices, new futuristic cropping system (crop cycle) relevant to needs of resource poor farmers that can address climatic risks is being developed, validated, and deployed through a community-led approach to make farming relevant, remunerative, and stable.

2.4 Specific Objectives

- Baseline survey for identifying the suitable climate resilient technologies and impact assessment.
- Improve level of awareness and capacity of those involved with the farming system to strengthen farmer's ability to cope with climate change. Blend traditional practices and scientific approaches in a participative manner to encourage a high rate of farmer adoption on a voluntary basis.
- Development of on-farm innovation clusters of suitable climate resilient and futuristic cropping system (crop cycle) modules in climate resilient agriculture for technology evaluation, co-learning, and capacity development.
- Foster institutional transformation backed by needed policy changes. Attain convergence with existing schemes of state departments of agriculture and rural development, and on-going programs of other agencies to ensure wider acceptance and roll out.
- Pursue research to develop improved understanding of climate change, adaptation and mitigation measures, and validation of the same for onward adoption in the field.

2.5 Technological interventions and their implementation:

One of the uniqueness of this project lies in cropping system-based management that increases cropping intensity, climate resilience, productivity and profitability which attracts attention at national and international level.

As part of the capacity building component of the project, around 1.5 lakh farmers have been trained and made aware of CRA technologies. This has been done through technical trainings and travelling seminars. The project is regularly monitored through a steering committee, chaired by the Secretary, Agriculture, Govt of Bihar. CIMMYT, IRRI and CIP are the international knowledge partners who provide support in capacity development to strengthen the CRA Program.

2.6 Program Strategy:

To achieve the laid-out objectives, climate resilient agriculture practices of a new futuristic cropping system (crop cycle) relevant to needs of resource poor farmers that can address climatic risks is being developed, validated and deployed through a community-led approach to make farming relevant, remunerative, and stable. The engagement model will work around principles of convergence with multi- stakeholder, multi-disciplinary, and multi-institute teams contributing to innovation and knowledge generation. Climate resilient agriculture will adopt an integrated social, biophysical and economic approach to understand the factors influencing the adoption and impact of climate resilient interventions. Once the dynamics stabilize in the local context, the climate resilient agriculture (CRA) model is being progressively rolled out in other villages. To begin, as indicated, one CRA is being established in a district as a project hub.

Table 1. *District wise details of project beneficiaries*

District	DSR	Alternate wetting and drying	Water harvesting & field bunding	Zero tillage	Raised bed planting	Nutrient expert/ Leaf color chart/ green seeker
Araria	300	89	52	1240	1187	140
Arwal	600	145	80	2015	63	312
Aurangabad	317	306	292	2647	5	265
Banka	1028	238	219	1996	692	235
Bhabua	527	200	139	1458	289	94
Bhagalpur	802	241	198	1851	1491	140
Bhojpur	293	120	80	2480	337	85
Gaya	112	186	91	2511	42	268
Jamui	670	180	150	2663	305	230
Jehanabad	582	292	21	3044	497	198
Katihar	578	50	87	625	1905	61
Khagaria	906	140	71	2472	447	98
Kishanganj	724	120	100	193	1561	100
Lakhisarai	367	318	80	1967	925	450
Madhepura	650	60	40	1800	375	111
Munger	574	140	100	2326	315	135
Nalanda	935	0	50	2576	264	75
Patna	663	145	145	2109	51	145
Purnea	402	70	67	858	1596	106
Rohtas	185	137	85	2070	38	75
Saharsa	403	155	140	1741	697	265
Sheikhpura	582	110	70	1879	30	65
Supaul	601	176	40	1059	879	417
Overall	12801	3618	2397	43580	13158	4070

3. CRA INTERVENTIONS

CRA INTERVENTIONS

Direct Seeded Rice (DSR)

Transplanting of rice after repeated puddling is the conventional method of rice growing which is not only intensive water user but also input intensive. Direct seeding is a crop establishment system wherein rice seeds are sown directly into the field, as opposed to the traditional method of growing seedlings in a nursery, then transplanting into flooded fields. Direct seeding is a method under which pre-germinated seeds are directly drilled into the field by a tractor drawn machine or by manual operated drum seeder. There is no need of nursery preparation or transplantation involved in this method. It is labour, fuel, time and water saving technology and gives similar yield to transplanted rice. DSR technique, improves the soil health, and fertilizer and water use efficiency which saves irrigation water.

Zero tillage sowing of crops

In the Indo-Gangetic plains, where rice-wheat cropping is practiced, the zero-tillage system is used. Through zero tillage technology the crops like wheat, lentil, chickpea and mustard being sown without any tillage practice after the rice harvest to increase yields and profits while lowering cultivation costs. For sowing of crop through zero tillage using the machinery to drill the seed in uncultivated land is critical to the success of zero tillage. During the Kharif season, zero tillage works best for direct-seeded rice, maize, soybean, cotton, pigeonpea, mungbean, clusterbean, pearl millet, and wheat; barley, chickpea, mustard, and lentil during the rabi season.

Laser land leveling (LLL)

Laser leveling is a process of smoothing the land surface (± 2 cm) from its average elevation using laser-equipped drag buckets. This practice uses large horsepower tractors and soil movers that are equipped with laser-guided instrumentation so that the soil can be moved either by cutting or filling to create the desired slope/level. This technique is well known for achieving higher levels of accuracy in land leveling and offers great potential for water savings and higher grain yields. Laser land leveling increases water application efficiency by about half when they compared with leveling by scraper, improved weed control efficiency and nutrient use efficiency.

Raised bed sowing of crops

In bed planting systems, wheat, maize, mustard, soybean, pigeon pea and other crops are planted on the raised beds in ridge - furrow system. Ridges or beds are prepared by using multi crop raised bed planter and beds get old in next season again reshape it and sow the crop. This system is often considered more appropriate for growing high value crops that are more sensitive to temporary water logging stress. Farmers often raise crops

such as, maize, soybean and wheat on the raised beds to reduce water use, conserve rainwater and improve system productivity. In CRA Programme the system of raised bed planting of crops may be particularly advantageous in areas where groundwater levels are falling and herbicide-resistant weeds are becoming a problem. Irrigation done with the furrow irrigation system which helps in saving irrigation water and timing of irrigation reduced by half and furrow act as drainage channel in case of heavy rains and hence save crops from excess moisture if stayed for longer period. Presence of previous crops' residue in the furrow soil becomes soft, light and friable consequently population of earthworm increased very fast and crop shows healthier.

Crop diversification/Intensification and climate resilient cropping systems

Crop diversification and intensification/ intercropping with high value crops have potential to help the thousand producing basic staples and surplus for modest incomes and it is the most important agriculture activity providing employment and food security to millions of people in the country. Crop diversification can be practiced in two ways i.e., temporal/horizontal/ crop rotational diversification and spatial/vertical diversification. The intercropping of Potato+ Maize, intercropping is introduced through this project and farmers are being benefited to both the crops with same inputs like field preparation expenditures, irrigation water, and fertilizer application. The growth in crop productivity of component crop is either stagnating (wheat) or declining (rice) despite the use of higher yielding cultivars. Thus, substitution of rice which requires more water with maize or cash crops like sugarcane and cotton will not only reduce water requirement but also enhance the system productivity which leads to increase in farmers' income.

Growing of early maturing, photo insensitive, high tillering crops' varieties, tolerant to biotic and abiotic stresses, mulching with crop residue for soil moisture conservation etc. can be implement ed for best cropping system mode.

Water harvesting and Field Bunding:

In CRA Programme sites to solve the irrigation water scarcity in upland as well as low land area in-situ rain water collection is being promoted. To collect the rain water construct 50 cm wide and 30 cm height of bunds around the field. To stop/ minimize water loss through seepage bunds are prepared well compacted and properly sealed with no cracks, holes etc. The collection of water for future life saving irrigation in corner of the field a small pond has prepared which was economically assisted by government under CRA Programme. With the help of this technique farmers are saving lots of money by saving number of irrigation, irrigation water and fuel burning required for irrigation.

Alternate wetting and drying (AWD) irrigation system:

AWD irrigation system is an efficient strategy for saving irrigation water as well as enhancing rice yields in the future. AWD irrigation system is an innovative irrigation system in which on project sites a PVC Pipes or Pani pipe are being established on farmer's rice field that allows the lowland rice growers to save water by intermittent irrigation by alternatively flooding and drying the field at certain days' interval which may vary from 1-10 or more days depending on the soil type. AWD irrigation system requires less water as compared to continuous flood irrigation thereby improving the water use efficiency (WUE), it reduces the anthropogenic GHGs emission without any

negative effect on grain yield. This system has shown to improve the grain quality by reducing total Arsenic and has been effective in decreasing insect pests and disease infestation.

Nutrient management

To prevent excess application of fertilizer due to indiscriminate application of fertilizer by the farmers under CRA programme different nutrient management tools are being used. These tools are Leaf colour chart (LCC), Nutrient Expert (NE), Green seeker and integrated nutrient management (INM).

Leaf colour chart (LCC) is a fairly good indicator of the nitrogen status of plant. To easy identify the nitrogen status a simple and eco-friendly tool called as leaf colour chart (LCC) is provided to the farmers of CRA programme sites of Bihar. LCC occurs with 4 colored called as four panel LCC and six colored called six panel LCC. It is an ideal tool to optimize nitrogen use in crops like rice at high yield levels irrespective of the source of nitrogen applied viz. organic matter, biological fixed nitrogen or chemical fertilizers.

International Plant Nutrition Institute (IPNI) in collaboration with CIMMYT has developed nutrient expert (NE) software. NE is a nutrient decision support system, based on site-specific nutrient management principles. NE provides fertilizer recommendations by considering yield responses and targeted agronomic efficiencies along with contribution of nutrient from indigenous sources. NE has been successfully in major maize growing agro-ecologies of country and also increased yield and farm-profitability over existing fertilizer recommendations.

Soil Fertility Map

The soil fertility evaluation is the most basic decision making tool in order to efficient plan for a particular land use system. For easy understandable, informative and precision management of soil of project sites a soil fertility map has been prepared. It is a data-driven farming by collecting, analyzing and correlating information about the soil nutrient status, soil nutrient supplying capacity, fertilizer rate and potential yield in the respective location, will make farmers more informed decisions. All this information has presented on map for the purpose of visual display and analyzing spatial distribution of the available data. So, farmers of the villages of project sites can easy know about their soil status and take precision soil management steps.

Benefits of soil fertility map

Judicious use of fertilizers, based on soil test-based recommendations, farmers may be advised to use balance use of fertilizers, thus can save money. Farmers may start using the Site specific nutrient recommendations in CRA villages, this display may be helpful in diverting the fertilizer demand based on its regional referencing, help in choosing suitable cropping pattern and agronomic procedure.


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4. METHODOLOGY


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प्रदर्शन तकनीक - धान की सीधी बुआई
दिनांक - 16 सितम्बर 2020
प्रदर्शन - गोरगीड़

METHODOLOGY

The study was conducted in 2023. We used ex-post-facto research to study the impact of climate resilient agriculture, where data was collected from the sampled project beneficiary framers regarding impact indicator parameter values before and after implementation. In order to assess the impact of the CRA programme, information pertaining to two years prior to implementation (2018-19 and 2019-20) and three years after implementation (2020-21, 2021-22 and 2022-23) was considered.

4.1 Population frame and sampling:

The population frame consists of beneficiaries of the CRA programme who availed the technical advisory, input assistance etc. for implementation of CRA interventions in their field. The data was collected from 23 districts falling under the jurisdiction of Bihar which included Araria, Arwal, Aurangabad, Banka, Bhabua, Bhagalpur, Bhojpur, Gaya, Jamui, Jehanabad, Katihar, Khagaria, Kishanganj, Lakhisarai, Madhepura, Munger, Nalanda, Patna, Purnea, Rohtas, Saharsa, Sheikhpura and Supaul districts. From each district, data was collected from a randomly selected sample of 75 farmers (i.e. 15 farmers were selected from each of the five villages in a given district.

4.2 Impact indicators and their measurement:

The data was gathered using a face to face interview method using a semi-structured interview schedule. The data was collected from farmers on different parameters including Demographic factors, Cropping pattern, Cropping intensity, Crop wise resource utilization, Crop performance, and System productivity. Data was also collected from farmers to assess the comparative scenario of crop residue utilization prior to and post CRA introduction.

Often it has been observed that technology adoption declines significantly after withdrawal of project assistance. Therefore, it is imperative to understand to what extent farmers are willing to continue CRA technologies adoption in future when project assistance is withdrawn. To estimate the extent of continued adoption of CRA technologies after withdrawal, data was also collected from farmers pertaining to technology wise conditions under which farmers are willing to continue the adoption of CRA technologies. The parameter wise brief description of indicators is given in the following table.

The data collected was screened and cleaned. Only those responses were considered for each parameter wherein the response was complete, non-contradictory and unambiguous. Further the data was summarized using measures of central tendency and measures of dispersion. The summary of findings is described in subsequent section.

3.3 Description of parameters and indicators

Sl. No.	Parameter	Impact Indicators
1.	Demographic factors	Age, education, annual income from crop production, livestock rearing, Business & other activities, Total annual income
2.	Cropping pattern	Cropping pattern with area under each crop in acres prior to and post introduction of CRA
3.	Cropping intensity	Area sown once, twice and thrice prior to and post introduction of CRA
4.	Crop wise resource utilization	Quantity of seeds, fertilizers, pesticides and fuel consumption Number of irrigation and estimated quantity of water used
5.	Crop performance	Crop duration, cost of cultivation, yield, net profit, B:C Ratio
6.	System productivity	Per hectare annual productivity of various cropping systems promoted under CRA as compared to conventional rice-wheat cropping system
7.	System profitability	Per hectare annual income earned from various cropping systems promoted under CRA as compared to conventional rice-wheat cropping system

5. FINDINGS OF THE SURVEY


Latitude: 25.109818
Longitude: 87.080601

FINDINGS OF THE SURVEY

The data collected was screened, cleaned and summary of the findings are organized under following sub-sections.

5.1 Impact of CRA Interventions on cropping pattern & cropping diversity
5.2 Impact of CRA Interventions on cropping intensity
5.3 Impact of CRA Interventions on system productivity
5.4 Water use efficiency and nutrient status
5.5 Crop-wise impact of CRA intervention on cost of cultivation, resource utilization and agro-economic performance
5.6 Crop Residue Management

Impact of CRA on Cropping Pattern & Cropping Diversity

Rice-wheat is the predominant cropping pattern in Bihar. It is estimated that more than 50% of area under field crops is constituted by Rice-wheat cropping system. While other major cropping patterns in the state include Rice-Maize, Rice-Mustard, Rice-lentil, Rice-Chickpea etc. Under CRA programme, the targeting of cropping pattern was a multi-pronged approach aimed at (i) increasing overall system productivity (ii) introduction of cropping diversity (iii) enhancing cropping intensity. To achieve this objective the following interventions were implemented.

Intervention

- Replacement of late sown long duration rice with early sown medium duration rice to provide sufficient window for summer crop
- Early sowing and harvesting wheat with the help of zero till technology
- Introduction and promotion of summer mung cultivation
- Promotion of Maize + Potato intercropping

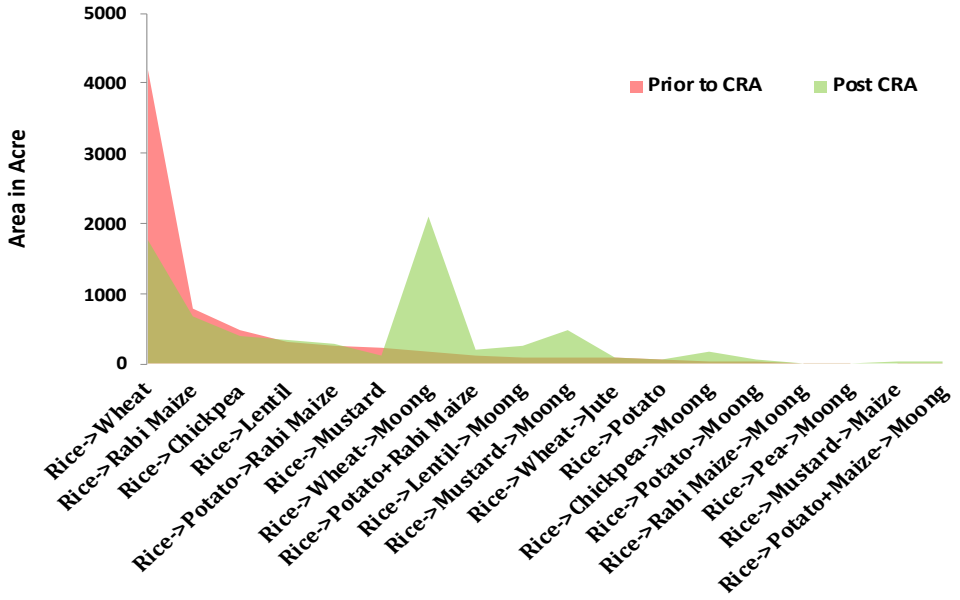
Impact

As a result of these interventions, a major shift was observed in the project area in terms of cropping patterns. The area under the less productive rice-wheat cropping pattern has declined by 58%. Similarly, the area under the Rice-mustard cropping pattern has declined by 48%; the area under Rice-Chickpea has declined by 16% and the area under Rice-Rabi maize has declined by 13%. These double crop based cropping patterns were largely replaced by triple crop based Rice-Wheat-Moong; Rice-Chickpea-Moong; Rice-Mustard-Moong; Rice-Lentil-Moong. Below is a table and graph illustrating the cropping pattern area and the corresponding change in area coverage after the introduction of CRA.

***Table 2** : Area under various cropping systems prior to and post introduction of CRA*

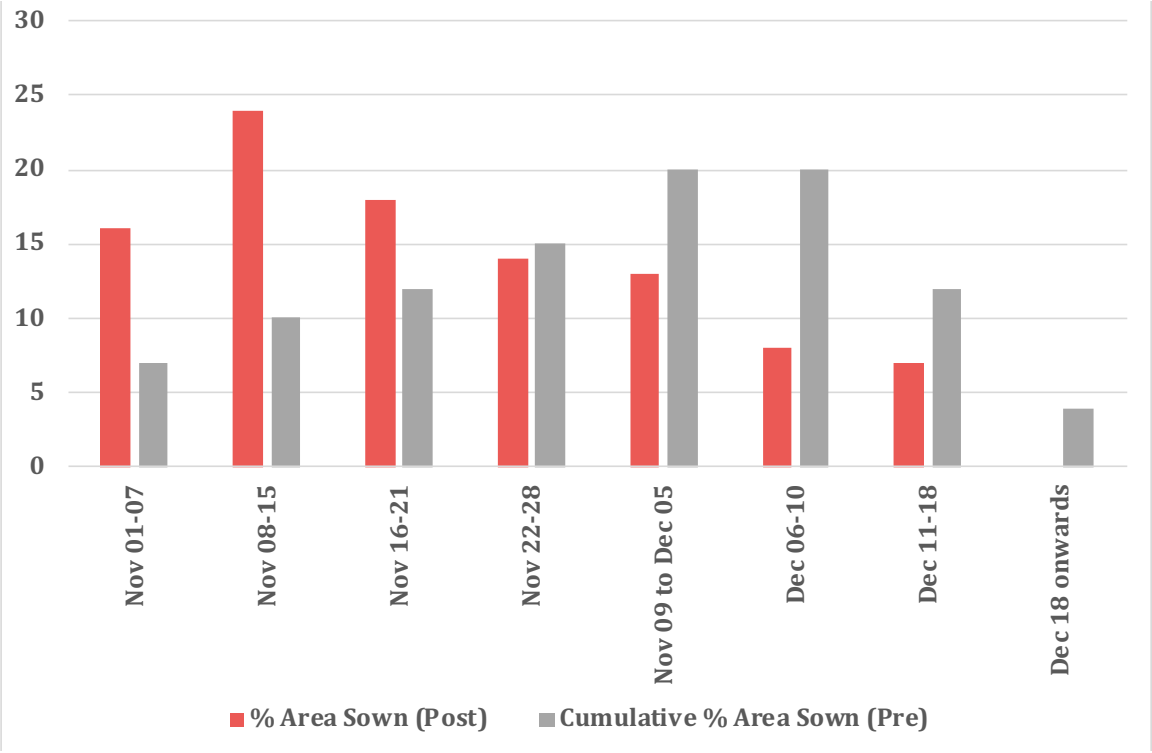
Cropping pattern	Prior to CRA	Post CRA	% change
Rice-Wheat	4198.5	1773.0	-57.8
Rice-Rabi Maize	791.5	687.5	-13.1
Rice-Chickpea	485.4	406.0	-16.4
Rice-Lentil	329.2	334.5	1.6
Rice-Potato-Rabi Maize	272.0	297.3	9.3
Rice-Mustard	247.0	128.3	-48.1
Rice-Wheat-Moong	170.2	2091.3	1128.7
Rice-Potato+Rabi Maize	116.3	217.3	86.9
Rice-Lentil-Moong	91.2	256.1	180.8
Rice-Mustard-Moong	90.3	486.5	438.7
Rice-Wheat-Jute	82.5	99.0	20.0
Rice-Potato	76.5	68.5	-10.5
Rice-Chickpea-Moong	29.9	172.1	475.6
Rice-Potato-Moong	28.3	69.0	144.1
Rice-Rabi Maize	10.5	22.0	109.5
Rice-Pea-Moong	3.0	10.0	233.3
Rice-Mustard-Maize	0.5	29.5	5800.0

***Fig. 2 :** Area (in acres) under different cropping patterns prior to and post introduction of CRA*



Effect of CRA programme on Date of Sowing: Sowing window of wheat in CRA Villages indicates that 72% of wheat sowing was completed within 1-28, November and remaining 28% was completed between 29 November to 18 December.

Fig.3 *Impact of CRA interventions on earliness of wheat sowing window*



5.1 Impact of CRA Interventions on Cropping Intensity

One of the major issues faced by agriculture in the state is poor cropping intensity. It is estimated that since last few decades, the cropping intensity has been poor and remained stagnant around 138-142 %. This indicates that approximately less than half of the cultivated area is cultivated twice in a year. To address this issue, the various interventions were implemented to facilitate cultivation of summer crop to increase cropping intensity.

Technological interventions:

- Varietal replacement in the kharif crop to facilitate early harvest of rabi crop
- Identification and promotion of suitable summer crops and crop varieties
- Promotion of water conservation and water use efficiency enhancing practices including in-situ water harvesting, field bunding etc.

Impact:

As a result of these interventions farmers were able to realize significant enhancement in cropping intensity. The overall cropping intensity has increased from 201 % during the pre-CRA period to 250 % after introduction of CRA registering increment of cropping intensity by 48% which corresponds to 25% increment as compared to pre-CRA cropping intensity.

Fig. 4 *Impact of CRA Interventions on cropping intensity*

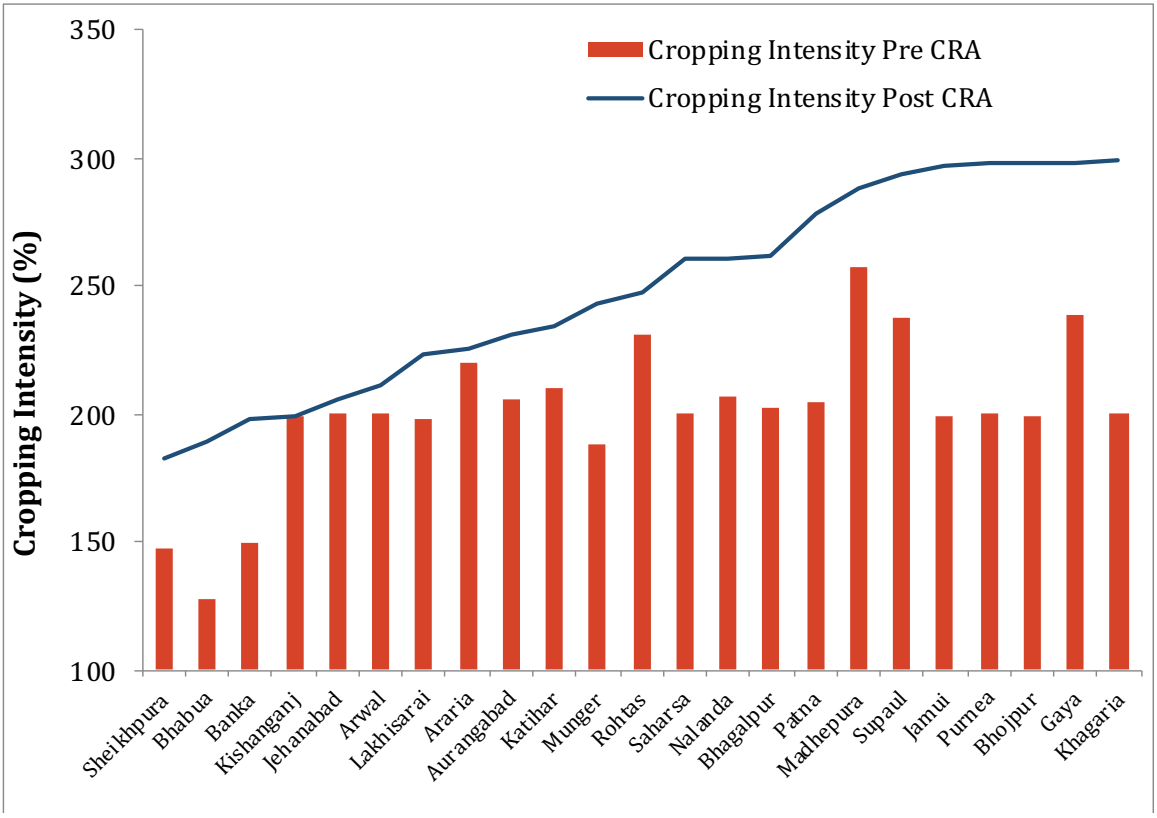


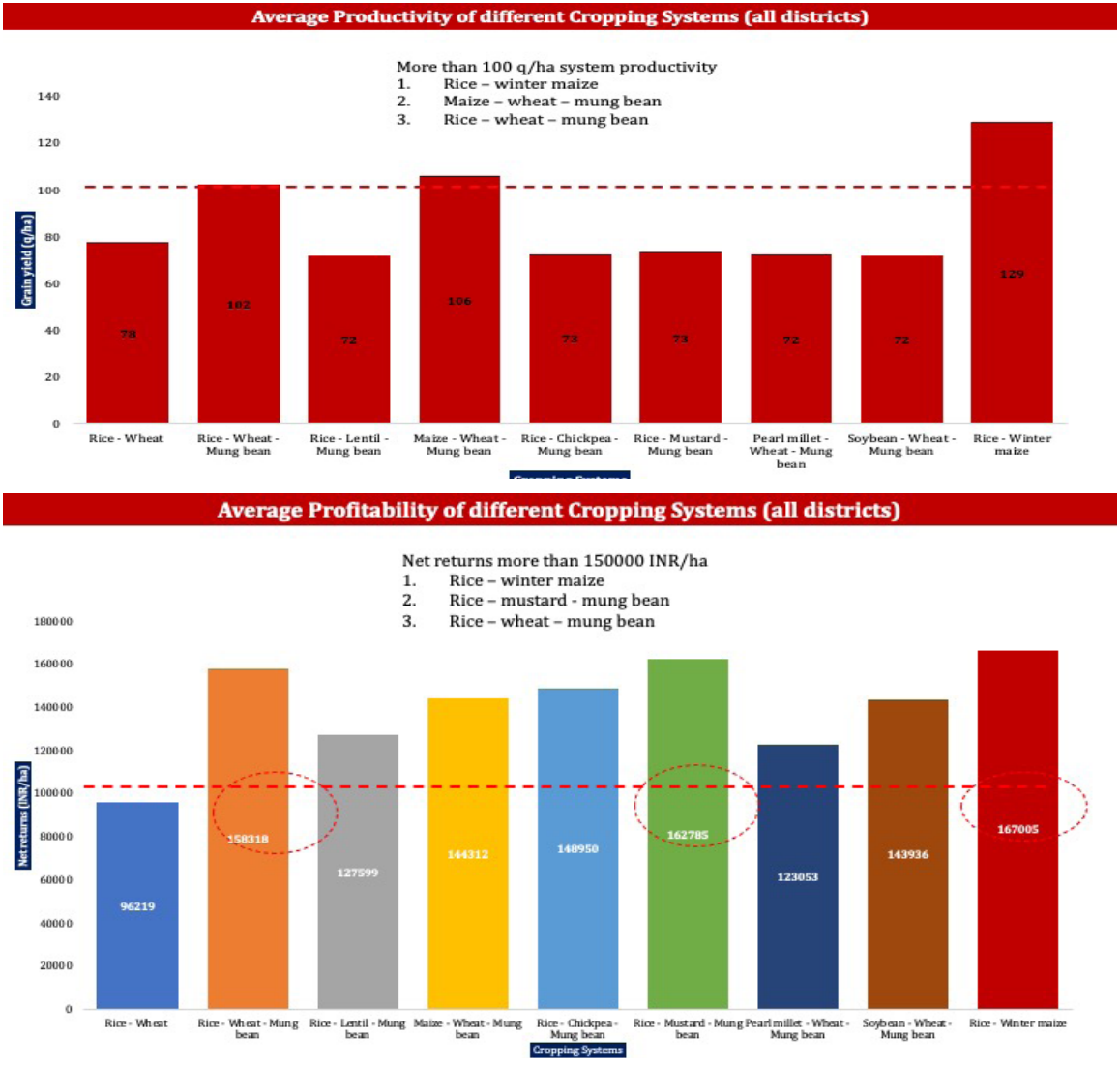
Table 3 *District wise change in cropping intensity*

District	Pre CRA	Post CRA	% change
Araria	220	225	5
Arwal	200	211	11
Aurangabad	206	231	25
Banka	149	198	49
Bhabua	128	189	61
Bhagalpur	202	261	59
Bhojpur	199	298	99
Gaya	239	298	59
Jamui	199	297	98
Jehanabad	200	206	6
Katihar	211	234	23
Khagaria	201	299	98
Kishanganj	199	199	0
Lakhisarai	198	224	26
Madhepura	258	289	31
Munger	188	243	55
Nalanda	207	261	54
Patna	205	278	73
Purnea	200	298	98
Rohtas	231	248	17
Saharsa	200	261	61
Sheikhpura	148	182	34
Supaul	238	293	55
Overall	201	249	48

5.2 Impact of CRA Interventions on System Productivity

As a result of various interventions, the farmers were able to realize multiple benefits from CRA technologies. These benefits include shift in cropping intensity, increase in cropping intensity, reduction in cost of cultivation, enhancement in resource use efficiency and increase in crop productivity. These benefits together have resulted in overall increase in net income earned from each of the crops and consequent improvement in overall system productivity. The improvement in system productivity can be estimated either in the farm of yield or in the form of profitability. The details of improvement in system productivity on the basis of yield and profitability are depicted below.

Fig. 5 *System productivity of different cropping systems*



5.3 Water Use Efficiency in Major Crops & Nutrient Status

The increasing extent of urbanization and industrialization, drastic changes in topography and drainage system coupled with irrational use of water bodies is resulting in reducing availability of water for agricultural purposes. While the intensive agriculture is consuming more water resources, at the same time shrinking water bodies are resulting in reduced availability of water for irrigation purpose. Therefore, in the days to come, it is expected that water availability for agricultural purposes is going to reduce further. To address this issue it is necessary to increase the water productivity and reduce consumption of water for agricultural purposes. To achieve this number of technological interventions were implemented under CRA.

Table 4 *District wise irrigation water saving under CRA Programme*

Sl. No.	District	mm equivalent	mm equivalent	Water saving (mm)	% water saving
1	Araria	750	525	240	32
2	Arwal	1106	875	256	23
3	Aurangabad	1068	700	392	37
4	Banka	1090	700	415	38
5	Bhabua	1090	700	415	38
6	Bhagalpur	920	700	240	26
7	Bhojpur	1090	700	415	38
8	Gaya	1430	1050	415	29
9	Jamui	920	700	240	26
10	Jehanabad	1423	1050	408	29
11	Katihar	920	700	240	26
12	Khagaria	750	525	240	32
13	Kishanganj	580	525	65	11
14	Lakhisarai	920	525	415	45
15	Madhepura	750	525	240	32
16	Munger	1090	525	590	54
17	Nalanda	1063	700	387	36
18	Patna	750	525	240	32
19	Purnea	750	525	240	32
20	Rohtas	881	525	375	43
21	Saharsa	580	350	240	41
22	Sheikhpura	954	616	359	38
23	Supaul	854	677	196	23
	Overall	**944.74**	**649.68**	**315.79**	**33.10**

Technological intervention:

- Alternate wetting and drying method of irrigation
- Better utilization of residual soil moisture through zero tillage
- In-situ water harvesting and field bunding
- Reducing water use of land preparation through DSR and zero tillage

Impact:

Water saving in rice crop cultivation:

The above-mentioned technological efforts have resulted in drastic reduction in water consumption in both rice and wheat crops. It was observed that in case of rice crop, the average number of irrigations have reduced from 5.23(~ 5) to 3.76 (~4). Further, the major irrigation water saving has occurred in the form of elimination of intensive water consumption which used to happen in the event of puddling. In addition to this, water saving has been be also achieved through need-based irrigation using alternate wetting and drying method. The average external water application through irrigation has reduced from 944.74 mm to 649.68 mm registering a saving of 33.10 % (315.79 mm).

The relatively higher amount of water saving was observed in districts like Munger, Banka, Bhabua, Gaya, Lakhisarai which are generally known for water scarcity. This also highlights the relative importance of CRA interventions in the water scare regions of the state. The district wise details of rice crop irrigation water requirement are mentioned in table 4 below.

Water saving in wheat crop cultivation:

The above-mentioned technological efforts have resulted in drastic reduction in water consumption in both wheat crop as well. It was observed that in case of wheat crop, the average number of irrigations have reduced from 3.51 (~ 4) to 2.98 (~3). Further, the major irrigation water saving has occurred in the form of elimination of water consumption which used to happen in the event of tillage followed by irrigation. The average external water application through irrigation has reduced from 507.7 mm to 446.5 mm registering a saving of 11.88 % (60.20 mm).

Fig. 6 *Amount of water applied through irrigation for rice crop cultivation in m hectare CRA Programme.*

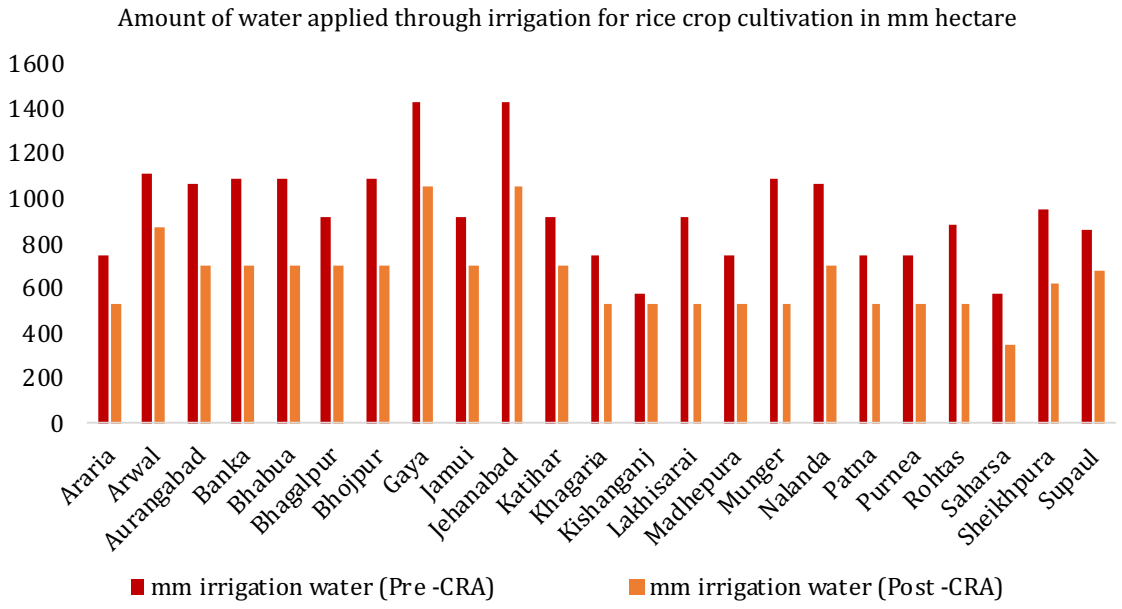
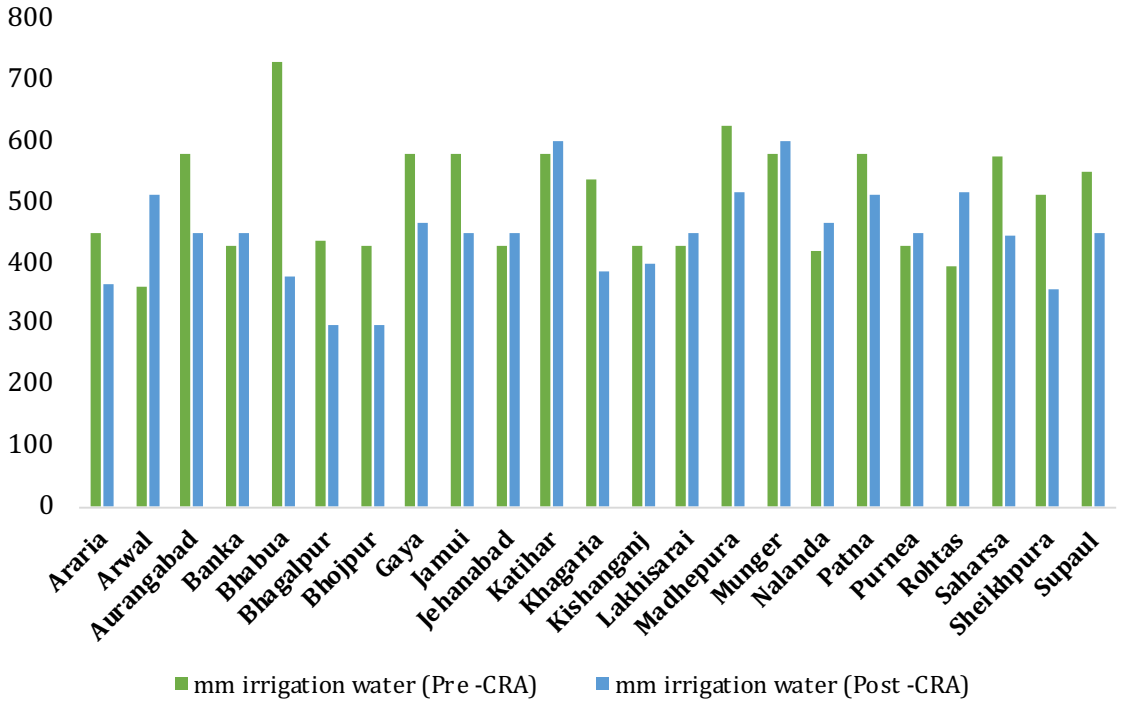


Fig. 7 *Amount of water applied through irrigation for Wheat crop cultivation in mm hectare*



5.4 Crop-Wise Impact of CRA Intervention on Cost of Cultivation, Resource Utilization and Agro-Economic Performance

5.4.1 RICE

Production problem: The major production problems in the rice based cropping system in Bihar include adoption of long duration varieties resulting in delayed harvesting of rice and consequent delay in sowing of wheat. Other problems include high irrigation water consumption; poor yields and extensive use of labour for crop establishment. Under the CRA programme, the following technological interventions were made to address these issues

Technological interventions:

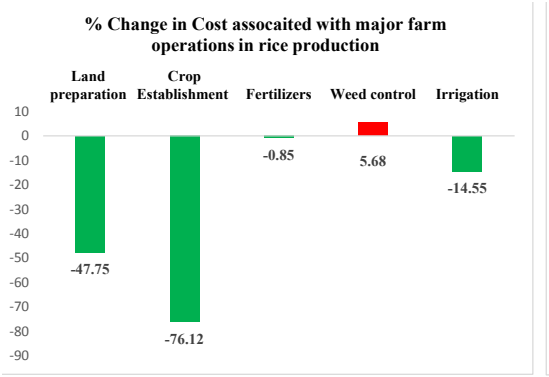
- Replacement of long duration rice with medium and short duration varieties
- Direct seeded rice cultivation instead of conventional transplanting
- Chemical weed management
- Use of high-quality farm inputs including seeds, fertilizers and agro-chemicals
- Replacement of conventional method of irrigation with alternate wetting and drying method
- Field bunding for water harvesting
- Use of nutrient expert, leaf colour chart and green seeker for efficient use of fertilizers

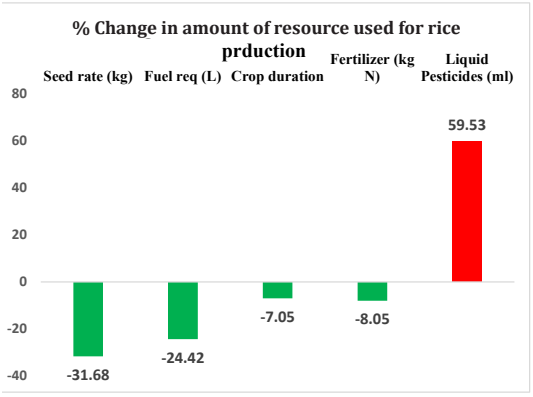
Impact:

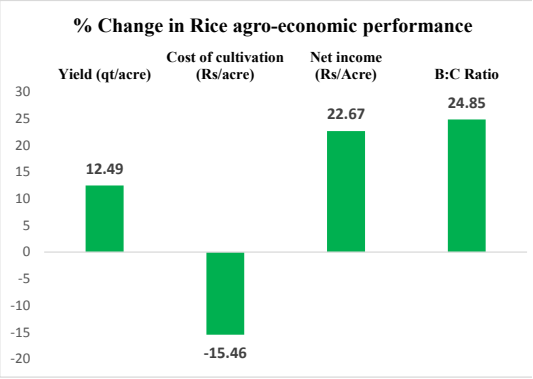
- **Cost of cultivation:** Rice production costs have significantly decreased as a result of the aforementioned interventions. For instance the cost associated with land preparation has declined by 47.75% (i.e. from 3415.1 to 1672.5 Rs./acre) and the cost related with crop establishment has declined by 76.12%. While, due to reduction in the number of irrigations, specifically with respect to land preparation activities, the cost related to field irrigation has dropped down by 14.55% (i.e. from 2534.28 to 2069.6 Rs./acre). Similarly, due to reduced use of nitrogenous fertilizers, the cost associated with procurement an application of fertilizers has dropped down by 0.85% (i.e. from 2295.39 to 2262.39 Rs./acre). Contrary to this, weed control costs have increased by 5.68% (i.e. from 1248.56 to 1123.44 Rs./acre). This drastic increase in weed control expenses can be attributed to the fact that, directed seeded rice is cultivated in aerobic condition which results in increased weed population as compared to anaerobic condition.
- Crop performance: The reduction in use of farm inputs and consequent reduction in cultivation costs has significantly contributed to an increase in net income from rice cultivation. Further, net income has also increased due to an increase in crop yields by 12% (i.e. from 16.09 to 18.10 q/acre). The overall net profit from rice cultivation has risen by 23% (i.e. 19197.77 to 23526.27 Rs./acre) whereas B:C Ratio has increased by 24.85% (i.e. from 2.17 to 2.71).
- **Resource use efficiency:** The reduction in cultivation costs can be attributed to the reduced requirement for farm production inputs. We observed that CRA project interventions have resulted in nearly 32% reduction in seed rate (i.e. from 17.6 to 12 kg/acre), 24% reduction in fuel consumption (i.e. from 31.7 to 24.0 lit/acre) and 8% decline in fertilizer use (i.e. from 62.1 to 57.1 kg/acre). It was observed that the overall decline in fertilizer consumption largely arises out of reduced use of nitrogenous fertilizers. In contrast, potash fertilizers has increased

significantly. While direct sowing of rice has resulted in saving of resources, adoption of medium duration rice has resulted in a decline in crop duration by 7.05% (i.e. 10-12 days). However as stated earlier, due to high weed intensity in aerobic DSR rice, the consumption of liquid pesticides has increased significantly as a result of which the pesticide consumption has increased sharply by 59.53% (i.e. from 593.5 to 956.8 ml/acre).

Fig. 8 *Impact of CRA intervention on cost of cultivation, resource utilization and agro-economic performance in Rice crop.*







Conventional rice crop establishment involving saturation of field with intensive irrigation and puddling using heavy machinery resulting in destruction of soil structure and sub soil compaction (below 15 cm depth)

Direct seeding of rice in the main field without puddling which eliminates need for irrigation and reduces fuel consumption for land preparation

Transplanting-the labour intensive, time consuming and costly method of rice crop establishment

Direct seeding of the rice using drum seeder – a cost effective and less labour requiring method of rice crop establishment

Low-cost DIY device installed for assisting implementing alternate wetting and drying method of rice crop irrigation which reduces crop water requirement

Field bunding- an effective and easy method of in-situ water conservation

Left: *The conventionally grown (PTR) long duration rice crop exhibiting poor crop establishment and lodging*
Right: *Medium duration crop cultivated implementing CRA interventions DSR with minimum lodging which will be ready for harvest prior to conventionally established rice crop*

5.4.2 WHEAT

Production problem: The major problems in wheat-based cropping systems include delayed sowing wheat resulting in long term exposure to terminal heat stress and consequent decline in yield. Adoption of conventional non-scientific cultivation practices including broadcasting of seed, indiscriminate fertilizer use, intensive tillage culminates in disturbance of soil structure. The use of heavy tillage machinery also results in compactness of sub-soil (i.e. below 15 cm) and subsequent increase in soil bulk density, reduced porosity and poor water percolation. Because of poor drainage and water percolation, crops often turn yellow post irrigation. To address these issues, the following technological interventions were promoted under CRA for wheat cultivation

Technological interventions:

- Replacement conventional varieties with abiotic stress resistance varieties
- Zero till sowing of wheat
- Raised bed sowing
- Efficient use of nutrients through nutrient expert/green seeker/leaf colour chart

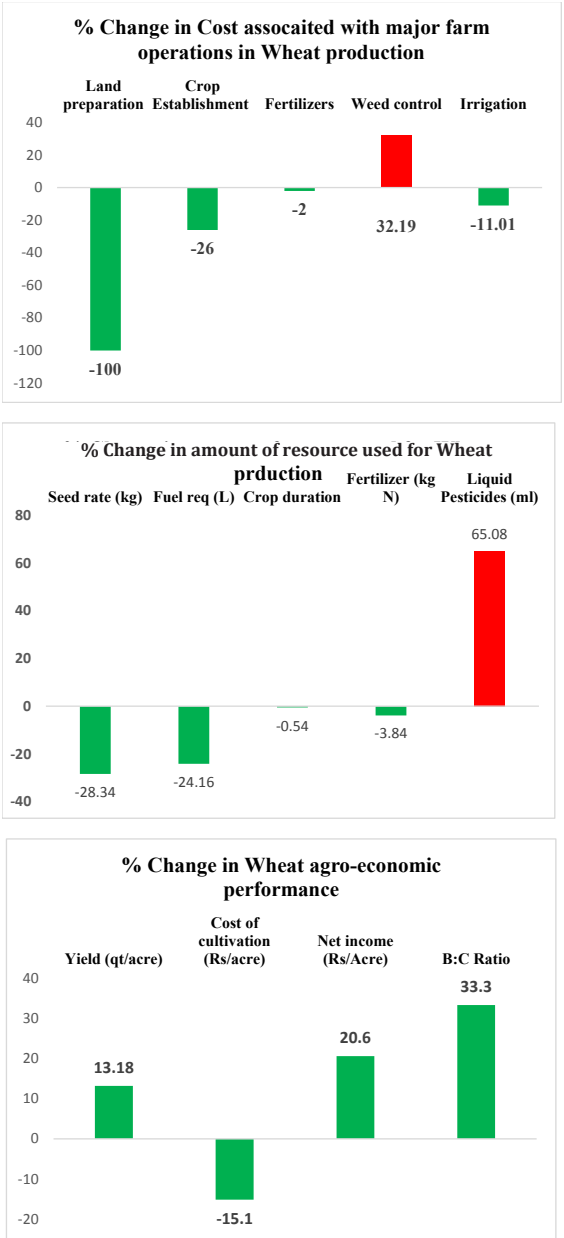
Impact

- Cost of cultivation: In wheat crop the major intervention was a change in the method of crop establishment. Conventional land preparation and sowing methods have been replaced with zero till direct sowing of wheat. As a result of this technological intervention the cost associated with land preparation has been eliminated 100% whereas the cost associated with sowing has been reduced by 26% (i.e. from 1371 to 878 Rs./acre) whereas the cost of fertilizer application has been reduced by 2% (i.e. from 2373 to 2255 Rs./acre) and 11 % (i.e. from 2284 to 2033 Rs./acre) cost saving was observed in case of irrigation management. Contrary to this, weed control costs have increased by 32% (i.e. from 693 to 917 ml/acre). This drastic increase in the weed control operations can be attributed the fact that, the due to absence of tillage operation after harvest rice crop, the weed population remains high which demands higher investment for chemical weed management. However, after 2-3 cycles of zero-till wheat cultivation, the problem of high weed intensity subsides. In the long run,

it is expected that the cost of weed control will also reduce proportionally.

- Resource use efficiency: The reduction in cultivation costs can also be attributed to the reduction in consumption of farm production inputs. It was observed that in case of zero till wheat crop the seed rate has declined by 28% (i.e. from 56.4 to 40.5 kg/acre) whereas the fuel consumption has reduced by 24% (i.e. from 33.3 to 25.3 lit./acre) and the crop duration has reduced slightly by 0.54% (~ 1 days). In wheat too, chemical pesticide use has increased drastically by 65 percent (i.e. from 511.4 to 844.2 ml/acre), similar to rice. This increase can be attributed to the fact that, under the CRA programme the chemical method of weed control has been promoted intensively.
- Crop Performance: Farmers in the project area realized better crop performance owing to reduction in cultivation costs, early sowing of crops and reduced irrigation need. It was observed that due to reduced exposure to terminal heat stress the wheat crop yield has increased by 13% (i.e. from 14.03 to 15.88 q/acre). Coupled with the yield increase, the reduction in cultivation costs has resulted in a 21% (i.e. from 16157 to 19478 Rs./ acre) increment in net income from wheat cultivation. While the B:C ratio has increased by 33% (i.e. from 1.96 to 2.61).

Fig. 9 Impact of CRA intervention on cost of cultivation, resource utilization and agro-economic performance in Wheat.



Conventional wheat broadcasting followed by the soil tillage after harvest of rice

Early sowing of wheat directly in rice harvested field with zero tillage using residual moisture

Wheat sown on raised beds for enhanced water use efficiency and crop productivity

Farmers using leaf colour chart for making nutrient application related decisions

Conventionally established wheat crop on 30th March and not yet ready to harvest and exposed to terminal heat stress at grain filling stage

Zero till established wheat crop on 30th March and ready to harvest escaping from terminal heat stress exposure

5.4.3 MAIZE

Production problem:

Maize is a major rabi crop, especially in the Tal and Diara regions. In many of the regions, the maize productivity is very high and better than national average. However, there still exist number of production constraints with respect to maize crop in the state. This includes excessive soil moisture, nutrient deficiency especially with respect to potassium, high crop-weed competition and crop diseases and pests viz. stem rot, army worm, fall army worm etc.

Technological interventions:

To address these production problems following interventions were promoted under CRA.

Raised bed planting of maize crop

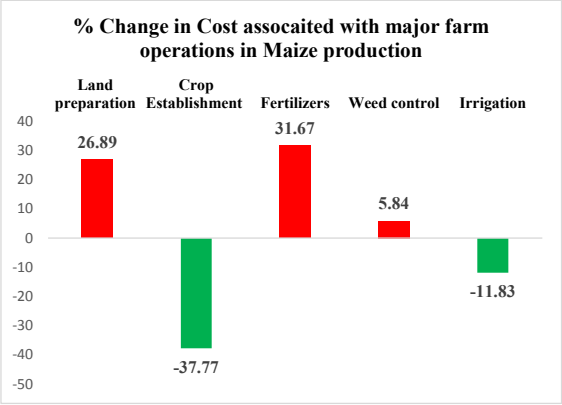
- Cost of cultivation: In maize crop the major intervention was change from sowing of maize crop after 2-3 ploughing of field by broadcasting method or line sowing have been replaced with raised bed sowing and zero tillage sowing of maize crop. As a result of this technological intervention the cost associated with land preparation, fertilizer application and weed control is increased by 26.89%, 31.67% and 5.84%, (i.e. from 2027 to 2572, 3354 to 3503, 1073 to 1135 Rs./acre) respectively. The reason behind increase in cost of cultivation is preparation of raised bed after land preparation and extra herbicide application for weed management germinated on raised bed. However, cost involved in crop establishment and irrigation cost is reduced by 37.77% and 11.83%, (i.e. from 2313 to 1441 and 3620 to 3149 Rs. /acre) respectively. Establishment cost was reduced due to use of machine for establishment while in conventionally maize sowing was done by farmers manually and irrigation cost also reduced due to irrigation practiced in furrow, so it takes very less time and irrigation water.
- Crop Performance: Sowing of crop with raised bed technology is very cost effective which improved the economics of farmers. Since, initial cost of land preparation and fertilizer is more but because of better conditions developed there is considerable improvement in grain yield (13.99%) (i.e. from 31.02 to 35.6 q./acre) consequently improvement in net income and B:C ratio by 48.13% and 31.78%, (i.e. from 27571.6 to 40842.65 Rs. /acre) respectively.

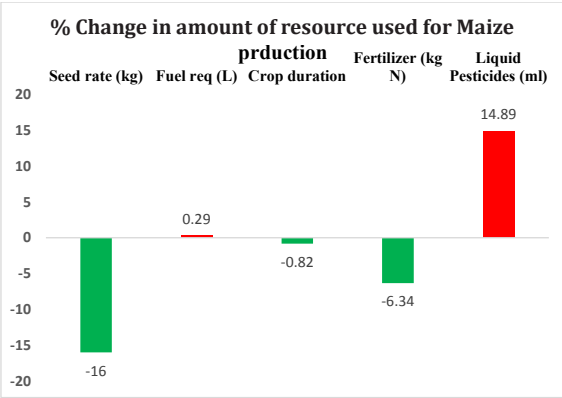
Resource use efficiency:

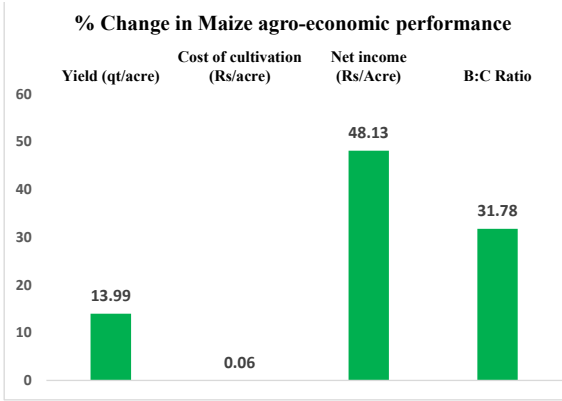
The amount of different resources used in maize production also varied in which seed rate, crop duration and fertilizer requirement reduced by 16%, 0.82% and 6.34% respectively while requirement of fuel increased by 0.29%. (i.e. from 40 to 41 lit/acre).


SEED
NATIONAL
RAISED BED PLANTER

Fig. 10 *Impact of CRA intervention on cost of cultivation, resource utilization and agro-economic performance in Maize*







5.4.4 LENTIL

Production Problem:

Lentil being an important pulse crop is mainly challenged by lack of input investment and variable weather conditions. The crop is also vulnerable to different abiotic and biotic stress occurring during the crop growing period. Other production constraints faced by farmers are inadequate knowledge of recommended package of practices, lack of good quality and high yielding variety seed, lack of drought and heat tolerant varieties with multiple disease resistance, non-adoption of short duration varieties for rice based systems, lack of knowledge on advanced production technologies, trade-offs related to higher production costs and lower crop productivity, improper plant protection measures and weed management and poor quality land use.

Technological interventions:

- Promotion of high yielding and early maturing varieties
- Zero till crop sowing to ensure timely sowing of crop
- Promotion of scientific crop production and crop protection practices
- Scientific nutrient and water management

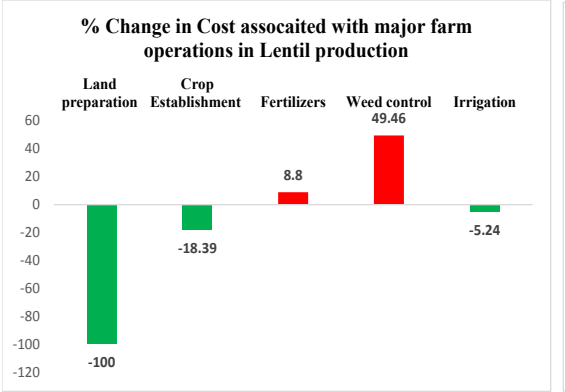
Impact:

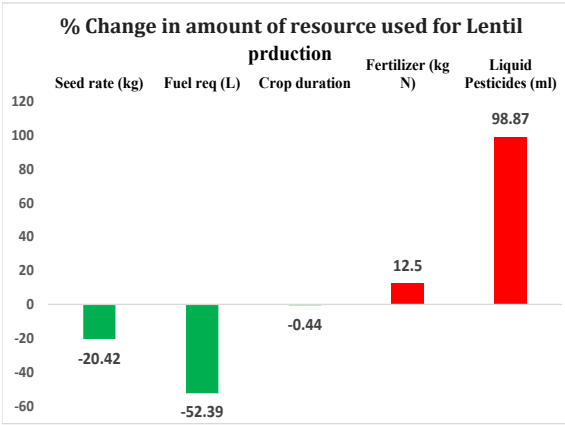
- Cost of cultivation: Similar to wheat crop, in lentil crop as well, the zero tillage was able to bring about significant reduction in cost of cultivation by the way of reducing cost associated with land preparation. The cost of land preparation has been reduced by 100% (i.e. from 1750 to 0 Rs. /acre) whereas the cost of crop establishment and irrigation have been reduced by 18.39% (i.e. from 858 to 700 Rs./ acre) and 5.24% (i.e. from 587 to 557 Rs. /acre), respectively. However, the

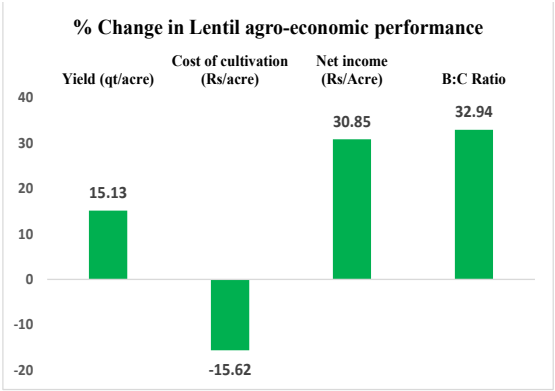
cost associated with nutrient management and weed control have increased by 8.8% (i.e. from 671 to 730 Rs./ acre) and 49.46% (i.e. from 429 to 641 Rs. /acre), respectively.

- Resource utilization: In lentil, crop sown with zero tillage technology has reduced seed requirement by 20.42% (i.e. from 21 to 17 kg/acre), and the fuel consumption has gone down by 52.39% (i.e. from 23 to 11 lit/acre). However no significant change was observed with respect to crop duration. Whereas the consumption of fertilizers has increased by 12.5% (i.e. from 9 to 10 kg/acre) Similarly, the pesticide –especially herbicide – consumption has increased drastically by 98.87% (i.e. from 295 to 587 ml/acre).
- Agroeconomic performance: The zero till cultivation of lentil has not only reduced the cost of cultivation but also was able to increase the crop yield, net income and B:C ratio by 15.13% (i.e. from 4.41 to 5.07 q/ acre), 30.85% (i.e. from 16098 to 21064.44 Rs./ acre) and 32.94% (i.e. from 2.47 to 3.28) respectively. The overall cost of cultivation has reduced by 15.62% (i.e. from 11554.89 to 9750 Rs./ acre).

Fig. 11 *Impact of CRA intervention on cost of cultivation, resource utilization and agro-economic performance in Lentil*







5.5.5 MUSTARD

Production Problem:

Mustard is one of the major oilseed crops produced in India. Mustard accounts for the second highest contribution of oilseed production and area. In the production process of mustard one of the major aspects associated is the processing of the oilseed. This concerns the market functionaries, oil mill owners and from the consumer point of view. Among the various production constraints associated with the mustard crop are lack of availability of quality seed, non-adoption of short duration high yielding varieties, instability in yield due to different biotic stresses like blight, rust and aphids and abiotic stress like drought and frost, knowledge of recommended seed rate and seed treatment, lack of knowledge about importance of use of Phosphorus Solubilizing bacteria, sulphur and micronutrients that enhance mustard productivity, limited accessibility of farmers to proper weed control methods/ chemicals and advanced production technologies.

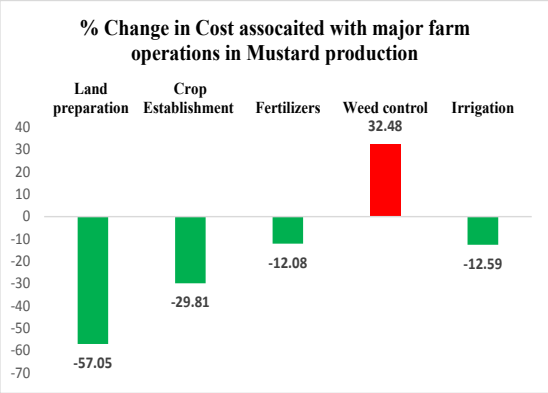
Technological Interventions:

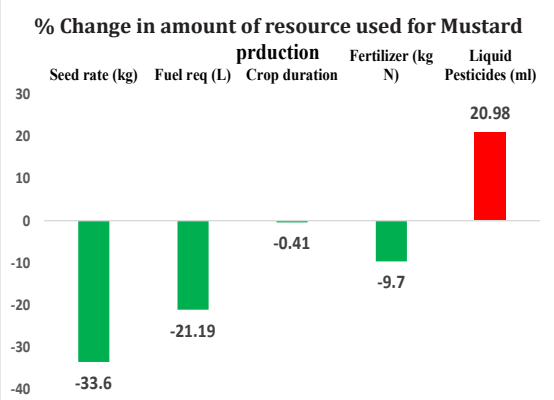
- Zero till sowing of mustard crop
- Promotion of suitable crop varieties
- Efficient nutrient management, with special emphasis on phosphorous and micro-nutrients management
- Promotion of scientific weed management practices and disease insect control measures

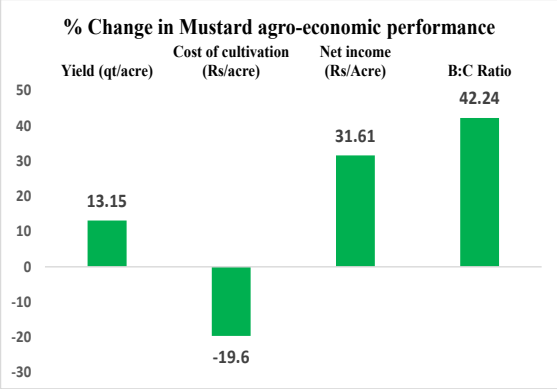
Impact

- Cost of cultivation: Similar to wheat and lentil crops, mustard crops as well, zero tillage and raised bed cultivation brought about significant reduction in the cost of cultivation by reducing cost associated with land preparation. The cost of land preparation has been reduced by 57.05% (i.e. from 1711 to 735 Rs./acre) whereas the cost of crop establishment and irrigation have been lowered by 29.81% (i.e. from 1312 to 921 Rs./acre) and 12.59% (i.e. from 1187 to 1037), respectively. Contrary to lentil and wheat, in case of mustard crop, the cost of nutrient management has dropped down by 12.08% (i.e. from 706 to 621 Rs./acre). There has been a 32.48% increase in weed management costs in mustard produce (i.e. from 225 to 298 Rs./acre) owing to the absence of tillage, requiring heavy investments in weed control.
- Resource utilization: In lentil, crop sown with zero tillage technology has reduced seed requirement by 33.6% (i.e. from 3 to 2 kg/acre), and the fuel consumption has gone down by 21.19% (i.e. from 21 to 16 lit/acre). However no significant change was observed in crop duration. While fertilizer consumption has increased by 9.7% (i.e. from 39 to 35 kg/acre). Similar to other zero till sown crops, mustard also has increased pesticide consumption by 20.98% (i.e. from 240 to 290 ml/acre).
- Farmers in the project area realized better crop performance owing to reduction in cultivation costs, early sowing of crop and reduced need for irrigation. It was observed that mustard crop yield has increased by 13.15% (i.e. from 3.82 to 4.33 q/acre) and cultivation cost has decreased by 19.6% (i.e. from 7411 to 5958.79 Rs./acre). Mustard cultivation net income has increased by 31.61% (i.e. from 16898 to 22239.26 Rs./acre).

Fig. 12 *Impact of CRA intervention on cost of cultivation, resource utilization and agro-economic performance in Mustard*







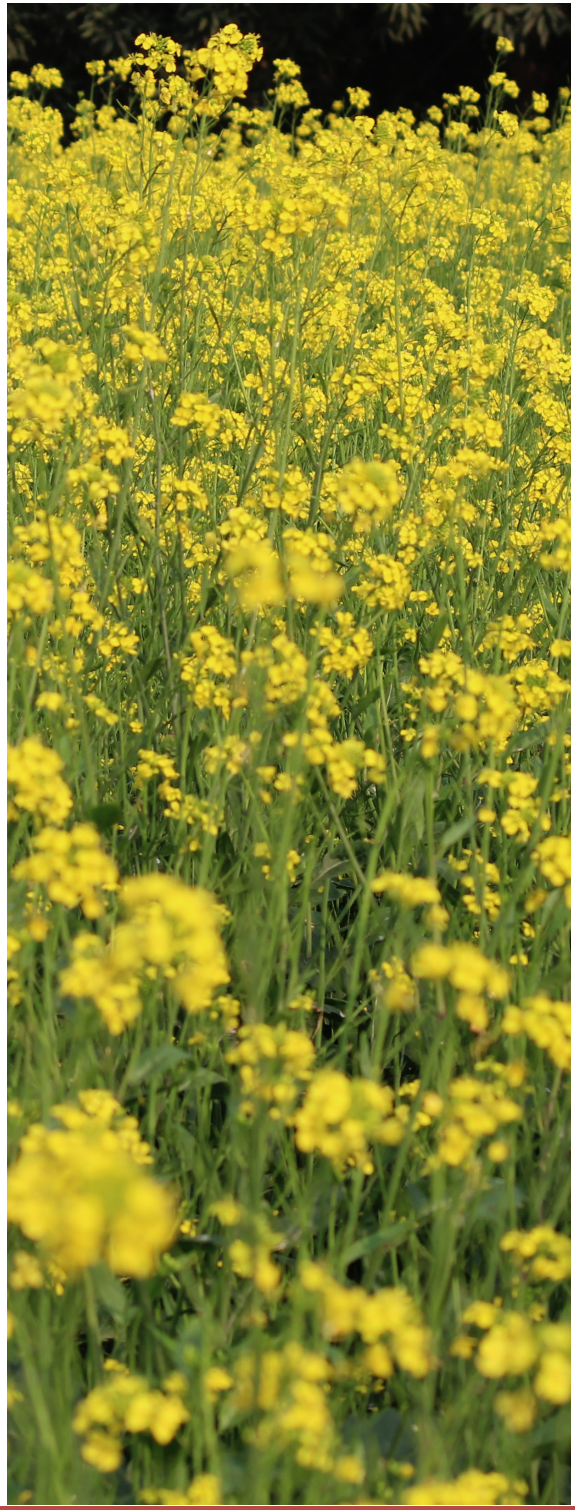


Table: 5 *Expenses on major farm operations in Rice*

KVK	Land preparation			Crop Establishment			Fertilizers			Weed control			Irrigation		
	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change
Araria	3580	1450	-59.50	5818	1350	-76.80	3310	2960	-10.57	864	1211	40.16	1642	1468	-10.60
Arwal	3250	2150	-33.85	7000	1350	-80.71	3600	2870	-20.28	650	534	-17.85	4142	3101	-25.13
Aurangabad	2870	1330	-53.66	6150	1290	-79.02	3215	2240	-30.33	1250	1000	-20.00	2426	2374	-2.14
Banka	2540	1400	-44.88	6085	2000	-67.13	3190	2975	-6.74	1500	1453	-3.13	2585	1535	-40.62
Bhabua	2820	1650	-41.49	5625	1575	-72.00	1560	1255	-19.55	350	444	26.86	2300	1500	-34.78
Bhagalpur	4463	2100	-52.95	6150	1145	-81.38	3612	2827	-21.73	882	1341	52.04	5675	3740	-34.10
Bhojpur	2350	1700	-27.66	6250	1450	-76.80	1645	1553	-5.59	600	800	33.33	2100	1680	-20.00
Gaya	2930	1380	-52.90	7000	1500	-78.57	2803	3116	11.17	1380	1058	-23.33	2050	1125	-45.12
Jamui	2925	1500	-48.72	5000	1400	-72.00	3200	3100	-3.13	1197	1785	49.12	2600	2000	-23.08
Jehanabad	3830	2160	-43.60	6820	1550	-77.27	1150	929	-19.22	2490	1490	-40.16	3000	2850	-5.00
Katihar	4600	1500	-67.39	6400	1200	-81.25	1400	1700	21.43	400	550	37.50	2000	1200	-40.00
Khagaria	4150	2000	-51.81	5975	1450	-75.73	1992	2294	15.16	1004	1234	22.91	1780	2000	12.36
Kishanganj	3460	2020	-41.62	5500	2000	-63.64	2224	2310	3.87	558	666	19.35	2089	2200	5.31
Lakhisarai	2330	1685	-27.68	6400	1500	-76.56	1645	1596	-2.98	587	700	19.25	2330	1940	-16.74
Madhepura	6750	1660	-75.41	5850	1150	-80.34	3430	2975	-13.27	763	1372	79.82	3000	1500	-50.00
Munger	2150	1475	-31.40	5100	1000	-80.39	2374	1916	-19.29	2011	1057	-47.44	4400	3500	-20.45
Nalanda	2710	1800	-33.58	5450	1200	-77.98	2556	2235	-12.56	1207	654	-45.82	2635	3000	13.85
Patna	2840	1700	-40.14	5800	1900	-67.24	2700	3050	12.96	900	652	-27.56	2381	1579	-33.68
Purnea	3575	1150	-67.83	5650	1200	-78.76	2002	2400	19.88	2000	1665	-16.75	1458	1921	31.76
Rohtas	3290	1650	-49.85	6275	1700	-72.91	2270	2600	14.54	2876	1770	-38.46	2160	1950	-9.72
Saharsa	3250	1440	-55.69	6550	1445	-77.94	1829	1265	-30.84	1808	1491	-17.53	4055	3142	-22.52
Sheikhpura	2880	1685	-41.49	5550	1200	-78.38	2040	1930	-5.39	550	900	63.64	776	610	-21.39
Supaul	2990	1500	-49.83	6850	1850	-72.99	2445	2927	19.71	1261	1037	-17.76	1128	1316	16.67
Overall	**3415.17**	**1672.50**	**-47.75**	**6031.67**	**1435.56**	**-76.12**	**2295.39**	**2262.39**	**-0.85**	**1248.56**	**1123.44**	**5.68**	**2534.28**	**2069.61**	**-14.55**

Table: 6 *Agro-economic performances in Rice*

KVK	Yield (qt/acre)			Cost of cultivation (Rs/acre)			Net income (Rs/Acre)			B:C Ratio		
	Pre-CRA	Post-CRA	% change	Pre-CRA	Post-CRA	% change	Pre-CRA	Post-CRA	% change	Pre-CRA	Post-CRA	% change
Araria	16.2	18.1	11.73	15392	13304	-13.57	21005	25762	22.65	2.36	2.94	24.18
Arwal	18.6	19.3	3.76	24733	19871	-19.66	13177	15484	17.51	1.53	1.78	16.08
Aurangabad	17.4	18	3.45	15032	11790	-21.57	29732	32761	10.19	2.98	3.78	26.89
Banka	15.6	17.1	9.62	15175	12871	-15.18	15551	16992	9.27	2.02	2.32	14.59
Bhabua (Kaimur)	16.5	18	9.09	17119	15955	-6.80	14884	18119	21.73	1.87	2.14	14.24
Bhagalpur	17.7	21.1	19.21	22639	18685	-17.47	16560	19464	17.54	1.73	2.04	17.92
Bhojpur	11.2	13.4	19.64	14112	10731	-23.96	21739	27244	25.32	2.54	3.54	39.30
Gaya	16	18.8	17.50	15402	12557	-18.47	19657	23863	21.40	2.28	2.90	27.42
Jamui	14.2	15.5	9.15	16107	12848	-20.23	20165	24810	23.03	2.25	2.93	30.16
Jehanabad	12.3	13.4	8.94	12532	9468	-24.45	15609	21050	34.86	2.25	3.22	43.54
Katihar	14.3	16.4	14.69	15400	13200	-14.29	19100	23800	24.61	2.24	2.80	25.12
Khagaria	15.7	17.8	13.38	10317	9100	-11.80	21730	28339	30.41	3.11	4.11	32.45
Kishanganj	18.8	20.4	8.51	17039	15193	-10.83	24049	30440	26.57	2.41	3.00	24.56
Lakhisarai	16.5	18.4	11.52	18540	16140	-12.94	19810	22720	14.69	2.07	2.41	16.40
Madhepura	13.6	15.8	16.18	22910	17678	-22.84	15745	18606	18.17	1.69	2.05	21.65
Munger	15.7	18.6	18.47	18289	16224	-11.29	14817	19011	28.31	1.81	2.17	19.98
Nalanda	12.1	14.2	17.36	14656	12922	-11.83	16372	20486	25.13	2.12	2.59	22.12
Patna	15	17	13.33	14969	13353	-10.80	15811	20476	29.50	2.06	2.53	23.21
Purnea	17.6	17.8	1.14	14562	11832	-18.75	21453	24192	12.77	2.47	3.04	23.10
Rohtas	24.7	28.1	13.77	25685	22625	-11.91	24771	31748	28.17	1.96	2.40	22.34
Saharsa	16.8	20.5	22.02	18442	16025	-13.11	18658	23667	26.85	2.01	2.48	23.12
Sheikhpura	12.3	14.5	17.6	19100	22190	16.1	19657	23868	21.5	1.51	1.76	16.3
Supaul	17.4	20.4	17.24	21578	19400	-10.09	21956	28544	30.01	2.02	2.47	22.49
Overall	**16.09**	**18.10**	**12.49**	**17301.36**	**14626.00**	**-15.46**	**19197.77**	**23526.27**	**22.67**	**2.17**	**2.71**	**24.85**

Table: 7 *Resource utilization in Rice*

KVK	Seed rate (kg)			Fuel req (L)			Crop duration			Fertilizer (kg N)			Liquid Pesticides (ml)		
	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change
Araria	18	13	-27.78	37	24	-35.14	143	139	-2.80	86	88	2.33	750	2000	166.67
Arwal	12	12	0.00	65	50	-23.08	140	135	-3.57	49	50	2.04	1000	1500	50.00
Aurangabad	13	9	-30.77	16	12	-25.00	149	138	-7.38	56	42	-25.00	600	1120	86.67
Banka	20	12	-40.00	18	12	-33.33	145	134	-7.59	60	50	-16.67	250	1250	400.00
Bhabua	12	10	-16.67	24	12	-50.00	127	123	-3.15	48	45	-6.25	750	500	-33.33
Bhagalpur	19	13	-31.58	18	12	-33.33	146	135	-7.53	41	40	-2.44	800	1250	56.25
Bhojpur	15	10	-33.33	39	41	5.13	153	139	-9.15	20	32	60.00	200	400	100.00
Gaya	35	10	-71.43	20	16	-20.00	142	130	-8.45	58	48	-17.24	2130	1750	-17.84
Jamui	16	12	-25.00	19	12	-36.84	155	130	-16.13	55	40	-27.27	100	80	-20.00
Jehanabad	13	10	-23.08	34	19	-44.12	150	137	-8.67	53	32	-39.62	625	700	12.00
Katihar	20	12	-40.00	40	22	-45.00	145	136	-6.21	100	100	0.00	1000	2100	110.00
Khagaria	18	12	-33.33	30	27	-10.00	145	132	-8.97	125	120	-4.00	50	300	500.00
Kishanganj	20	17	-15.00	31	30	-3.23	144	133	-7.64	45	46	2.22	200	250	25.00
Lakhisarai	20	12	-40.00	40	22	-45.00	145	140	-3.45	100	100	0.00	1000	2100	110.00
Madhepura	12	13	8.33	22	16	-27.27	135	124	-8.15	68	90	32.35	500	200	-60.00
Munger	12	12	0.00	67	50	-25.37	146	134	-8.22	47	42	-10.64	840	577	-31.31
Nalanda	17	12	-29.41	32	35	9.38	137	131	-4.38	61	47	-22.95	127	116	-8.66
Patna	30	15	-50.00	27	21	-22.22	144	134	-6.94	64	79	23.44	150	120	-20.00
Purnea	13	12	-7.69	27	28	3.70	137	129	-5.84	50	33	-34.00	688	976	41.86
Rohtas	10	12	20.00	32	24	-25.00	161	152	-5.59	69	53	-23.19	40	1250	3025.0
Saharsa	13	10	-23.08	20	16	-20.00	153	144	-5.88	51	47	-7.84	850	1037	22.00
Sheikhpura	30	12	-60.00	28	18	-35.71	144	132	-8.33	60	45	-25.00	750	1700	126.67
Supaul	16	14	-12.50	43	32	-25.58	148	138	-6.76	63	45	-28.57	250	500	100.00

Table: 8 *Expenses on major farm operations in Wheat:*

KVK	Land preparation			Crop Establishment			Fertilizers			Weed control			Irrigation		
	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change
Araria	3215	0	-100.00	1118	1000	-10.55	4322	3306	-23.51	976	1656	69.67	2198	1964	-10.65
Arwal	2240	0	-100.00	600	700	16.67	3628	3140	-13.45	68	1000	1370.59	1764	1338	-24.15
Aurangabad	2300	0	-100.00	1350	700	-48.15	2712	2374	-12.46	691	793	14.76	2472	2272	-8.09
Banka	2000	0	-100.00	2300	700	-69.57	2500	2080	-16.80	1000	1000	0.00	1486	1486	0.00
Bhabua	1750	0	-100.00	1200	700	-41.67	1281	1530	19.44	102	411	302.94	0	0	0
Bhagalpur	3000	0	-100.00	1360	850	-37.50	1548	1891	22.16	0	552	NA*	2260	1701	-24.73
Bhojpur	2100	0	-100.00	600	800	33.33	1880	2453	30.48	603	600	-0.50	1600	1200	-25.00
Gaya	2170	0	-100.00	1680	1000	-40.48	1968	2410	22.46	821	945	15.10	2437	2009	-17.56
Jamui	2480	0	-100.00	800	1200	50.00	3200	2500	-21.88	800	1500	87.50	2800	2400	-14.29
Jehanabad	3220	0	-100.00	800	800	0.00	1700	1544	-9.18	690	890	28.99	0	0	NA*
Katihar	1800	0	-100.00	1600	850	-46.88	1600	1600	0.00	500	800	60.00	1900	1600	-15.79
Khagaria	2990	0	-100.00	1225	700	-42.86	3013	2949	-2.12	1192	1190	-0.17	0	0	0
Kishanganj	2110	0	-100.00	1571	700	-55.44	1812	1902	4.97	691	880	27.35	1925	2307	19.84
Lakhisarai	2075	0	-100.00	1150	700	-39.13	1754	1500	-14.48	575	584	1.57	1523	1173	-22.98
Madhepura	3530	0	-100.00	1790	900	-49.72	2255	2330	3.33	0	750	NA*	6000	4500	-25.00
Munger	2085	0	-100.00	1930	1000	-48.19	2864	2534	-11.52	1359	826	-39.22	3892	5477	40.72
Nalanda	2125	0	-100.00	1355	1000	-26.20	2443	2074	-15.10	0	649	NA*	1072	1156	7.84
Patna	2025	0	-100.00	1180	950	-19.49	2561	2470	-3.55	753	1055	40.11	4500	4000	-11.11
Purnea	3120	0	-100.00	800	1050	31.25	2409	2818	16.98	900	1531	70.11	2409	1877	-22.08
Rohtas	2750	0	-100.00	2616	1000	-61.77	2425	2200	-9.28	2277	969	-57.44	1888	1305	-30.88
Saharsa	2340	0	-100.00	900	750	-16.67	2022	1716	-15.13	1023	801	-21.70	3694	2741	-25.80
Sheikhpura	1980	0	-100.00	1680	850	-49.40	2040	1704	-16.47	0	595	NA*	639	454	-28.95
Supaul	2480	0	-100.00	1290	1130	-12.40	3356	3093	-7.84	1019	1419	39.25	2192	2556	16.61
Overall	**2416**	**0**	**-100.00**	**1371**	**878**	**-26**	**2373**	**2255**	**-2**	**693**	**917**	**32.19**	**2284**	**2033**	**-11.01**

Table: 9 *Agro-economic performances in Wheat*

KVK	Yield (qt/acre)			Cost of cultivation (Rs/acre)			Net income (Rs/Acre)			B:C Ratio		
	Pre-CRA	Post-CRA	% change	Pre-CRA	Post-CRA	% change	Pre-CRA	Post-CRA	% change	Pre-CRA	Post-CRA	% change
Araria	14.3	16.8	17.48	15736	13415	-14.75	15652	20285	29.6	1.93	2.66	37.8
Arwal	15.1	15.6	3.31	17030	14952	-12.20	16058	17198	7.1	1.88	2.22	17.7
Aurangabad	13.5	14.8	9.63	13481	10972	-18.61	16207	19478	20.2	2.13	2.87	34.7
Banka	12.9	15	16.28	14688	12278	-16.41	14725	18597	26.3	1.87	2.60	39.1
Bhabua	11.9	14	17.65	14990	13597	-9.29	11298	15153	34.1	1.69	2.19	29.7
Bhagalpur	13.4	14.78	10.30	13452	11523	-14.34	16023	18885	17.9	2.12	2.73	28.8
Bhojpur	11.4	12.9	13.16	12026	10374	-13.74	13199	16039	21.5	2.01	2.64	31.2
Gaya	12.8	14.3	11.72	14176	11050	-22.05	14024	18338	30.8	1.92	2.75	43.3
Jamui	12.5	14.2	13.60	14679	11700	-20.29	13584	17475	28.6	1.81	2.58	42.5
Jehanabad	13.2	13.8	4.55	12828	10524	-17.96	16222	17801	9.7	2.19	2.79	27.4
Katihar	13.8	15.6	13.04	14300	12100	-15.38	16025	20050	25.1	2.05	2.74	33.6
Khagaria	15.9	16.6	4.40	12044	10195	-15.35	22744	24080	5.9	2.81	3.46	23.3
Kishanganj	15.5	17.1	10.32	16839	15088	-10.40	17099	20250	18.4	1.96	2.41	23.1
Lakhisarai	14.2	16.2	14.08	15080	13133	-12.91	16095	20292	26.1	2.00	2.62	31.0
Madhepura	15.5	17.4	12.26	18374	15418	-16.09	15564	20557	32.1	1.79	2.40	33.8
Munger	11.8	14.7	24.58	18268	15793	-13.55	12807	14445	12.8	1.37	1.98	44.1
Nalanda	13.4	14.7	9.70	13967	11410	-18.31	15508	18828	21.4	2.04	2.74	34.3
Patna	16	18.6	16.25	15698	13727	-12.56	19302	24798	28.5	2.17	2.88	32.9
Purnea	18.8	22.1	17.55	16195	13244	-18.22	27706	29768	7.4	2.47	3.55	43.7
Rohtas	14.1	17	20.57	19096	16274	-14.78	15867	18851	18.8	1.57	2.22	41.5
Saharsa	14.4	15.9	10.42	17089	14775	-13.54	14511	18013	24.1	1.79	2.29	27.7
Sheikhpura	11.2	12.7	13.2	12044	10195	15.7	16200	19470	20.3	1.95	2.40	23.1
Supaul	14.3	17.3	20.98	19156	16433	-14.21	15232	19330	26.9	1.59	2.24	41.0
Overall	**14.03**	**15.88**	**13.18**	**15417.82**	**13089.77**	**-15.10**	**16157**	**19478**	**20.6**	**1.96**	**2.61**	**33.3**

Table: 10 *Resource utilization in Wheat*

KVK	Seed requirement (kg)			Fuel req (L)			Crop duration			Fertilizer (kg N)			Liquid Pesticides (ml)		
	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change
Araria	50	40	-20.00	38	30	-21.05	126	125	-0.79	98	101	3.06	1400	1160	-17.14
Arwal	60	42	-30.00	53	40	-24.53	125	125	0.00	51	52	1.96	0	650	100
Aurangabad	58	44	-24.14	29	18	-37.93	132	135	2.27	56	47	-16.07	0	14	100
Banka	58	40	-31.03	18	12	-33.33	135	135	0.00	60	50	-16.67	250	250	0.00
Bhabua	47	40	-14.89	25	18	-28.00	127	127	0.00	55	47	-14.55	800	15	-98.13
Bhagalpur	62	42	-32.26	52	42	-19.23	136	132	-2.94	80	76	-5.00	750	1015	35.33
Bhojpur	60	45	-25.00	39	42	7.69	140	140	0.00	30	48	60.00	0	1515	100
Gaya	69	35	-49.28	20	15	-25.00	135	135	0.00	55	48	-12.73	1750	1014	-42.06
Jamui	60	40	-33.33	28	17	-39.29	130	130	0.00	60	55	-8.33	1000	1250	25.00
Jehanabad	54	40	-25.93	34	21	-38.24	130	125	-3.85	73	48	-34.25	465	300	-35.48
Katihar	60	40	-33.33	33	30	-9.09	125	123	-1.60	100	100	0.00	950	1500	57.89
Khagaria	46	40	-13.04	32	21	-34.38	131	135	3.05	165	150	-9.09	0	15	100
Kishanganj	44	36	-18.18	31	31	0.00	135	135	0.00	55	58	5.45	750	1000	33.33
Lakhisarai	60	40	-33.33	33	29	-12.12	128	125	-2.34	100	100	0.00	700	900	28.57
Madhepura	55	40	-27.27	34	24	-29.41	125	125	0.00	75	90	20.00	0	200	100
Munger	56	39	-30.36	47	34	-27.66	138	142	2.90	48	42	-12.50	500	1500	200.00
Nalanda	60	40	-33.33	31	18	-41.94	132	130	-1.52	61	77	26.23	750	1630	117.33
Patna	56	40	-28.57	32	22	-31.25	140	130	-7.14	70	84	20.00	0	1000	100
Purnea	48	36	-25.00	23	14	-39.13	134	134	0.00	64	59	-7.81	500	963	92.60
Rohtas	59	43	-27.12	38	18	-52.63	130	130	0.00	82	61	-25.61	0	1250	100
Saharsa	56	49	-12.50	24	15	-37.50	130	135	3.85	65	59	-9.23	943	755	-19.94
Sheikhpura	60	40	-33.33	27	30	11.11	134	127	-5.22	46	46	0.00	750	1335	78.00
Supaul	57	40	-29.82	51	35	-31.37	137	135	-1.46	73	60	-17.81	15	15	0.00
Overall	**56.5**	**40.5**	**-28.34**	**33.3**	**25.3**	**-24.16**	**132.0**	**131**	**-0.54**	**69.5**	**66.8**	**-3.84**	**511.4**	**844.2**	**65.08**

Table: 11 *Expenses on major farm operations in Maize*

KVK	Land preparation			Crop Establishment			Fertilizers			Weed control			Irrigation		
	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change
Araria	4143	4727	14.10	2282	1100	-51.80	9934	9325	-6.13	2149	2251	4.75	4670	4230	-9.42
Banka	1500	1500	0.00	2500	2500	0.00	2500	2500	0.00	1000	1000	0.00	1500	1500	0.00
Bhabua	1898	1929	1.63	2346	1100	-53.11	1312	2792	112.80	184	333	80.98	5550	4670	-15.86
Bhagalpur	0	2500	100	2250	1100	-51.11	4645	4425	-4.74	0	1052	100	2500	2500	0.00
Bhojpur	0	2300	100	2200	1100	-50.00	483	2355	387.58	134	500	273.13	3000	2680	-10.67
Jamui	3600	3200	-11.11	2400	2400	0.00	3600	3000	-16.67	1500	1000	-33.33	3200	2300	-28.13
Katihar	2000	3160	58.00	2400	2400	0.00	2100	2000	-4.76	1300	2100	61.54	3000	2800	-6.67
Khagaria	2870	3550	23.69	3220	1250	-61.18	3170	2945	-7.10	1519	808	-46.81	3675	2800	-23.81
Kishanganj	2463	3163	28.42	1990	1150	-42.21	3665	3746	2.21	767	854	11.34	2700	3210	18.89
Lakhisarai	1925	2600	35.06	2670	1100	-58.80	1645	2843	72.83	338	475	40.53	3650	2980	-18.36
Madhepura	3950	4560	15.44	1800	1100	-38.89	2850	3000	5.26	450	950	111.11	6000	4637	-22.72
Munger	2580	1960	-24.03	2080	2600	25.00	4060	3780	-6.90	1160	620	-46.55	5200	4280	-17.69
Nalanda	0	2076	100	1780	1200	-32.58	2352	2742	16.58	2254	756	-66.46	2550	2000	-21.57
Purnea	3135	2556	-18.47	2000	1300	-35.00	2495	2991	19.88	700	1800	157.14	2990	3200	7.02
Saharsa	1400	1400	0.00	2700	1450	-46.30	6000	5600	-6.67	800	600	-25.00	5000	5000	0.00
Sheikhpura	1350	0	-100.00	1660	0	-100.00	1800	1500	-16.67	0	1200	100	2400	1700	-29.17
Supaul	1650	2550	54.55	3045	1640	-46.14	4399	4000	-9.07	3979	3000	-24.60	3950	3040	-23.04
Overall	**2027**	**2572**	**26.89**	**2313**	**1441**	**-37.77**	**3354**	**3503**	**31.67**	**1073**	**1135**	**5.84**	**3620**	**3149**	**-11.83**

Table: 12 *Agro-economic performances in Maize*

KVK	Yield (qt/acre)			Cost of cultivation (Rs/acre)			Net income (Rs/Acre)			B:C Ratio		
	Pre-CRA	Post-CRA	% change	Pre-CRA	Post-CRA	% change	Pre-CRA	Post-CRA	% change	Pre-CRA	Post-CRA	% change
Araria	39.9	43.1	8.02	14466	17009	17.58	40069	48585	21.25	3.77	3.86	2.30
Banka	28.8	33.7	17.01	18000	15200	-15.56	30869	44142	43.00	2.71	3.90	43.80
Bhabua	34.6	35.9	3.76	7833	9121	16.44	13652	18676	36.80	2.74	3.05	11.11
Bhagalpur	33	35.4	7.27	12587	10143	-19.42	13866	19311	39.27	2.10	2.90	38.17
Bhojpur	23.9	26.1	9.21	11602	13975	20.45	8859	23818	168.86	1.76	2.70	53.34
Jamui	41.6	44.3	6.49	19300	17400	-9.84	23430	35625	52.05	2.21	3.05	37.64
Katihar	34.2	40.6	18.71	15050	18600	23.59	32800	44232	34.85	3.18	3.38	6.25
Khagaria	28	35.8	27.86	15411	13334	-13.48	40723	57477	41.14	3.64	5.31	45.80
Kishanganj	33.2	39.1	17.77	18254	15666	-14.18	43786	56279	28.53	3.40	4.59	35.12
Lakhisarai	33.6	39	16.07	18500	15250	-17.57	43900	56600	28.93	3.37	4.71	39.68
Madhepura	24.3	27.7	13.99	16132	17626	9.26	17571	25899	47.40	2.09	2.47	18.20
Munger	24.5	28.5	16.33	20922	23898	14.22	20425	40286	97.24	1.98	2.69	35.90
Nalanda	25.2	29.9	18.65	12715	14498	14.02	25038	41259	64.79	2.97	3.85	29.53
Purnea	29.8	34.7	16.44	13515	16085	19.02	32569	64551	98.20	3.41	5.01	47.02
Saharsa	33.7	39	15.73	18500	15250	-17.57	43900	56600	28.93	3.37	4.71	39.68
Sheikhpura	33.3	37.2	11.71	12360	14950	20.95	13348	25985	94.67	2.08	2.74	31.64
Supaul	25.8	31.2	20.93	20350	17650	-13.27	23913	35000	46.36	2.18	2.98	37.14
Overall	**31.02**	**35.36**	**13.99**	**15617.47**	**15626.76**	**0.06**	**27571.65**	**40842.65**	**48.13**	**2.76**	**3.64**	**31.78**

Table: 13 *Resource utilization in Maize*

KVK	Seed requirement (kg)			Fuel req (L)			Crop duration			Fertilizer (kg N)			Liquid Pesticides (ml)		
	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change
Araria	11	8	-27.27	51	45	-11.76	154	151	-1.95	96	90	-6.25	1440	1050	-27.08
Banka	10	8	-20.00	34	29	-14.71	140	130	-7.14	70	60	-14.29	1500	1750	16.67
Bhabua	10	8	-20.00	36	42	16.67	110	110	0.00	80	90	12.50	1250	1500	20.00
Bhagalpur	11	9	-18.18	34	48	41.18	150	151	0.67	66	57	-13.64	800	500	-37.50
Bhojpur	10	10	0.00	36	42	16.67	145	145	0.00	55	52	-5.45	1500	450	-70.00
Jamui	10	8	-20.00	50	40	-20.00	155	150	-3.23	70	50	-28.57	1000	750	-25.00
Katihar	10	8	-20.00	48	54	12.50	150	150	0.00	110	100	-9.09	1000	1700	70.00
Khagaria	10	9	-10.00	33	24	-27.27	151	150	-0.66	115	100	-13.04	1250	850	-32.00
Kishanganj	13	11	-15.38	42	35	-16.67	152	150	-1.32	82	87	6.10	750	500	-33.33
Lakhisarai	10	8	-20.00	52	49	-5.77	150	150	0.00	110	100	-9.09	1000	1450	45.00
Madhepura	9	8	-11.11	36	43	19.44	160	155	-3.13	95	100	5.26	200	1270	535.00
Munger	10	8	-20.00	56	49	-12.50	159	165	3.77	60	60	0.00	780	1250	60.26
Nalanda	7	8	14.29	45	28	-37.78	131	135	3.05	64	67	4.69	1200	1450	20.83
Purnea	12	10	-16.67	29	37	27.59	151	150	-0.66	64	60	-6.25	900	1500	66.67
Saharsa	10	8	-20.00	25	38	52.00	120	120	0.00	55	48	-12.73	950	1030	8.42
Sheikhpura	12	10	-16.67	42	36	-14.29	135	130	-3.70	45	45	0.00	280	850	203.57
Supaul	10	8	-20.00	38	50	31.58	119	120	0.84	72	60	-16.67	485	860	77.32
Overall	**10**	**9**	**-16.00**	**40**	**41**	**0.29**	**143**	**142**	**-0.82**	**77**	**72**	**-6.34**	**958**	**1101**	**14.89**

Table: 14 *Expenses on major farm operations in Lentil*

KVK	Land preparation			Crop Establishment			Fertilizers			Weed control			Irrigation		
	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change
Arwal	2243	0	-100.00	600	700	16.67	500	500	0.00	459	966	110.46	0	0	0
Aurangabad	1400	0	-100.00	592	700	18.24	0	225	100	1678	1356	-19.19	400	500	25.00
Banka	1800	0	-100.00	870	700	-19.54	1100	780	-29.09	1000	1000	0.00	0	0	0
Bhagalpur	2000	0	-100.00	600	700	16.67	950	880	-7.37	0	0	0	800	800	0.00
Bhojpur	1700	0	-100.00	200	700	250.00	400	575	43.75	0	0	0	0	0	0
Gaya	1747	0	-100.00	812	700	-13.79	445	500	12.36	670	810	20.90	1550	880	-43.23
Jamui	1800	0	-100.00	600	700	16.67	1200	1000	-16.67	800	1200	50.00	1200	1000	-16.67
Jehanabad	2226	0	-100.00	526	700	33.08	499	942	88.78	0	593	100	0	0	0
Khagaria	2004	0	-100.00	1005	700	-30.35	1155	811	-29.78	0	700	100			0
Lakhisarai	1700	0	-100.00	600	700	16.67	600	850	41.67	0	0	00	0	0	0
Madhepura	1280	0	-100.00	610	700	14.75	0	520	100	0	350	100	1000	1500	50.00
Munger	1663	0	-100.00	1000	700	-30.00	1238	550	-55.57	1325	756	-42.94	1270	1050	-17.32
Nalanda	2004	0	-100.00	1250	700	-44.00	1055	1210	14.69	0	639	100	16	13	-18.75
Patna	2000	0	-100.00	1500	700	-53.33	600	500	-16.67	0	1000	100	1600	800	-50.00
Rohtas	2000	0	-100.00	1300	700	-46.15	960	660	-31.25	1336	1344	0.60	0	900	100
Saharsa	126	0	-100.00	1475	700	-52.54	675	938	38.96	446	365	-18.16	1100	970	-11.82
Sheikhpura	1500	0	-100.00	800	700	-12.50	0	999	100	0	450	100	800	800	0.00
Supaul	2300	0	-100.00	1100	700	-36.36	700	700	0.00	0	0	0	250	250	0.00
Overall	**1750**	**0**	**-100.00**	**858**	**700**	**-18.39**	**671**	**730**	**8.80**	**429**	**641**	**49.46**	**587**	**557**	**-5.24**

Table: 15 *Agro-economic performances in Lentil*

KVK	Yield (qt/acre)			Cost of cultivation (Rs/acre)			Net income (Rs/Acre)			B:C Ratio		
	Pre-CRA	Post-CRA	% change	Pre-CRA	Post-CRA	% change	Pre-CRA	Post-CRA	% change	Pre-CRA	Post-CRA	% change
Arwal	4.4	4.5	2.27	11843	10096	-14.75	15437	17804	15.33	2.30	2.76	19.97
Aurangabad	4.3	5.2	20.93	12959	11383	-12.16	13701	19857	44.93	2.06	2.74	33.40
Banka	3.7	4.4	18.92	10950	8400	-23.29	11990	17180	43.29	2.09	3.05	45.36
Bhagalpur	5.9	7.1	20.34	11850	10413	-12.13	24730	33607	35.90	3.09	4.23	36.95
Bhojpur	4.8	6.3	31.25	12800	10370	-18.98	18960	23690	24.95	2.48	3.28	32.37
Gaya	3.9	4.3	10.26	10707	8902	-16.86	13473	17758	31.80	2.26	2.99	32.61
Jamui	3.6	3.9	8.33	11200	8950	-20.09	11120	15230	36.96	1.99	2.70	35.57
Jehanabad	5.7	6.5	14.04	10905	8927	-18.14	24435	31373	28.39	3.24	4.51	39.30
Katihar	3.6	4.1	13.89	12645	9100	-28.03	11675	16320	39.79	1.92	2.79	45.24
Khagaria	6.5	7	7.69	9369	7572	-19.18	30931	35828	15.83	4.30	5.73	33.25
Lakhisarai	3.9	4.5	15.38	14200	12500	-11.97	11080	15400	38.99	1.78	2.23	25.37
Madhepura	5.1	5.7	11.76	14034	12722	-9.35	17586	22618	28.61	2.25	2.78	23.29
Munger	4.1	5	21.95	11988	10638	-11.26	13432	18362	36.70	2.12	2.73	28.56
Nalanda	5	5.6	12.00	13797	11751	-14.83	17203	22969	33.52	2.25	2.95	31.50
Patna	3.5	4	14.29	9950	9450	-5.03	11750	15350	30.64	2.18	2.62	20.33
Rohtas	4	4.4	10.00	10088	8125	-19.46	14712	19155	30.20	2.46	3.36	36.58
Saharsa	4	4.7	17.50	13218	11567	-12.49	12582	17573	39.67	1.95	2.52	29.07
Sheikhpura	3.3	4.1	24.24	5485	4635	-15.50	14975	19085	27.45	3.73	5.12	37.19
Supaul	3.7	4.3	16.4	10509	8750	-16.7	14970	19000	26.8	1.8	2.3	27.14
Overall	**4.41**	**5.07**	**15.13**	**11554.89**	**9750.06**	**-15.62**	**16098.44**	**21064.39**	**30.85**	**2.47**	**3.28**	**32.94**

Table: 16 *Resource utilization in Lentil*

KVK	Seed requirement (kg)			Fuel req (L)			Crop duration			Fertilizer (kg N)			Liquid Pesticides (ml)		
	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change
Arwal	19	16	-15.79	17	11	-35.29	125	125	0.00	0	0	0	0	300	100
Aurangabad	17	16	-5.88	21	10	-52.38	121	120	-0.83	0	0	0	400	400	0.00
Banka	23	18	-21.74	19	8	-57.89	125	120	-4.00	25	20	-20.00	250	250	0.00
Bhagalpur	20	17	-15.00	25	13	-48.00	135	134	-0.74	0	0	0	350	1400	300.00
Bhojpur	22	16	-27.27	39	9	-76.92	118	120	1.69	16	0	-100.00	100	50	-50.00
Gaya	22	16	-27.27	26	11	-57.69	120	120	0.00	0	8	0	0	1000	100
Jamui	20	15	-25.00	20	10	-50.00	130	130	0.00	15	15	0.00	1500	1250	-16.67
Jehanabad	17	16	-5.88	23	8	-65.22	120	115	-4.17	15	0	-100.00	0	750	100
Katihar	18	16	-11.11	20	12	-40.00	130	128	-1.54	0	20	0	500	850	70.00
Khagaria	25	18	-28.00	19	11	-42.11	131	135	3.05	25	0	-100.00	450	1250	177.78
Lakhisarai	22	20	-9.09	20	12	-40.00	130	130	0.00	0	20	0	0	450	100
Madhepura	15	16	6.67	24	15	-37.50	120	122	1.67	0	0	0	0	0	0
Munger	19	16	-15.79	37	21	-43.24	125	125	0.00	15	15	0.00	350	350	0.00
Nalanda	24	17	-29.17	19	10	-47.37	120	121	0.83	15	24	60.00	455	1450	218.68
Patna	25	16	-36.00	24	9	-62.50	130	134	3.08	0	16	100	60	45	-25.00
Rohtas	23	20	-13.04	27	12	-55.56	123	120	-2.44	8	9	12.50	0	0	0
Saharsa	20	16	-20.00	17	8	-52.94	122	124	1.64	6	8	33.33	795	690	-13.21
Sheikhpura	26	15	-42.31	21	9	-57.14	125	117	-6.40	20	25	25.00	100	75	-25.00
Supaul	18.3	15	-15	23.8	17.6	-26.4	125	125	0	0	0	0	0	0	0
Overall	21	17	-20.42	23	11	-52.39	125	124	-0.44	9	10	12.50	295	587	98.87

Table: 17 *Expenses on major farm operations in Mustard*

KVK	Land preparation			Crop Establishment			Fertilizers			Weed control			Irrigation		
	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change
Araria	**2333**	**1833**	**-21.43**	**1160**	**1670**	**43.97**	**650**	**800**	**23.08**	**0**	**0**	**00**	**1400**	**1233**	**-11.93**
Arwal	2243	1300	-42.04	1300	300	-76.92	700	720	2.86	0	0	00	1250	1000	-20.00
Aurangabad	2215	00	-100.00	1500	700	-53.33	580	700	20.69	575	375	-34.78	1800	1500	-16.67
Banka	1500	00	-100.00	2200	700	-68.18	450	400	-11.11	540	400	-25.93	1000	1000	0.00
Bhabua	1400	1750	25.00	800	1033	29.13	600	600	0.00	0	400	100	1250	980	-21.60
Bhojpur	525	1690	221.90	1000	1670	67.00	900	545	-39.44	0	0	00	650	775	19.23
Gaya	1662	00	-100.00	1190	700	-41.18	755	450	-40.40	0	890	100	950	750	-21.05
Jamui	1800	00	-100.00	800	700	-12.50	780	800	2.56	600	400	-33.33	2000	1600	-20.00
Jehanabad	3231	00	-100.00	2230	700	-68.61	670	500	-25.37	0	60	10	0	0	00
Katihar	1000	1000	0.00	1000	1800	80.00	1000	680	-32.00	350	0	-100.00	0	0	00
Khagaria	2016	00	-100.00	1360	700	-48.53	1014	675	-33.43	445	400	-10.11	2300	1900	-17.39
Lakhisarai	1744	1135	-34.92	1800	1052	-41.56	890	800	-10.11	1500	655	-56.33	980	850	-13.27
Madhepura	1200	00	-100.00	1600	700	-56.25	370	700	89.19	0	350	100	1000	1500	50.00
Munger	1992	800	-59.84	1050	1000	-4.76	650	550	-15.38	260	577	121.92	1570	800	-49.04
Nalanda	1375	680	-50.55	1270	1210	-4.72	780	600	-23.08	0	334	100	1171	944	-19.39
Patna	2200	00	-100.00	1000	700	-30.00	00	250	100	0	400	100	1600	1600	0.00
Rohtas	2000	2000	0.00	1450	700	-51.72	675	550	-18.52	0	0	00	1400	1400	0.00
Saharsa	1050	975	-7.14	1050	757	-27.90	980	635	-35.20	0	416	100	1772	1475	-16.76
Sheikhpura	1025	800	-21.95	1160	700	-39.66	970	839	-13.51	0	0	00	452	400	-11.50
Total	**1711**	**735**	**-57.05**	**1312**	**921**	**-29.81**	**706**	**621**	**-12.08**	**225**	**298**	**32.48**	**1187**	**1037**	**-12.59**

Table: 18 *Agro-economic performances in Mustard*

KVK	Yield (q/acre)			Cost of cultivation (Rs/acre)			Net income (Rs/Acre)			B:C Ratio		
	Pre-CRA	Post-CRA	% change	Pre-CRA	Post-CRA	% change	Pre-CRA	Post-CRA	% change	Pre-CRA	Post-CRA	% change
Araria	4.2	4.8	14.29	8250	6075	-26.36	19470	25605	31.51	3.36	5.21	55.20
Arwal	3.8	4.2	10.53	7609	6265	-17.66	17471	21455	22.80	3.30	4.42	34.24
Banka	3.6	4.4	22.22	6159	5390	-12.49	17601	23650	34.37	3.86	5.39	39.66
Bhabua	2.8	3	7.14	7539	6202	-17.73	10941	13598	24.28	2.45	3.19	30.24
Bhojpur	3.4	3.9	14.71	7210	5875	-18.52	11235	19865	76.81	2.56	4.38	71.26
Gaya	3.9	4.1	5.13	8211	5200	-36.67	17529	21860	24.71	3.13	5.20	66.00
Jamui	3.1	3.4	9.68	7100	6370	-10.28	13360	20362	52.41	2.88	4.20	45.63
Jehanabad	3.7	4.1	10.81	9415	6095	-35.26	11970	20965	75.15	2.27	3.80	67.30
Katihar	4.6	5.1	10.87	7200	6200	-13.89	23160	27460	18.57	4.22	5.43	28.75
Khagaria	3.5	4.3	22.86	8460	6971	-17.60	12760	21409	67.78	2.51	4.07	62.31
Lakhisarai	2.3	2.4	4.35	5830	4960	-14.92	9350	10880	16.36	2.60	3.19	22.65
Madhepura	3.6	4	11.11	5660	5020	-11.31	18100	21380	18.12	4.20	5.26	25.28
Munger	4.9	6.1	24.49	6881	5284	-23.21	25459	34976	37.38	4.70	7.62	62.11
Nalanda	4.3	4.3	0.00	8025	6600	-17.76	16450	20355	23.74	2.70	3.49	29.35
Patna	3.85	4.4	14.29	8600	6970	-18.95	16810	22070	31.29	2.95	4.17	41.01
Rohtas	4.7	6	27.66	8188	6900	-15.73	22832	24760	8.44	3.79	4.59	21.11
Saharsa	4.5	4.7	4.44	6737	5203	-22.77	22963	25817	12.43	4.41	5.96	35.24
Sheikhpura	4.1	4.4	7.32	6236	5639	-9.57	20824	23401	12.38	4.34	5.15	18.68
Overall	**3.82**	**4.33**	**13.15**	**7411.05**	**5958.79**	**-19.60**	**16898.16**	**22239.26**	**31.61**	**3.31**	**4.71**	**42.24**

Table: 19 *Resource utilization in Mustard*

KVK	Seed requirement (kg)			Fuel req (L)			Crop duration			Fertilizer (kg N)			Liquid Pesticides (ml)		
	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change
Araria	3	2	-33.33	24	22	-8.33	110	110	0.00	35	40	14.29	775	555	-28.39
Arwal	2	2	0.00	23	18	-21.74	120	120	0.00	37	37	0.00	350	800	128.57
Aurangabad	4	2	-50.00	15	9.5	-36.67	129	122	-5.43	31	42	35.48	100	300	200.00
Banka	3	2	-33.33	20	19	-5.00	125	125	0.00	50	40	-20.00	75	50	-33.33
Bhabua	4	2.5	-37.50	10	9	-10.00	124	124	0.00	33	30	-9.09	350	350	0.00
Bhojpur	3.5	2	-42.86	34	26	-23.53	115	110	-4.35	43	36	-16.28	50	50	0.00
Gaya	3	1.75	-41.67	26	14	-46.15	120	124	3.33	37	32	-13.51	750	750	0.00
Jamui	3	2	-33.33	21	13	-38.10	115	115	0.00	50	35	-30.00	350	350	0.00
Jehanabad	3	2	-33.33	23	13	-43.48	110	110	0.00	45	40	-11.11	0	350	100
Katihar	4	2	-50.00	25	33	32.00	132	132	0.00	30	35	16.67	0	0	00
Khagaria	3	2.5	-16.67	15	10	-33.33	130	130	0.00	30	25	-16.67	250	0	-100.00
Lakhisarai	3	2	-33.33	15	11	-26.67	134	134	0.00	45	30	-33.33	0	0	100
Madhepura	3.5	1.5	-57.14	16	10	-37.50	123	125	1.63	50	45	-10.00	0	200	100
Munger	3.5	2	-42.86	33	21	-36.36	137	135	-1.46	32	35	9.38	200	200	0.00
Nalanda	3	2	-33.33	16	8	-50.00	122	123	0.82	45	40	-11.11	100	450	350.00
Patna	3	2	-33.33	23	12	-47.83	119	120	0.84	50	34	-32.00	250	200	-20.00
Rohtas	2	2	0.00	17	9	-47.06	127	130	2.36	35	30	-14.29	300	300	0.00
Saharsa	3	2.25	-25.00	16	9	-43.75	115	115	0.00	35	32	-8.57	540	540	0.00
Sheikhpura	3	2	-33.33	23	30	30.43	125	123	-1.60	30	30	0.00	200	200	0.00
Overall	**3**	**2**	**-33.60**	**21**	**16**	**-21.19**	**123**	**122**	**-0.41**	**39**	**35**	**-9.70**	**240**	**290**	**20.98**

6. CROP RESIDUE MANAGEMENT

CROP RESIDUE MANAGEMENT

6.1 Bale Making:

Paddy straw burning has become a significant concern in major rice growing area of Bihar. In order to curb the crop residue burning in Bihar, a systematic approach was adopted under CRA Programme. To overcome this problem the crop residue utilization model was developed and successfully deployed among the farmers. Under this approach, BAU, Sabour have developed a model in which round/square straw baler has been introduced. This baler is being used for left over straw post paddy harvesting collected in the form of round or square bundle of paddy straw weighing around 20-25 kg. This straw baler is cost effective and transport efficient and prepared 365 ton rice residue bales and supplied 153ton bale to Bihar State Milk Co¬ Operative Federation Ltd (COMFED) and some farmers also contacted and sold to COMFED. In Bihar, about 950 ton rice straw bale was collected from 4295 acre of that area with the help of 3 baler machine. Apart from bale making for animal feed, production of Compressed Bio-Gas (CBG).

6.2 Mushroom Production:

Every KVK of BAU, Sabour, jurisdiction providing the training to the 200 farmers of each CRA selected villages for production of mushroom by using crop residues like paddy straw, wheat straw, rice husk and maize stover etc. Farmer have used about 550 ton of crop residues and produced about 296.3 ton mushroom.

6.3 Biochar Production:

To prevent the burning and increase the consumption of extra produced rice crop residue another method being adopted under CRA Programme i.e. biochar production. Biochar is produced by the burning of rice residue in the absence of oxygen inside the especially made clint. Biochar production unit have been established in 10 KVKs and they have produced 84.9ton biochar by the use of about 300ton residue of rice. The produced biochar being used as a soil amendment which improves the physical, chemical and biological properties of soil. Its application in soil will save nitrogen, increase crop productivities, improves soil health.

6.4 Spraying of Pusa waste decomposer:

To prevent the burning of crop residue of rice and wheat remains after harvesting of crop by using combine harvester in CRA Programme spraying of Pusa waste decomposer being done in 200 acres in each KVK (18) (total 3600 acre) for In- situ decomposition of crop residue. So, that decomposed crop residue of rice and wheat improves organic carbon which work as food for microbial population present in soil consequently improves the sustainable soil health.

6.5 Use of Happy seeder machine:

After harvesting of paddy crop by combine harvester generally farmers burn the residue in-situ because to remove the crop residue from field labour cost is more. If residue will not be removed from the field, it will increase the problem in sowing of forthcoming rabi crop. To solve this problem, in CRA selected villages BAU have provided happy seeder machine which can perform sowing operations even in the presence of crop residue in field.

7. ADOPTION OF INNOVATIVE PRACTICES


BISA
Borlaug Institute for South Asia
कृषि विज्ञान केन्द्र, भागलपुर
(बिहार कृषि विश्वविद्यालय, सबौर)
जल जीवन हरियाली
के अर्न्तगत
मौसम के अनुकूल कृषि कार्य
प्रत्यक्षण तकनीक - जीरो टीलेज से सरसों की बुआई

7.1 Community Rice Nursery

In Rohtas district, at the peak time of paddy transplanting there is huge demand of rice seedling. To solve this problem KVK Rohtas is promoting and assisting a group of young farmers for nursery model business as a young entrepreneur to grow and sell the seedling of rice. The KVK is providing technical and scientific support related to growing seedling and they are earning money and fulfilling seedling demand of the CRA as well as nearby villages. Total costs involved in raising one-acre of rice seedling are about Rs. 17,358. According to the young entrepreneur, from one-acre area seedling can be transplanted into 44-acre area. Selling rate of seedling is Rs. 600/- for one-acre area, so they are earning a net profit of about Rs. 9000from one-acre area by investing 17400 within one month.

Table 20 *Economics of Nursery Model Business (Area = 1 Acre)*

S.No.	Input	Quantity	Rate (Rs./acre)	Amount (Rs.)
1	Seed quantity	192 Kg.	42/Kg.	8064.00
2	Seed treatment @ 2 g/kg	384 gm.	25/acre	384.00
3	Ploughing cost	1 acre	1500/acre	1500.00
4	Irrigation (3 times)	1 acre	300/acre	900.00
5	DAP	30 Kg.	25/Kg.	750.00
6	Urea	60 kg.	7/kg.	420.00
7	MoP	20 Kg.	22/Kg.	440.00
8	Plant Protection (per acre)	-	-	500.00
9	Herbicides (per acre)	-	-	400.00
10	Labour cost	10 Mandays	300/-labour	3000.00
11	Misc. expenses	-	-	1000.00
			Total cost (Rs.)	17358.00

Economics for one acre: Single Seedling transplanting will be done in 44 acre area with 1 acre nursery business model.

1	Selling rate	Rs. 600/acre	
2	Gross Income	Rs. 600 X 44 acre area	Rs. 26400.00
3	Net Income	= (26400-17400)	Rs. 9000.00

7.2 Use of Drones for Crop Protection

CRA Programme is also promoting the use of drone on farmers' field for application of fertilizer, spray of pesticides, assess the crop damage etc. offering the chance to automate yet another labour-intensive work. The advantage of using drone is that it has a 10-liter tank capacity for filling pesticides which can spray 1-acre field in 10-15 minutes, which if sprayed manually by hand will take an entire day. Therefore, using a combination of GPS, laser measurement and ultrasonic positioning; a crop spraying drone can adopt to altitude and location easily, adjusting for variables such as wind speed, topography, and geography. This enables the drone to perform crop spraying herbicide, fertilizers and pesticides more efficiently, and with greater accuracy and less waste.

7.3 Laser Land Leveling (LLL) of field

Levelling of land/field is done with the help of laser/sensors guided system to get perfectly levelled field, and therefore called laser land levelling which is another resource conservation technology. In Bihar, farmers generally level their fields by using locally available scrapers resulting in fields having 5-15 cm uneven and undulated condition which sometimes results in water stagnation, uneven fertilizer application and germination of field crops. Through the CRA programme under BAU jurisdiction every KVK has been directed to laser land level 100-acre of area in CRA villages on farmers field. Farmers are experiencing that there is yield advantage in zero tillage sown crops, direct seeded rice and transplanted rice and getting 20-25 per cent of irrigation water savings apart from several other benefits like better crop establishment, nutrient use efficiency, uniform irrigation etc. due to laser land leveling. Farmers also stated that as a consequence of laser land leveling, water application efficiency has increased by almost 50% when compared to levelling by scraper.

7.4 Farmer's Library

Farmer's library has been established in Climate resilient Agriculture (CRA) adopted village Uprama (Rajoun Block) inaugurated by Dr. D.R. Singh, Hon'ble VC, BAU, Sabour at Panchayat Bhawan of Uprama village. Farmer's library have all agriculture related books both

in Hindi as well as English.The collections include printed materials of Extension bulletin, Kisan Diary, Agriculture magazines, Krishak Sandesh, Kisan Samachar, agricultural books with ease of access to the farmers of the village. The Farmers's library provides effective convenient alternative where farmers need to pay in a small token of membership fees and can get to access to a variety of books, newspapers and magazines etc. Farmer's Library offers a door for one and all, of every age group strengthening the knowledge base and creating awareness among masses.

7.5 Award and recognition:

Krishi Vigyan Kendra, Rohtas has been awarded for rice straw collection and its supply to COMFED on "Jal-Jeevan –Hariyali Diwas" on 04.05.2022 at BAMETI, Patna.

Kalakriti/Scenery

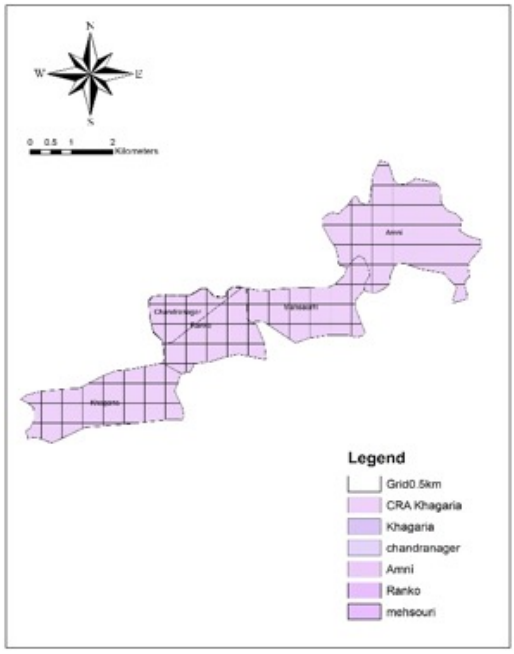
A group of women from Jehanabad district are preparing some beautiful wall scenery by using rice residues and wheat straw. After preparation of scenery, they are selling in market and earning money. KVK Jehanabad is assisting the selected group of women for recognition, promotion and selling those scenery.

7.6 Village Level Digital Soil Fertility Map

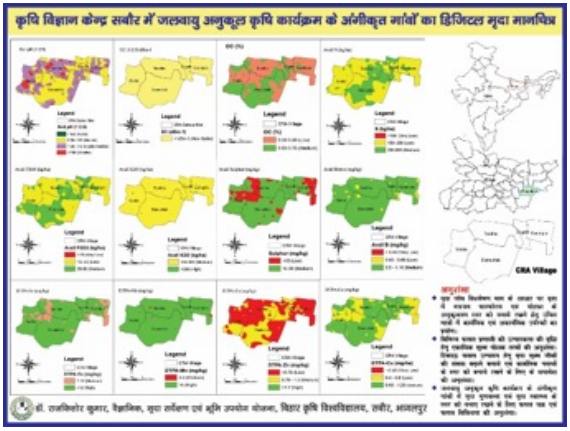
Digital soil fertility mapping is a process that involves the collection, analysis, and mapping using computer system and geospatial software. This technology helps to design a methodology, way of collection of the soil samples from area of interest, and their analysis process in the laboratory. The process involves remote sensing and geographic information systems (GIS) used to create detailed maps over the status of soil fertility and their characteristics across of a given area. Digital soil fertility mapping empowers the farmers with precise information about their soils, enabling them to optimize resource allocation, enhance the crop management practices, reduce costs, improve the soil health, and make informed decisions for sustainable and productive agriculture. To fulfil the objectives in CRA program, grid based total 1400 soil samples were collected from 500m x 500 m grid at different locations with a sampling intensity of 100 meters from the adopted Climate Resilient Agriculture (CRA) selected villages of KVKs.

The physio-chemical properties (pH, EC and OC) and major nutrients like (N, P2O5 and K2O) were analyzed from the adopted CRA villages and DTPA-micro-nutrients analysis of all adopted CRA villages is still in progress. The results showed that the soil pH value varied from neutral to alkaline conditions. The EC value was placed under the optimum range. Almost all the soil samples analysed were deficient in available nitrogen. The organic carbon varied from low to medium. The available P and K varied from low to high. The overall results concluded that the soil pH of the CRA village of Khagaria KVK is more than 8.5 which acts as a major soil constraint for the rice-wheat cropping system under the CRA program. However, the exact interpretation of soil fertility constraints will be interpreted through a digital fertility map which would be useful for targeting the constrained areas.

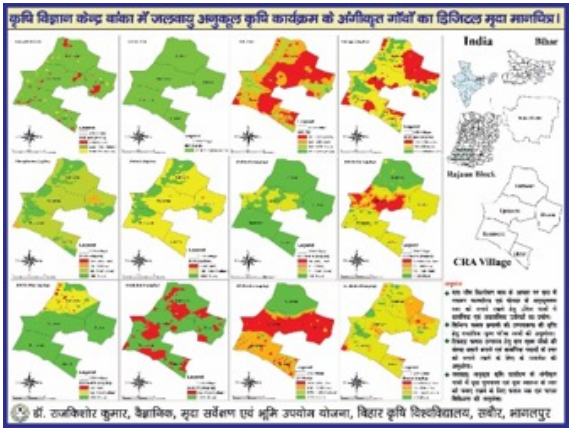
Soil Sample collection grid map of KVK Supaul



Soil Sample collection grid map of KVK Khagaria



Digital soil Fertility Map of KVK, Banka



Digital soil Fertility Map of KVK, Bhagalpur

8. SUCCESS STORIES

CRA MULTI-PRONGED STRATEGY FOR HIGHER YIELDS WITH LESSER RESOURCES AND TIME

The village of Lougain in the Goradih block in Bhagalpur district, Bihar, is inhabited by small and marginal farmers. In a village of 300 households, agriculture is the primary survival mode for most families. This area also sees significant migration among farm families due to low harvests and the inability of current agricultural practices to withstand extreme weather conditions. These conditions have become more frequent in recent years. Sunil Kumar from Laugain has a two-acre farm. He supplements his low income by engaging in petty work and casual labour. Farming incomes have stagnated and water crises are severe in the village. It was pure chance that he crossed the Peepal tree under which an agricultural meeting about emerging technology was taking place. He watched from the last row out of curiosity. A year after that meeting, not only did he adopt all the practices, he also played a significant role in influencing small and marginalized farmers to try this new method on their farms.

Cultivation of medium duration rice using DSR method coupled with early sowing of wheat using zero tillage machine was a multipronged strategy of CRA which helped him to achieve multiple objectives that included (i) water saving in rice crop (ii) early sowing of wheat resulting in minimized exposure of wheat crop to terminal heat stress and (iii) early harvesting of wheat which enabled Sunil to cultivate third crop (i.e. summer moong) in the same year.

Sunil says "The precious time saved by adoption of CRA has helped me to grow three crops from the same piece of land at the same time. I was also able to save water requirement and gain higher yields"

Zero Tillage and DSR change farming scenario in Khagaria

Khagaria district in Bihar is surrounded by seven rivers that flood each year. The district also bears the brunt of extreme climates, with very hot summers and bitingly cold winters. Long dry spells during the monsoon followed by bursts of torrential rain are common. Sudarshan Kumar from Mehsoudi, a village in the Khagaria block of Khagaria district, is an entrepreneur. Despite traditionally running a small dairy enterprise, today he has a dairy farm with 20 cows and a medium-sized poultry unit. He also grows mushrooms commercially. Given the extreme unpredictability of the climate in this part of Bihar, he had to stay away from agriculture. However, four years ago he finally tried his hand at maize cultivation to manage poultry feed prices spike. His plan was to process this maize into feed. In its third year, Sanjeev's maize crop suffered relentless pest attacks. He reached out to the KVK, seeking support in reducing pest attacks. This is when he was introduced to CRA during an ongoing training session on the premises.

Sanjeev owns 1.6 acres of land. Three years ago,

he leased six acres to grow maize. In the village of Chandranagar most farmers are small landholders with one to two acres of landholding. Climate uncertainty has intensified farmers' vulnerability. Even a crop like paddy, which is grown across Bihar is considered a risk in this area for small landholders. In this region, summer green gram, which is grown only after wheat harvest, is used as a manure crop. It is not for consumption or commercial use. This is primarily due to the poor quality of seeds but also to the longer harvest duration. Harvesting overlaps with field preparation for paddy. Farmers broadcast green gram and till the crop into the soil later, before the advent of the monsoons without harvesting significant number of pods. This is to turn the crop into manure.

After adoption of CRA technologies in the first season, Sanjeev was able to cultivate green gram on two acres of land. A significant number of farmers have come forward to pilot zero-tillage technology through Happy Seeder. In Chandranagar, farmland is usually left empty after wheat harvest. By using zero tillage technology and the short duration cultivars, now farmers can sow the green gram crop early. This gives them a considerable amount of time before monsoon for harvesting green gram pods. In one year, Sanjeev earned an additional INR 30,000 income from enhanced productivity from moong and paddy crops compared to the previous year due to CRA; a significant gain for a small landholder.

Sanjeev has a standing crop of six acres of wheat, which he cultivates through zero-tillage technology. Now, 105 farmers grow wheat using zero-tillage technology on 70 acres in the village. “We got significant production. There was so much production that we are still consuming green gram nearly eight months after the harvest. There are four reasons why farmers gravitate towards CRA: it requires less tilling, fewer seeds, less water and less manure.

CRA: A BOON FOR DROUGHT PRONE AREAS

A medium landholding farmer with 13 acres of land, Rupesh has been experimenting with diverse technologies on his farmland since he began farming a few years ago. In drought-prone areas like Banka, farmers continue to face two major challenges, unpredictable weather and rising input costs. At a training KVK in Uprama in 2019, Rupesh was introduced to an innovative approaches of climate resilient agriculture technologies like direct seeding of rice, zero till cultivation of wheat and raised bed planting of maize etc. This innovation could potentially address both issues threatening agriculture in his region. Rupesh, who attended the meeting, reached out to KVK officials and browsed the internet for additional information on this new technology. Once he was convinced, he adopted the practice in his wheat crop as a first trial.

Rupesh decided to try climate-resilient agriculture technologies on four acres of land using zero-tillage technology in wheat. Thanks to CRA, Rupesh has earned Rs 93,000 extra in a single year. This is through the enhanced productivity of different crops compared to previous years. This is a significant gain for a medium-sized landowner. After experiencing the benefit of CRA technologies, Rupesh stated “CRA will be most useful in periods when dry spells loom over our villages. The weather gods have been kind in the last few seasons, but Banka has a history of drought, and we farmers recognize it. CRA adoption is the only insurance available to farmers like us."

Zero tillage for prosperity

In Sartha village of Bihar's Nalanda district farmers traditionally cultivated wheat, paddy, pulses and vegetables. However, in recent years, rising costs and uncertain weather conditions have made farming unsustainable in the region. The area is also prone to flash floods and extreme dry conditions. Farming income has stagnated while production costs have significantly increased, making small and medium farmers extremely vulnerable. Climate change has further aggravated this vulnerability with unpredictable weather patterns resulting in losses. For Dinesh Prasad Singh, yields from his four-acre plot could barely cover his family's rising expenses, including his children's education. With every passing season, the mounting pressures of changing weather cycles, input and labour costs had this farmer desperately seeking a holistic approach to his farming conundrums.

While he had heard of several different and new crop husbandry methods, Dinesh was skeptical about moving away from traditional cultivation methods. Despite average yields, traditional cultivation methods stood the test of time and shaped life in most parts of rural India. A meeting organised by the KVK in Sartha on CRA provided the first trigger for change for Dinesh. A village meeting organized by the KVK introduced Dinesh to Climate-Resilient Agriculture.

In the past year, Dinesh has grown multiple crops using CRA technologies. His first wheat plot, adopting zero-tillage technology, brought in hordes of curious neighbours and farmers from other villages. Dinesh saved three weeks by early wheat sowing and harvesting. Zero-tillage technology does not require prior land preparation. By using a machine equipped with drillers, it is possible to sow seeds at optimal distances. Besides saving time on field preparation, this undisturbed land facilitates the growth of earthworms and beneficial microbes. Irrigation time is also reduced by half. Dinesh recorded higher production 33% higher than the previous season. Dinesh earned an additional income of Rs. 2 lakh from enhanced productivity from different crops compared to the previous year due to the adoption of CRA.

DSR brings smile on faces of farmers in Araria

Farming is the primary source of livelihood in Tedhi Mushari, a village in the Farbisganj block of Bihar's Araria district. Araria has historically been a rainfed area and nature plays a significant role in farmers' lives. Climate change has aggravated an already dire situation by making weather patterns unpredictable. In the past, people in the village of Tedhi Mushari offset this by the broadcasting technique; a method of seeding that involves scattering seeds, by hand or mechanically, over a relatively large area. Over the years, this was replaced by transplanting paddy. Ashok attended CRA training before the Kharif season of 2020. KVK organized the training in his village. A medium landholding farmer, with a Farmland of 5 acres, he had long borne the brunt of rising input costs and unpredictable weather.

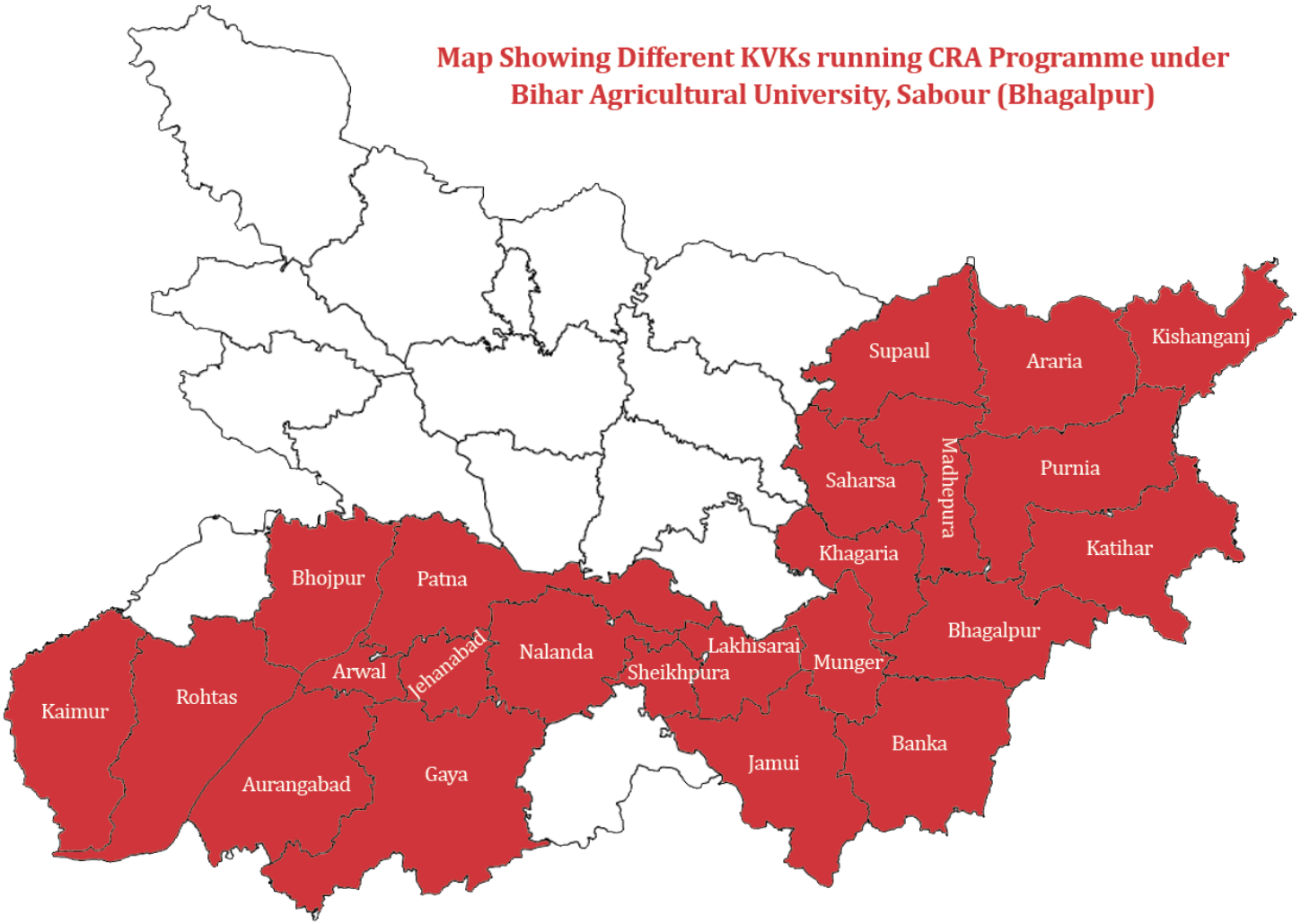
Ashok decided to adopt Direct Seeding of Rice (DSR) on one hectare of land. An intuitive farmer, Ashok found that there were several technical variations between his traditional method of rice cultivation and DSR. He sought answers to these variations by clarifying with the Technical Assistant, and other KVK officials. This helped allay his own doubts and better explain the technology to other farmers.

Sharing his experience in the use of DSR, Ashok says that "Broadcasting of rice seeds was widely prevalent when I was small. My grandfather used to leave some patches of unplanted land, and he would scatter seeds over them. This made for sturdy plants that could withstand any climate of course, it was not done scientifically; it was done unstructured. Zero-tillage technology blends my ancestors' knowledge with scientific fact to produce a truly resilient technique." He further says "I saved INR 3,000 per Bigha due to DSR. The productivity gain was about 10%. More importantly, DSR will be a critical mitigation factor against climate change. My grandfather knew how to protect his crops from bad weather. DSR can help us increase productivity independent of the environment".

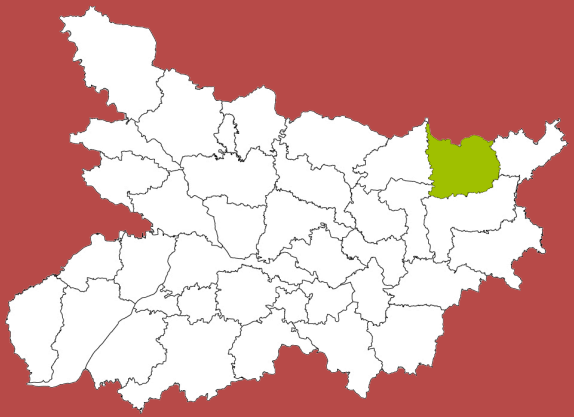
Annexure - I

DISTRICT PROFILE

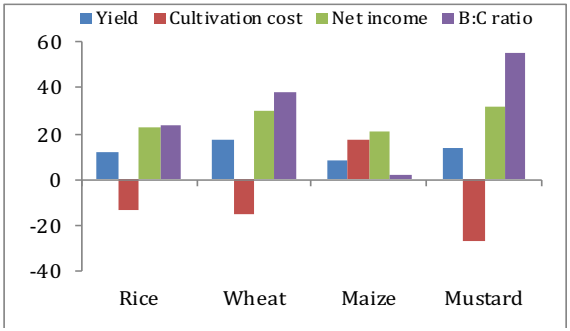
Map Showing Different KVKs running CRA Programme under Bihar Agricultural University, Sabour (Bhagalpur)



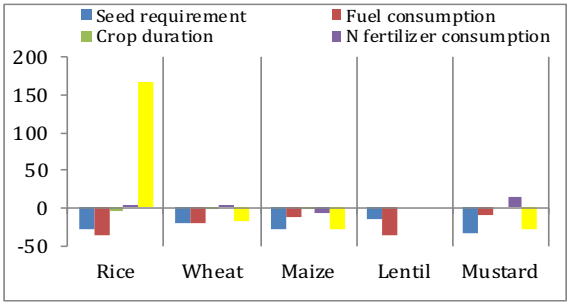
ARARIA



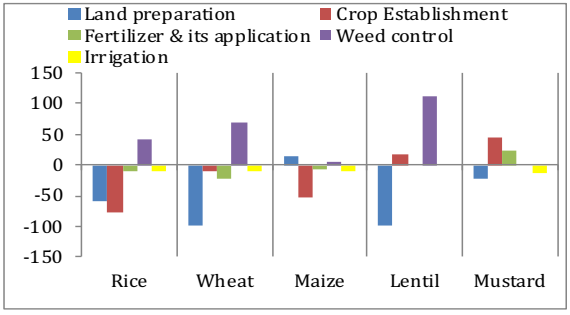
- As a result of CRA interventions, maximum increase in yield was recorded in wheat (>17%) and for other crops it ranged between (8-14%). Maximum increase in net income (>31%) was recorded in mustard and (>29%) in wheat crop while maize showed relatively lower gains (21%) in increased productivity and profitability compared to other crops.
- Shifting from traditional crop establishment practices to CRA interventions resulted in 26% reduced mustard cultivation costs and for other crops it ranged between (13-18%). This was mainly due to reduced seed (15-33%) and fuel requirements (8-35%). DSR benefits were suppressed mainly due to the increased use of liquid pesticides. This was more than 1.5 times the quantity of liquid pesticides being used in rice prior to the CRA program.
- Irrigation costs were reduced by 9-12% for rice, wheat, maize and mustard. Due to zero tillage, lentils were grown using the residual soil moisture from the previous crop.
- The savings in production costs were envisaged through reduced crop establishment costs (10 – 76%) with maximum reduction in rice (76%), followed by Maize and Wheat where intensive tillage operations are required



Graph-1: *Per cent change in agro-economic parameter*



Graph-2: *Per cent change in Resource utilization*



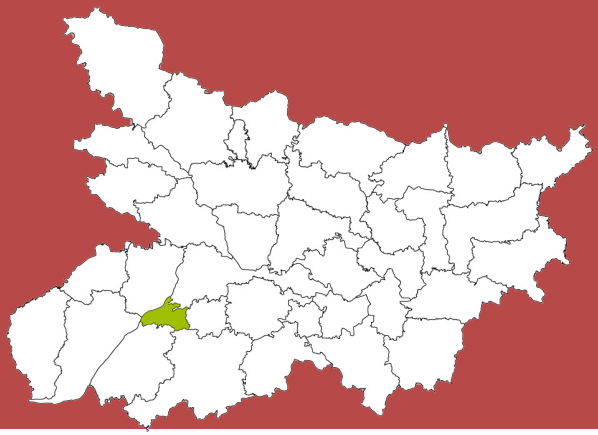
Graph-3: *Per cent change in cost of farm operations*

(especially rice) before crop establishment. Another major savings in cultivation costs was through reduced cost in land preparation with maximum reduction in wheat and lentil (100%). However, in Araria, the maize crop recorded increased crop establishment and weed control costs mainly due to the introduction of mechanized seeding and crop establishment methods which farmers previously did manually.

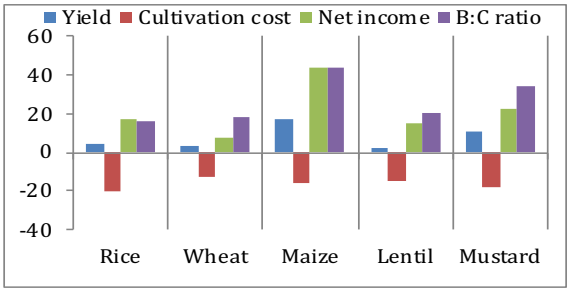
Table: *Percent change in crop performance over different agro-economic parameters for the district of Araria*

Particulars	Rice	Wheat	Maize	Lentil	Mustard
Yield	11.7	17.5	8.0	13.6	14.3
Cultivation cost	-13.6	-14.7	17.6	-18.5	-26.4
Net income	22.6	29.6	21.3	23.1	31.5
B:C ratio	24.2	37.8	2.3	21.2	55.2
Seed requirement	-27.8	-20.00	-27.27	-15.79	-33.33
Fuel consumption	-35.1	-21.05	-11.76	-35.29	-8.33
Crop duration	-2.8	-0.79	-1.95	0.00	0.00
N fertilizer consumption	2.3	3.06	-6.25	0.00	14.29
Pesticide use	166.7	-17.14	-27.08	0.00	-28.39
Land preparation	-59.50	-100.00	14.10	-100.00	-21.43
Crop Establishment	-76.80	-10.55	-51.80	16.67	43.97
Fertilizer & its application	-10.57	-23.51	-6.13	0.00	23.08
Weed control	40.16	69.67	4.75	110.46	0.00
Irrigation	-10.60	-10.65	-9.42	-100.00	-11.93

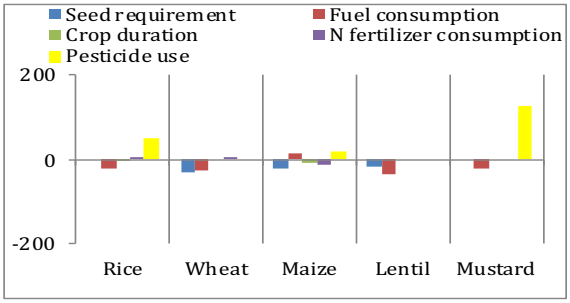
ARWAL



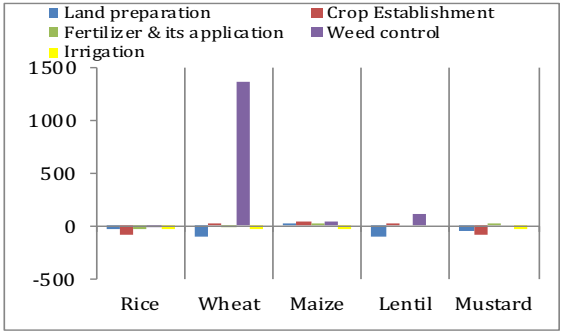
- With the implementation of the CRA program significant changes in agro – economic parameters for different crops were observed. The major interventions implemented through the CRA program involved direct seeding in rice (DSR), zero tillage in wheat (ZTW), raised bed / ZT in maize (RBM/ZTM) and zero tillage in lentil and mustard (ZTL and ZTMus). Maximum yield benefit was observed in maize and mustard (11-17%) while in rice, wheat and lentil it was only around 3%. The gain in net income varied from 7-40% for different crops (highest in maize). Maize received increased productivity and profitability (43%) whereas rice and wheat got relatively lower benefits (approx. 16%) as compared to other crops.
- Shifting from traditional crop establishment practices to CRA interventions resulted in a 12 – 20 percent reduction in cultivation costs. This was mainly due to reduced seed (15-30%) and fuel requirements (21-35%). The benefits of DSR were suppressed mainly due to increased use of pesticides which was nearly 50% prior to the CRA program.
- The savings in production costs were mainly envisaged through reduced crop establishment costs (16 – 80%) with



Graph-1: *Per cent change in agro-economic parameter*



Graph-2: *Per cent change in Resource utilization*

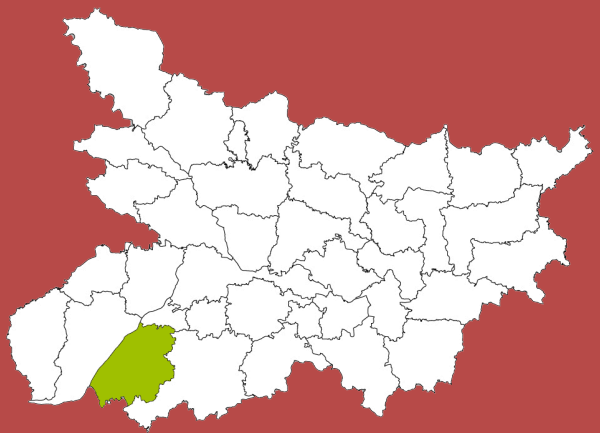


Graph-3: *Per cent change in cost of farm operations*

maximum reductions in rice and mustard (79%) where intensive tillage operations are required (especially rice) before crop establishment. Another major savings in the cost of cultivation was through reduced irrigation water requirements. CRA reduced irrigation application costs by 21-25%. However, in Arwal, wheat crop recorded reduced crop establishment costs and irrigation costs mainly due to introduction of mechanized seeding and crop establishment method which farmers previously did manually.

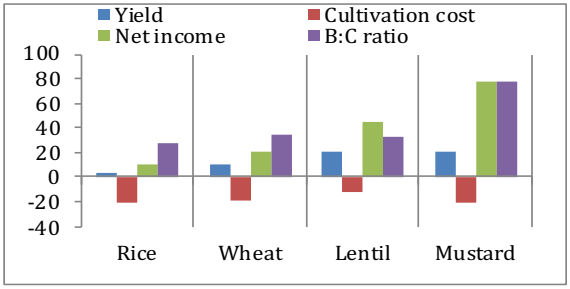
Table: *Percent change in crop performance over different agro-economic parameters for the district of Arwal*

Particular	Rice	Wheat	Maize	Lentil	Mustard
Yield	3.8	3.31	17.01	2.27	10.53
Cultivation cost	-19.7	-12.20	-15.56	-14.75	-17.66
Net income	17.5	7.1	43.00	15.33	22.80
B:C ratio	16.1	17.7	43.80	19.97	34.24
Seed requirement	0.00	-30.00	-18.9	-15.79	0.00
Fuel consumption	-23.08	-24.53	16.4	-35.29	-21.74
Crop duration	-3.57	0.00	-9.4	0.00	0.00
N fertilizer consumption	2.04	1.96	-13.2	0.00	0.00
Pesticide use	50.00	0.00	18.4	0.00	128.57
Land preparation	-33.85	-100.00	22.1	-100.00	-42.04
Crop Establishment	-80.71	16.67	43.9	16.67	-76.92
Fertilizer & its application	-20.28	-13.45	16.9	0.00	2.86
Weed control	-17.85	1370.59	42.3	110.46	0.00
Irrigation	-25.13	-24.15	-21.8	0.00	-20.00

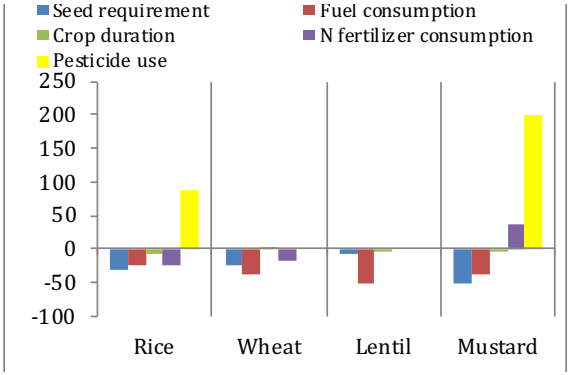


AURANGABAD

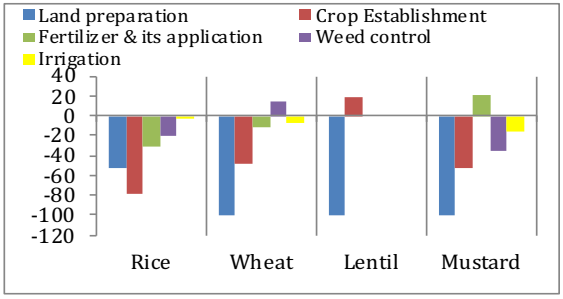
- Maximum yield increase was recorded in mustard and lentil (21%); and for other crops it ranged between (3-9%). Maximum increase in net income (77%) was recorded in mustard and (45%) in lentil crops while rice showed relatively lower benefits (10%) in increased profitability compared to other crops.
- Shifting from traditional crop establishment practices to CRA interventions resulted in 21% reduced cultivation costs in rice and mustard. For other crops it ranged between (12-18%). This was mainly due to reduced seed (5-50%) and fuel requirements (25-52%). Application of liquid pesticides was found to increase by 200 percent in mustard. DSR benefits were suppressed mainly due to the increased use of liquid pesticides. This was more than 86% compared to the quantity of liquid pesticide used in rice prior to the CRA program.
- In Aurangabad, the savings in irrigation costs were low for rice (2%) and wheat (8%) while the highest savings in irrigation costs were recorded in mustard as due to zero tillage the residual moisture reduced the water requirement of the crop.
- The savings in production costs were mainly envisaged through reduced crop



Graph-1: *Per cent change in agro-economic parameter*



Graph-2: *Per cent change in Resource utilization*



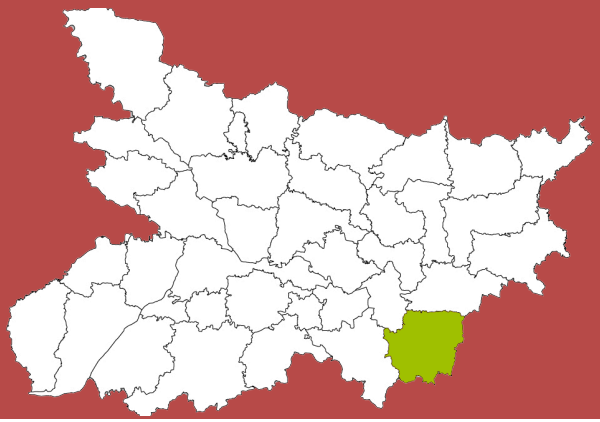
Graph-3: *Per cent change in cost of farm operations*

establishment costs (48–79%) with maximum reduction in rice (>79%) followed by mustard (>53%) where intensive tillage operations are required (especially rice) before crop establishment. Another major savings in cultivation costs was through reduced cost in land preparation with maximum reduction in wheat, mustard and lentil (100%). CRA reduced irrigation application costs by 2-16%.

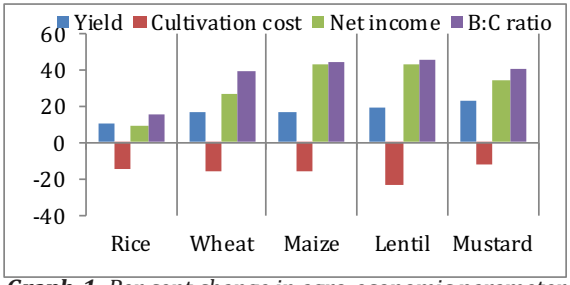
Table: *Percent change in crop performance over different agro-economic parameters for the district of Aurangabad*

Particular	Rice	Wheat	Lentil	Mustard
Yield	3.4	9.63	20.93	21.05
Cultivation cost	-21.6	-18.61	-12.16	-20.03
Net income	10.2	20.2	44.93	77.45
B:C ratio	26.9	34.7	33.40	76.81
Seed requirement	-30.77	-24.14	-5.88	-50.00
Fuel consumption	-25.00	-37.93	-52.38	-36.67
Crop duration	-7.38	2.27	-0.83	-5.43
N fertilizer consumption	-25.00	-16.07	0.00	35.48
Pesticide use	86.67	0.00	0.00	200.00
Land preparation	-53.66	-100.00	-100.00	-100.00
Crop Establishment	-79.02	-48.15	18.24	-53.33
Fertilizer & its application	-30.33	-12.46	0.00	20.69
Weed control	-20.00	14.76	0.00	-34.78
Irrigation	-2.14	-8.09	0.00	-16.67

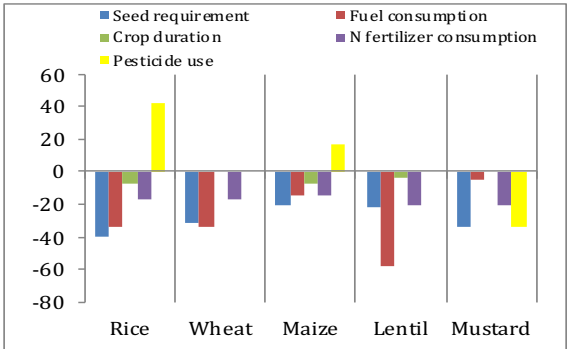
BANKA



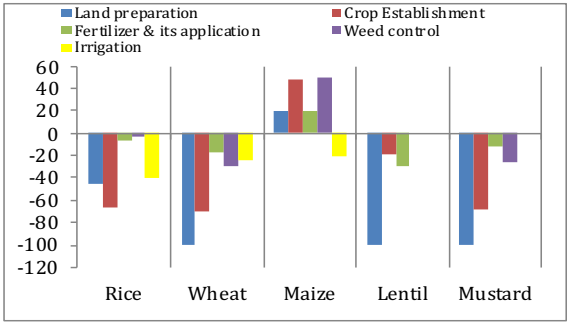
- Maximum yield increase was recorded in mustard and lentil (21%); and for other crops it ranged between (3-9%). Maximum increase in net income (77%) was recorded in mustard and (45%) in lentil crops while rice showed relatively lower benefits (10%) in increased profitability compared to other crops.
- Shifting from traditional crop establishment practices to CRA interventions resulted in 21% reduced cultivation costs in rice and mustard. For other crops it ranged between (12-18%). This was mainly due to reduced seed (5-50%) and fuel requirements (25-52%). Application of liquid pesticides was found to increase by 200 percent in mustard. DSR benefits were suppressed mainly due to the increased use of liquid pesticides. This was more than 86% compared to the quantity of liquid pesticide used in rice prior to the CRA program.
- In Aurangabad, the savings in irrigation costs were low for rice (2%) and wheat (8%) while the highest savings in irrigation costs were recorded in mustard as due to zero tillage the residual moisture reduced the water requirement of the crop.
- The savings in production costs were mainly envisaged through reduced crop



Graph-1: *Per cent change in agro-economic parameter*



Graph-2: *Per cent change in Resource utilization*



Graph-3: *Per cent change incost of farm operations*

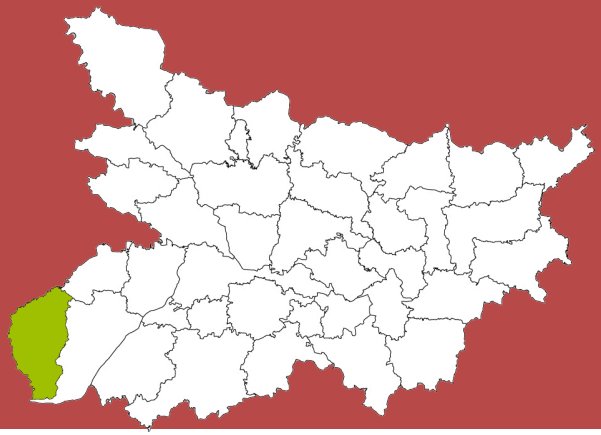
establishment costs (48–79%) with maximum reduction in rice (>79%) followed by mustard (>53%) where intensive tillage operations are required (especially rice) before crop establishment. Another major savings in cultivation costs was through reduced cost in land preparation with maximum reduction in wheat, mustard and lentil (100%). CRA reduced irrigation application costs by 2-16%.

- The savings in cost of production was mainly envisaged through reduced crop establishment costs (20 – 70%) with maximum reduction in rice, wheat, lentil and mustard where intensive tillage operations are required (especially rice) before crop establishment. Another major savings in cost of cultivation was through reduced irrigation water requirement. On an average 20-40% reduction in irrigation application costs was observed due to CRA. However, in Banka, maize crop recorded increased crop establishment, land preparation, fertilizer and weed control costs mainly due to introduction of mechanized seeding and crop establishment method which farmers previously did manually.

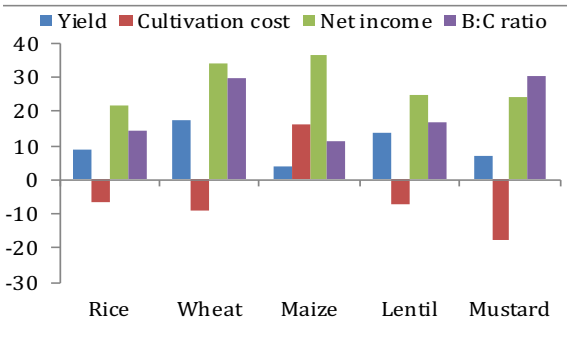
Table: *Percent change in crop performance over different agro-economic parameters for the district of Banka*

Particular	Rice	Wheat	Maize	Lentil	Mustard
Yield	9.6	16.28	17.01	18.92	22.22
Cultivation cost	-15.18	-16.41	-15.56	-23.29	-12.49
Net income	9.27	26.3	43.00	43.29	34.37
B:C ratio	14.59	39.1	43.80	45.36	39.66
Seed requirement	-40.00	-31.03	-20.00	-21.74	-33.33
Fuel consumption	-33.33	-33.33	-14.71	-57.89	-5.00
Crop duration	-7.59	0.00	-7.14	-4.00	0.00
N fertilizer consumption	-16.67	-16.67	-14.29	-20.00	-20.00
Pesticide use	42.00	0.00	16.67	0.00	-33.33
Land preparation	-44.88	-100.00	20.00	-100.00	-100.00
Crop Establishment	-67.13	-69.57	48.00	-19.54	-68.18
Fertilizer & its application	-6.74	-16.80	20.00	-29.09	-11.11
Weed control	-3.13	-30.00	50.00	0.00	-25.93
Irrigation	-40.62	-24.97	-20.00	0.00	0.00

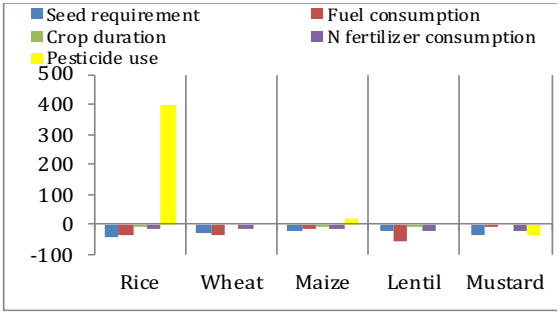
BHABHUA (KAIMUR)



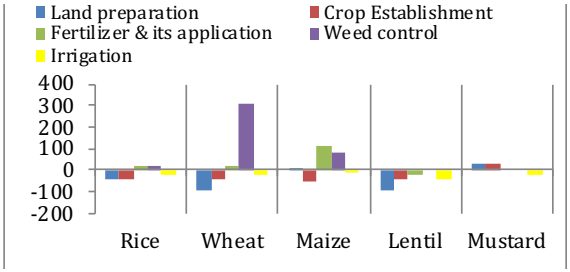
- With the implementation of the CRA program significant changes in agro – economic parameters for different crops were observed. The major interventions implemented through CRA program involved direct seeding in rice (DSR), zero tillage in wheat (ZTW), raised bed / zero tillage in maize (RBM/ ZTM) and zero tillage in lentil and mustard (ZTL and ZTMus). Maximum increase in yield was recorded in wheat and lentil (14-17%) and net income was recorded in Maize and wheat crop (34-37%).Except for maize crop, the cost of cultivation was reduced by 7-18% while maize recorded 16% increased cost of cultivation.
- Shifting from traditional crop establishment practices to CRA interventions resulted in 6 – 17 percent reduced cultivation costs. This was mainly due to reduced requirement of inputs like seed (20-40%), fuel (5-33%) and fertilizer (15-20%). DSR benefits were suppressed mainly due to increased use of pesticides. This was more than double the quantity of pesticides being used in rice prior to the CRA program.
- The savings in production costs was mainly envisaged through reduced crop



Graph-1: *Per cent change in agro-economic parameter*



Graph-2: *Per cent change in Resource utilization*



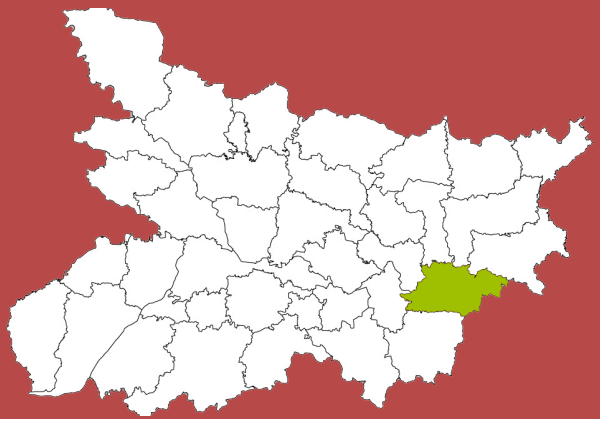
Graph-3: *Per cent change incost of farm operations*

establishment costs (29-53%) with maximum reduction in rice, lentil, wheat and mustard where intensive tillage operations are required (especially rice) before crop establishment. Another major savings in the cost of cultivation was through reduced irrigation water requirement. CRA interventions reduced irrigation application costs by 15-26%. However, in Bhabhua (Kaimur), maize crop recorded increased crop establishment, land preparation, fertilizer and weed control costs mainly due to introduction of mechanized seeding and crop establishment methods which farmers previously did manually.

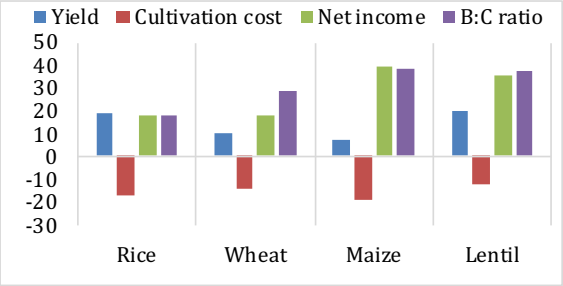
Table: *Percent change in crop performance over different agro-economic parameters for the district of Bhabhua (Kaimur)*

Particular	Rice	Wheat	Lentil	Maize	Mustard
Yield	9.1	17.65	13.5	3.76	7.14
Cultivation cost	-6.80	-9.29	-7.1	16.44	-17.73
Net income	21.73	34.1	25.1	36.80	24.28
B:C ratio	14.24	29.7	16.8	11.11	30.24
Seed requirement	-40.00	-31.03	-20	-21.74	-33.33
Fuel consumption	-33.33	-33.33	-14.71	-57.89	-5.00
Crop duration	-7.59	0.00	-7.14	-4.00	0.00
N fertilizer consumption	-16.67	-16.67	-14.29	-20.00	-20.00
Pesticide use	400.00	0.00	16.67	0.00	-33.33
Land preparation	-46.2	-100.00	-100	1.63	25.00
Crop Establishment	-49.1	-41.67	-41.3	-53.11	29.13
Fertilizer & its application	15.8	19.44	-19.3	112.80	0.00
Weed control	21.3	302.94	00	80.98	0.00
Irrigation	-26.5	-21.30	-41.9	-15.86	-21.60

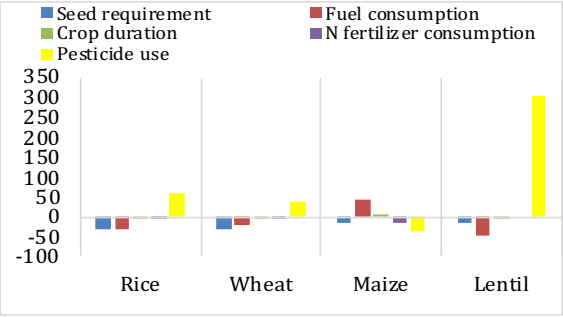
BHAGALPUR



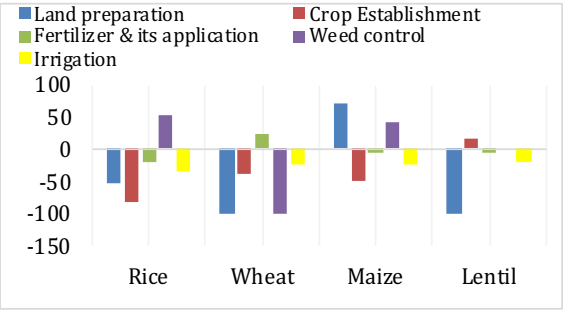
- With the implementation of the CRA program significant changes in agro – economic parameters for different crops were observed. The major interventions implemented through the CRA program involved direct seeding in rice (DSR), zero tillage in wheat (ZTW), raised bed / ZT in maize (RBM/ZTM) and zero tillage in lentil and mustard (ZTL and ZTMus). Maximum increase in yield and net income (>40%) was recorded in maize and lentil crops while rice recorded relatively lower benefits (10-15%) in increased productivity and profitability compared to other crops.
- Shifting from traditional crop establishment practices to CRA interventions resulted in a 12 – 23 percent reduction in cultivation costs. This was mainly due to reduced input requirements for seed (20-40%), fuel (15-58%) and fertilizer (14-20%). DSR benefits were suppressed primarily due to increased use of pesticides. This was more than double the quantity of pesticides being used in rice prior to the CRA program. ZT also resulted in reducing crop duration by 5-8 days mainly in maize due to DSR in rice.
- The savings in production costs were



Graph-1: *Per cent change in agro-economic parameter*



Graph-2: *Per cent change in Resource utilization*



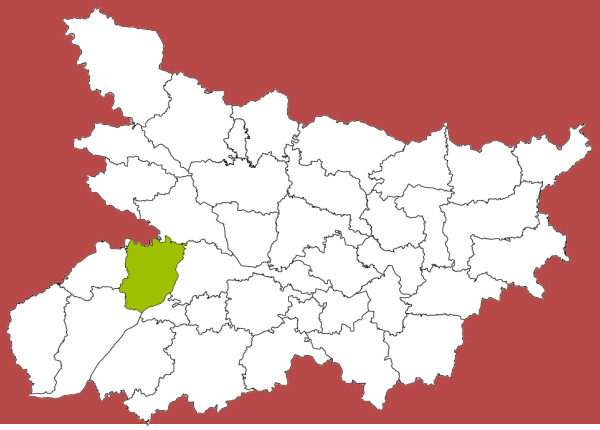
Graph-3: *Per cent change incost of farm operations*

mainly envisaged through reduced crop establishment costs (20 – 70%) with maximum reduction in rice, wheat, lentil and mustard where intensive tillage operations are required (especially rice) before crop establishment. Another major savings in the cost of cultivation was through reduced irrigation and water requirements. CRA observed a 20-40% reduction in irrigation application costs. However, in Bhagalpur, the maize crop recorded increased crop establishment, land preparation, fertilizer and weed control costs. This was mainly due to the introduction of mechanized seeding and

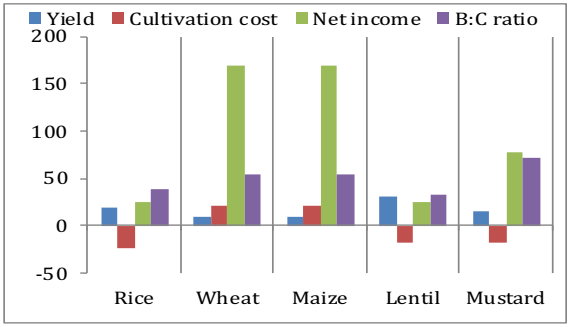
Table: *Percent change in crop performance over different agro-economic parameters for the district of Bhagalpur*

Particular	Rice	Wheat	Maize	Lentil
yield	19.2	10.30	7.27	20.34
COC/acre)	-17.47	-14.34	-19.42	-12.13
Net income/acre)	17.54	17.9	39.27	35.90
B:C Ratio	17.92	28.8	38.17	36.95
Seed requirement (kg)	-31.58	-32.26	-18.18	-15.00
Fuel req (L)	-33.33	-19.23	41.18	-48.00
Crop duration	-7.53	-2.94	0.67	-0.74
Fertilizer (kg N)	-2.44	-5.00	-13.64	0.00
Liquid Pesticides (ml)	56.25	35.33	-37.50	300.00
Land preparation	-52.95	-100.00	69.70	-100.00
Crop Establishment	-81.38	-37.50	-51.11	16.67
Fertilizers	-21.73	22.16	-4.74	-7.37
Weed control	52.04	-100.00	41.21	0.00
Irrigation	-34.10	-24.73	-24.00	-18.75

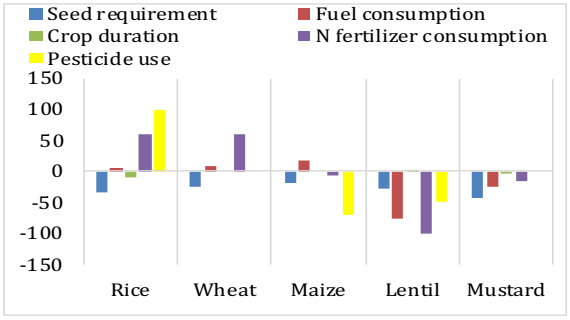
BHOJPUR



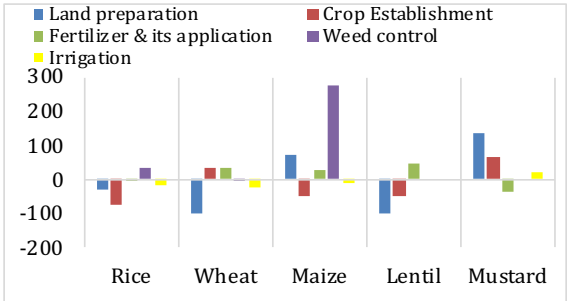
- Maximum yield increase was recorded in lentil (31%) followed by rice and mustard (15-20%). However for wheat and maize the yield increase was only around 9%. Maximum increase in net income was recorded in wheat and maize (168%) while lentil showed relatively lower benefits (24%) in increased productivity and profitability compared to other crops.
- Shifting from traditional crop establishment practices to CRA interventions resulted in 24% reduced cultivation costs in rice and for lentil and mustard crops (>18%). This was mainly due to reduced requirement for inputs like seed (20-42%) and fuel (>76%) in lentil and (>24%) in mustard. DSR benefits were suppressed mainly due to the increased use of liquid pesticides. This was double the quantity of liquid pesticides being used in rice prior to the CRA program.
- In Bhojpur, rice and wheat crops recorded higher irrigation and water costs savings of 20-25% and 11% in maize. However, in mustard increased land preparation and irrigation costs contributed to higher cultivation costs.
- The savings in production costs was mainly envisaged through reduced crop establishment costs (46-76%) with maximum



Graph-1: *Per cent change in agro-economic parameter*



Graph-2: *Per cent change in Resource utilization*



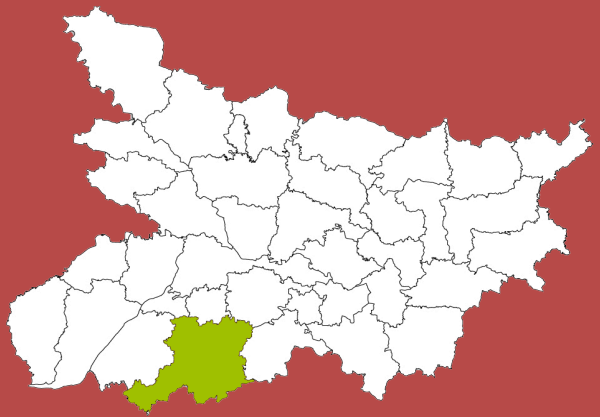
Graph-3: *Per cent change incost of farm operations*

reduction in rice (76%), followed by maize and lentil where intensive tillage operations are required (especially rice) before crop establishment. Another major savings in cultivation costs was through reduced cost in land preparation with maximum reduction in wheat and lentil (100%). However, in Bhojpur, maize crop recorded increased land preparation, fertilizer and weed control costs mainly due to introduction of mechanized seeding and crop establishment methods which farmers previously did manually.

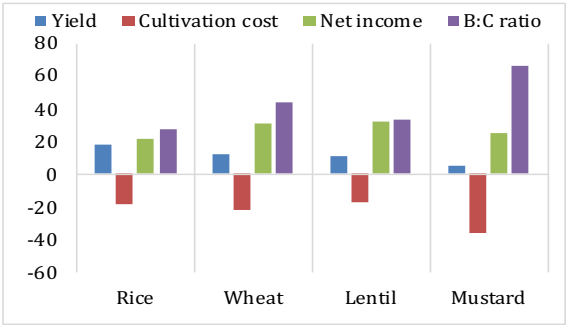
Table: *Percent change in crop performance over different agro-economic parameters for the district of Bhojpur*

Particular	Rice	Wheat	Maize	Lentil	Mustard
Yield	19.6	9.21	9.21	31.25	14.71
Cultivation cost	-23.96	20.45	20.45	-18.98	-18.52
Net income	25.32	168.86	168.86	24.95	76.81
B:C ratio	39.30	53.34	53.34	32.37	71.26
Seed requirement	-33.33	-25.00	-20.00	-27.27	-42.86
Fuel consumption	5.13	7.69	16.67	-76.92	-23.53
Crop duration	-9.15	0.00	0.00	1.69	-4.35
N fertilizer consumption	60.00	60.00	-5.45	-100.00	-16.28
Pesticide use	100.00	0.00	-70.00	-50.00	0.00
Land preparation	-27.66	-100.00	71.73	-100.00	133.10
Crop Establishment	-76.80	33.33	-50.00	-46.97	67.00
Fertilizer & its application	-5.59	30.48	25.34	43.75	-39.44
Weed control	33.33	-0.50	273.13	0.00	0.00
Irrigation	-20.00	-25.00	-10.67	0.00	19.23

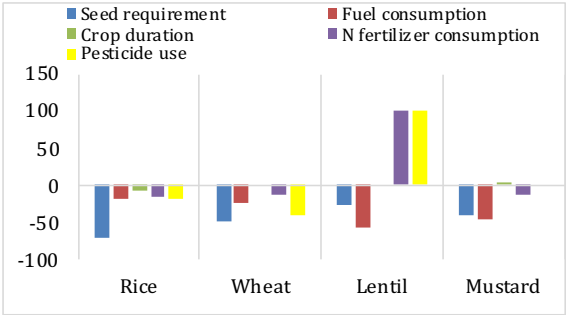
GAYA



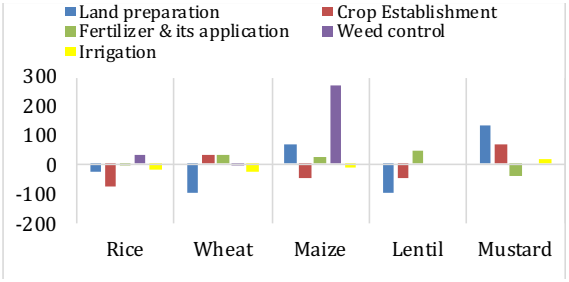
- With the implementation of the CRA program significant changes in agro – economic parameters for different crops was observed. The major interventions implemented through CRA program involved direct seeding in rice (DSR), zero tillage in wheat (ZTW), zero tillage in lentil and mustard (ZTMus). Maximum increase in yield was recorded in Rice (18%) followed by wheat and lentil (10-12%). The gain in net income was higher in wheat and lentil (32%) while in rice and mustard net income was increased by 21-25%.
- Shifting from traditional crop establishment practices to CRA interventions resulted in 16 – 36 percent reduced cost of cultivation. This was mainly due to reduced requirement of inputs like seed (27-71%), fuel (20-57%) and fertilizer (12-100%). The pattern of liquid pesticide use showed a reduced
- The savings in cost of production was mainly envisaged through reduced crop establishment costs (13– 78%) with maximum reduction in rice, wheat, lentil and mustard where intensive tillage operations are required (especially rice) before crop establishment. Another major savings in cost of cultivation was through reduced irrigation



Graph-1: *Per cent change in agro-economic parameter*



Graph-2: *Per cent change in Resource utilization*



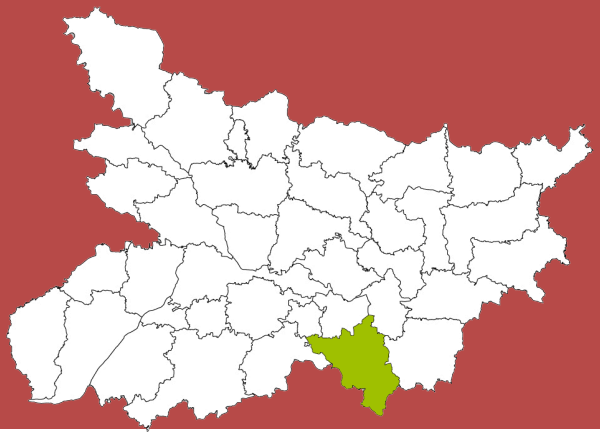
Graph-3: *Per cent change incost of farm operations*

water requirement. On an average 17-45% reduction in irrigation application costs was observed due to CRA. However, in Gaya, maize crop recorded increased crop establishment, land preparation, fertilizer and weed control costs mainly due to introduction of mechanized seeding and crop establishment method which farmers previously did manually.

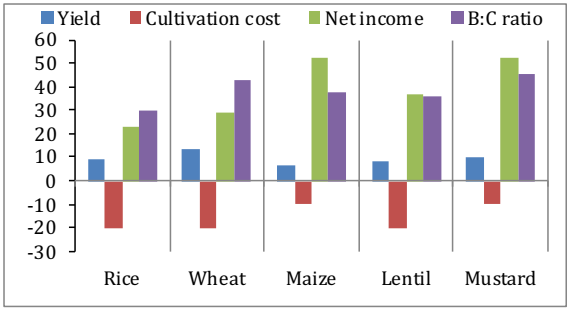
Table: *Percent change in crop performance over different agro-economic parameters for the district of Gaya*

Particular	Rice	Wheat	Lentil	Mustard
Yield	17.5	11.72	10.26	5.13
Cultivation cost	-18.47	-22.05	-16.86	-36.67
Net income	21.40	30.8	31.80	24.71
B:C ratio	27.42	43.3	32.61	66.00
Seed requirement	-71.43	-49.28	-27.27	-41.67
Fuel consumption	-20.00	-25.00	-57.69	-46.15
Crop duration	-8.45	0.00	0.00	3.33
N fertilizer consumption	-17.24	-12.73	100.00	-13.51
Pesticide use	-17.84	-42.06	100.00	0.00
Land preparation	-52.90	-100.00	-100.00	-100.00
Crop Establishment	-78.57	-40.48	-13.79	-41.18
Fertilizer & its application	11.17	22.46	12.36	-40.40
Weed control	-23.33	15.10	20.90	0.00
Irrigation	-45.12	-17.56	-43.23	-21.05

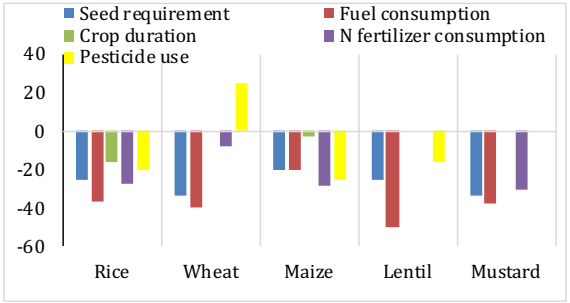
JAMUI



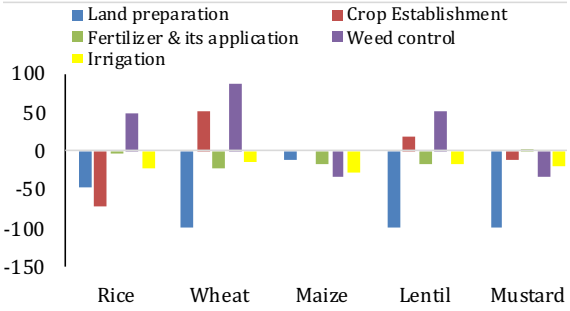
- With the implementation of the CRA program, significant changes in agro – economic parameters for different crops were observed. The major interventions implemented through CRA program include direct seeding in rice (DSR), zero tillage in wheat (ZTW), raised bed / ZT in maize (RBM/ ZTM) and zero tillage in lentil and mustard (ZTL and ZTMus). Among the crops grown percentage increase in yield varied from (6.5-9.7 %) and percentage increase in net income was recorded (>50%) in maize and mustard. Rice and wheat recorded a higher percentage decrease (>20%) in cultivation costs due to a decrease in the cost of seed, fuel, fertilizer and land preparation. The profitability of rice and wheat is also comparable with other crops.
- Shifting from traditional crop establishment practices to CRA interventions resulted in a 10 – 22 percent reduction in the cost of cultivation. This was mainly due to reduced input requirements like seed (20-25%), fuel (20-50%) and fertilizer (10-30%). DSR benefits were lowered mainly due to increased use of weed control chemicals. This showed a two-fold increase in pesticide use in rice prior to the CRA program.
- Rice crop establishment is the main strategy



Graph-1: *Per cent change in agro-economic parameter*



Graph-2: *Per cent change in Resource utilization*



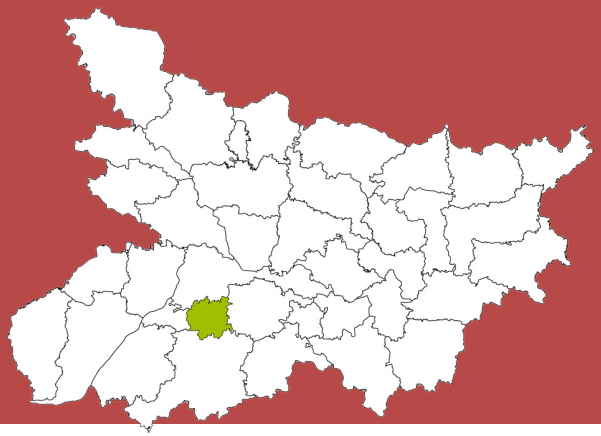
Graph-3: *Per cent change incost of farm operations*

used to minimise production costs, as it requires a lot of tillage activities before crop establishment. In Jamui, the reduction in rice cultivation costs was due to an increase in crop establishment (>70%), reduction in land preparation (48%), fertilizer (27%) and irrigation costs (23%). Mechanization in the farmers' field is the biggest reason for further cost reduction as previously farmers did all farm operations manually. Reduced irrigation water requirements led to significant crop cost reductions. On average, 14-28% reduction in irrigation application costs was observed due to CRA across all crops.

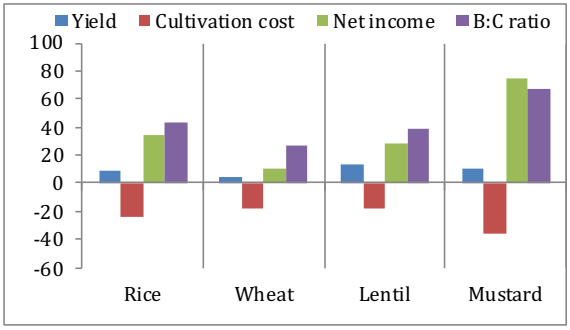
Table: *Percent change in crop performance over different agro-economic parameters for the district of Jamui*

Particular	Rice	Wheat	Maize	Lentil	Mustard
Yield	9.2	13.60	6.49	8.33	9.68
Cultivation cost	-20.23	-20.29	-9.84	-20.09	-10.28
Net income	23.03	28.6	52.05	36.96	52.41
B:C ratio	30.16	42.5	37.64	35.57	45.63
Seed requirement	-25.00	-33.33	-20.00	-25.00	-33.33
Fuel consumption	-36.84	-39.29	-20.00	-50.00	-38.10
Crop duration	-16.13	0.00	-3.23	0.00	0.00
N fertilizer consumption	-27.27	-8.33	-28.57	0.00	-30.00
Pesticide use	-20.00	25.00	-25.00	-16.67	0.00
Land preparation	-48.72	-100.00	-11.11	-100.00	-100.00
Crop Establishment	-72.00	50.00	0.00	16.67	-12.50
Fertilizer & its application	-3.13	-21.88	-16.67	-16.67	2.56
Weed control	49.12	87.50	-33.33	50.00	-33.33
Irrigation	-23.08	-14.29	-28.13	-16.67	-20.00

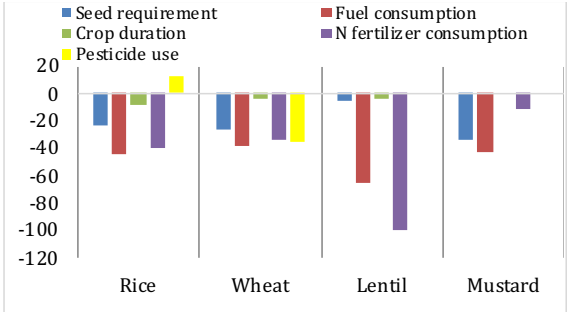
JEHANABAD



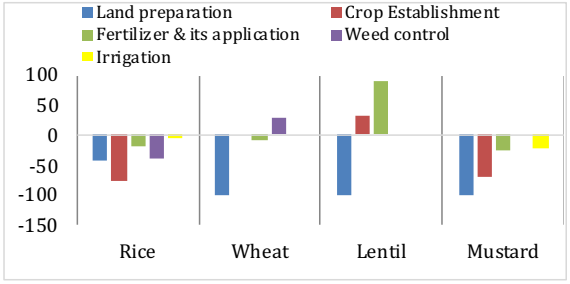
- Impact of CRA program can be properly assessed by calculating the significant changes in agro – economic parameters for different crops due to the interventions followed. Mainly the interventions like seeding in rice (DSR), zero tillage in wheat (ZTW), raised bed / ZT in maize (RBM/ZTM) and zero tillage in lentil and mustard (ZTL and ZTMus) were implemented. The increase in the yield may vary from 4% in wheat to 14% in lentil and the increased net income obtained from increased yield and reduced input cost varies from 9% in wheat, 34% in rice to 75% in mustard.Increased benefit in rice and mustard was observed due to significant decline in cost of cultivation.
- Adopting CRA interventions has resulted in up to 75%decline in the cost of cultivation, mainly due to reduced requirement of inputs like seed (5-33%), fuel (38-65%) and fertilizer (11-100%). The benefits of DSR and ZT system were mainly due to reduced input cost majorly from land preparation (43-100%) and fuel requirement (38-65%).
- The cost reduction in the crop establishment (upto 77%), with the greatest savings in rice and mustard where heavy tillage operations are needed (particularly rice), was the main



Graph-1: *Per cent change in agro-economic parameter*



Graph-2: *Per cent change in Resource utilization*



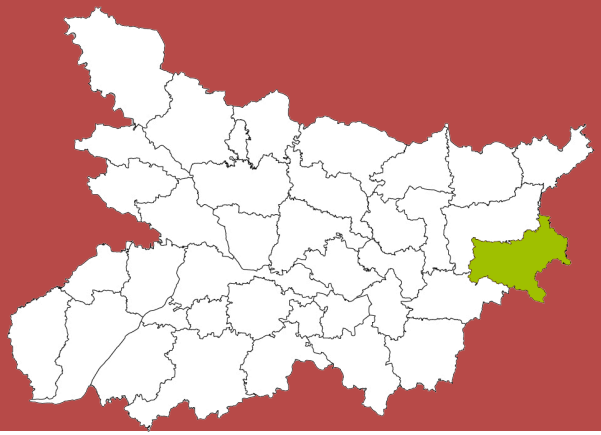
Graph-3: *Per cent change incost of farm operations*

strategy used to minimise production costs. Reducing number of irrigations also results in significant cost savings in the current scenario. Due to CRA, irrigation application costs were reduced by an average of 05–21%. On the same note, Jehanabad, recorded reduced crop establishment, land preparation, fertilizer and weed control costs in rice mainly due to introduction of mechanized seeding and crop establishment method which farmers previously did manually.

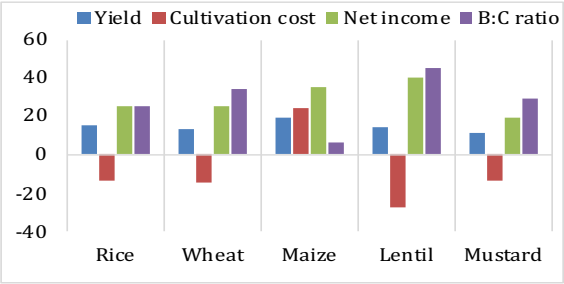
Table: *Percent change in crop performance over different agro-economic parameters for the district of Jehanabad*

Particular	Rice	Wheat	Lentil	Mustard
Yield	8.9	4.55	14.04	10.81
Cultivation cost	-24.45	-17.96	-18.14	-35.26
Net income	34.86	9.7	28.39	75.15
B:C ratio	43.54	27.4	39.30	67.30
Seed requirement	-23.08	-25.93	-5.88	-33.33
Fuel consumption	-44.12	-38.24	-65.22	-43.48
Crop duration	-8.67	-3.85	-4.17	0.00
N fertilizer consumption	-39.62	-34.25	-100.00	-11.11
Pesticide use	12.00	-35.48	0.00	0.00
Land preparation	-43.60	-100.00	-100.00	-100.00
Crop Establishment	-77.27	0.00	33.08	-68.61
Fertilizer & its application	-19.22	-9.18	88.78	-25.37
Weed control	-40.16	28.99	0.00	0.00
Irrigation	-5.00	0.00	0.00	-21.21

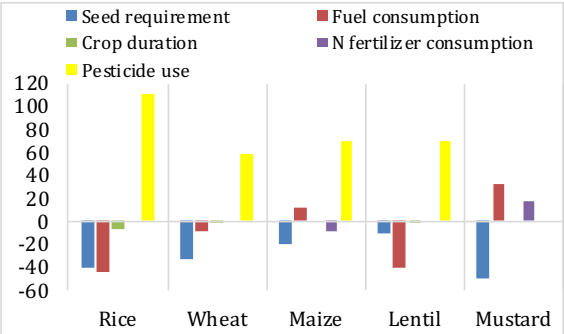
KATIHAR



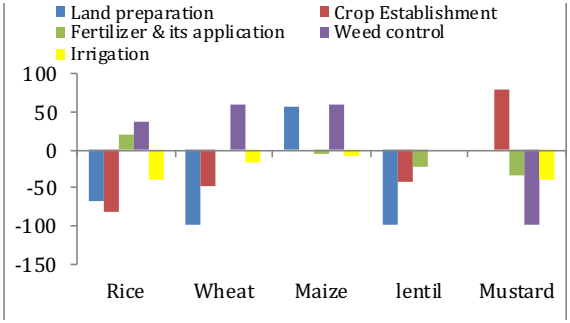
- In CRA program the implementation of the following interventions results in significant changes in agro – economic parameters for different crops. The major interventions implemented through CRA program involved direct seeding in rice (DSR), zero tillage in wheat (ZTW), raised bed / ZT in maize (RBM/ ZTM) and zero tillage in lentil and mustard (ZTL and ZTMus). Percentage increase in yield of the crops vary from (10 to 18%) and increase in the net income ranged upto 39% in lentil and 34% in maize crop while rice, wheat and mustard recorded relatively less increase (15-25%) due to increased productivity and profitability.
- Shifting from traditional crop practices to CRA interventions resulted in 15 – 28 percent reduced cost of cultivation. This was mainly due to reduced requirement of inputs like seed (11-50%), fuel (09-45%) and fertilizer (upto 9%). The profits in DSR were suppressed mainly due increased use of pesticides which was >100% the quantity of pesticide being used in rice prior to CRA program. However, reduced DSR crop duration by 5-6 days promotes the timely sowing of next crop, as a result of which we can take more than two crops in a year.



Graph-1: *Per cent change in agro-economic parameter*



Graph-2: *Per cent change in Resource utilization*



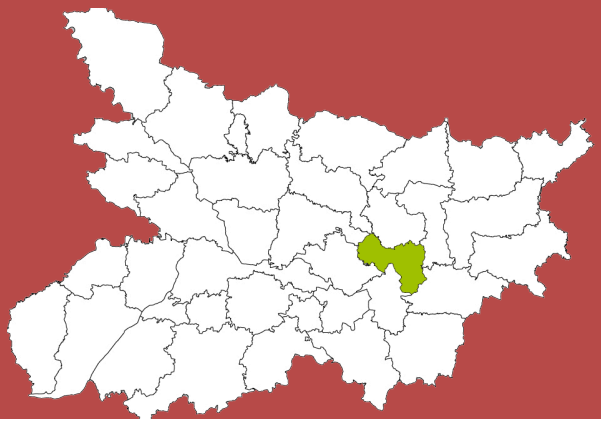
Graph-3: *Per cent change incost of farm operations*

- When it comes to rice and wheat, where intense tillage activities are needed (particularly for rice) prior to crop establishment, the cost of crop establishment lowered the most (by 40 to 80%) due to increased mechanization, reduced land preparation and input cost. However, prior to mechanisation farmers carryout all farm operations manually, which increased the cost of cultivation and decreased profitability.Reduced irrigation water requirements contributed significantly to further reductions in the cultivation costs. Due to CRA, irrigation application costs were reduced by 15–40% in Katihar in major cereal crops mainly in rice due to reduced water need at the time of land preparation.

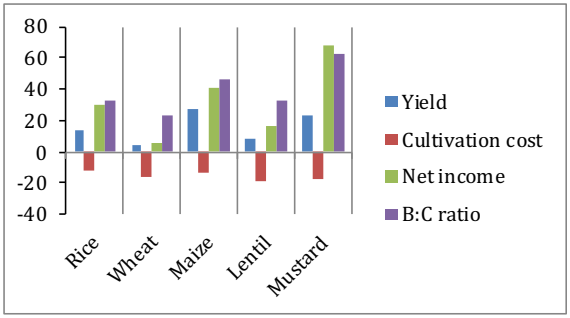
Table: *Percent change in crop performance over different agro-economic parameters for the district of Katihar*

Particular	Rice	Wheat	Maize	Lentil	Mustard
Yield	14.7	13.04	18.71	13.89	10.87
Cultivation cost	-14.29	-15.38	23.59	-28.03	-13.89
Net income	24.61	25.1	34.85	39.79	18.57
B:C ratio	25.12	33.6	6.25	45.24	28.75
Seed requirement	-40.00	-33.33	-20.00	-11.11	-50.00
Fuel consumption	-45.00	-9.09	12.50	-40.00	32.00
Crop duration	-6.21	-1.60	0.00	-1.54	0.00
N fertilizer consumption	0.00	0.00	-9.09	0.00	16.67
Pesticide use	110.00	57.89	70.00	70.00	0.00
Land preparation	-67.39	-100.00	58.00	-100	0.00
Crop Establishment	-81.25	-46.88	0.00	-42.6	80.00
Fertilizer & its application	21.43	0.00	-4.76	-21.1	-32.00
Weed control	37.50	60.00	61.54	0	-100.00
Irrigation	-40.00	-15.79	-6.67	0	-39.60

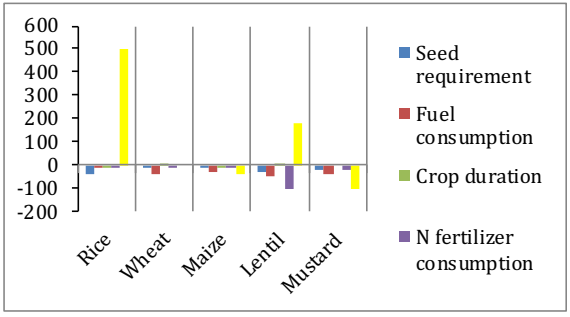
KHAGARIA



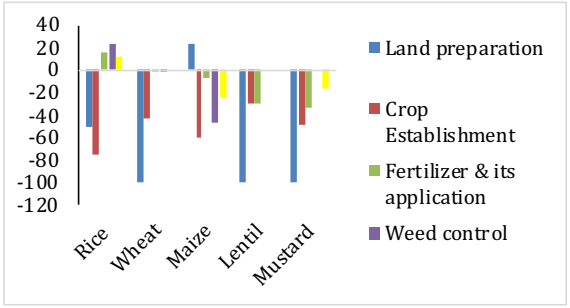
- With the implementation of the CRA program significant changes in agro – economic parameters for different crops was observed. The major interventions implemented through CRA program involved direct seeding in rice (DSR), zero tillage in wheat (ZTW), raised bed / ZT in maize (RBM/ZTM) and zero tillage in lentil and mustard (ZTL and ZTMus). Maximum increase in yield and net income (>67%) was recorded in Maize and Mustard crop while wheat recorded relatively lower benefits (5-67%) in increased productivity and profitability as compared to other crops.
- Shifting from traditional crop establishment practices to CRA interventions resulted in 11 – 19 percent reduced cost of cultivation. This was mainly due to reduced requirement of inputs like seed (10-33%), fuel (10-42%) and fertilizer (4-100%). The benefits of DSR were suppressed mainly due increased use of pesticides which was more than double to the quantity of pesticide being used in rice prior to CRA program.
- The savings in cost of production was mainly envisaged through reduced crop establishment costs (30 – 75%) with maximum reduction in rice, maize,mustard,wheat and lentil where intensive tillage operations are required



Graph-1: *Per cent change in agro-economic parameter*



Graph-2: *Per cent change in Resource utilization*



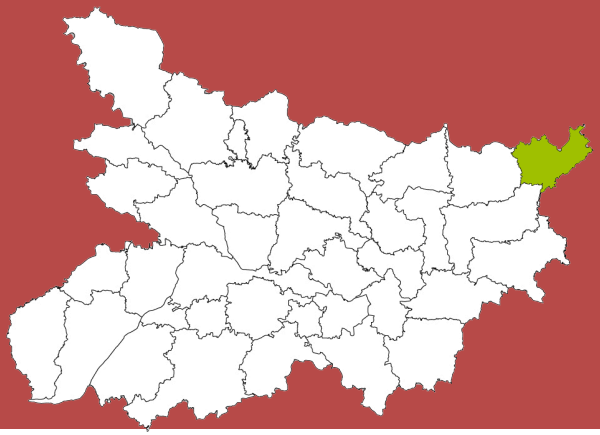
Graph-3: *Per cent change incost of farm operations*

(especially rice) before crop establishment. Another major savings in cost of cultivation was through reduced irrigation water requirement. On an average 12-23% reduction in irrigation application costs was observed due to CRA. However, in Khagaria, maize crop recorded increased crop establishment, land preparation, fertilizer and weed control costs mainly due to introduction of mechanized seeding and crop establishment method which farmers previously did manually.

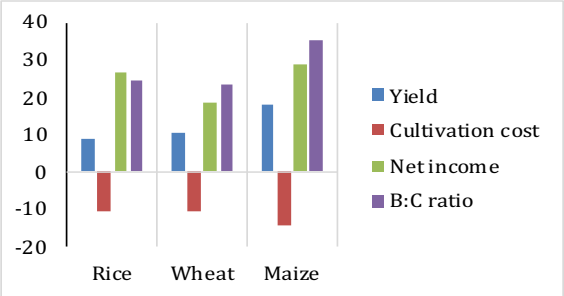
Table: *Percent change in crop performance over different agro-economic parameters for the district of Khagaria*

Particular	Rice	Wheat	Maize	Lentil	Mustard
Yield	13.4	4.40	27.86	7.69	22.86
Cultivation cost	-11.80	-15.35	-13.48	-19.18	-17.60
Net income	30.41	5.9	41.14	15.83	67.78
B:C ratio	32.45	23.3	45.80	33.25	62.31
Seed requirement	-33.33	-13.04	-10.00	-28.00	-16.67
Fuel consumption	-10.00	-34.38	-27.27	-42.11	-33.33
Crop duration	-8.97	3.05	-0.66	3.05	0.00
N fertilizer consumption	-4.00	-9.09	-13.04	-100.00	-16.67
Pesticide use	500.00	0.00	-32.00	177.78	-100.00
Land preparation	-51.81	-100.00	23.69	-100.00	-100.00
Crop Establishment	-75.73	-42.86	-61.18	-30.35	-48.53
Fertilizer & its application	15.16	-2.12	-7.10	-29.78	-33.43
Weed control	22.91	-0.17	-46.81	0.00	0.00
Irrigation	12.36	0.00	-23.81	0.00	-17.39

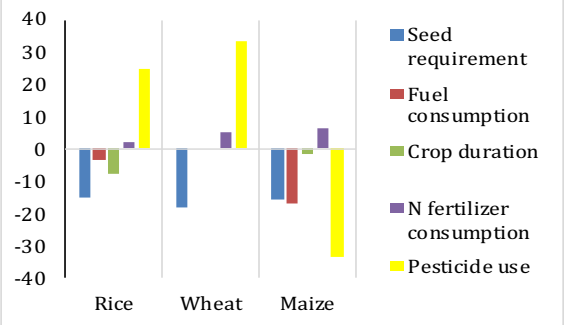
KISHANGANJ



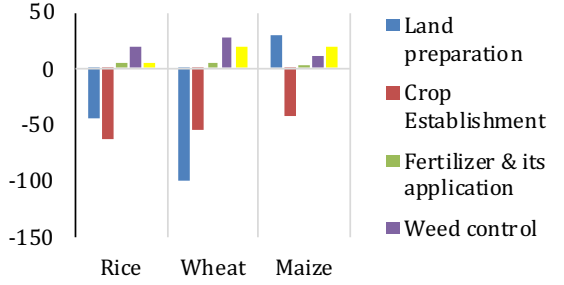
- With the implementation of the CRA program significant changes in agro – economic parameters for different crops was observed. The major interventions implemented through CRA program involved direct seeding in rice (DSR), zero tillage in wheat (ZTW), raised bed / ZT in maize (RBM/ZTM) and zero tillage in lentil and mustard (ZTL and ZTMus). With the adoption of new CRA technologies yield was increased 8-17% which was maximum in maize crop (>17%) and net income was also recorded in Maize (>28%) and Rice crop (>26%) and maize crop recorded more benefits (35%) in increased productivity and profitability as compared to other crops.
- Shifting from traditional crop establishment practices to CRA interventions resulted in 10-14% reduced cost of cultivation. This was mainly due to reduced requirement of inputs like seed (15-18%), fuel up to 16%. The benefits of DSR and zero tillage technology were suppressed mainly due increased use of pesticides which was more than double to the quantity of pesticide being used in rice prior to CRA program. ZT also resulted in reducing the crop duration by 8-10 days mainly in DSR in rice.



Graph-1: *Per cent change in agro-economic parameter*



Graph-2: *Per cent change in Resource utilization*



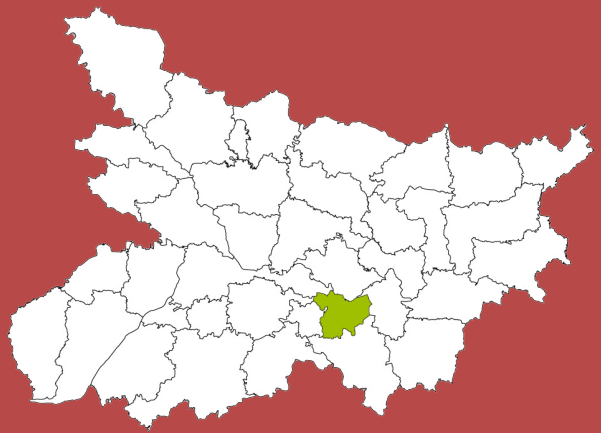
Graph-3: *Per cent change incost of farm operations*

- • The savings in cost of production was mainly envisaged through reduced crop establishment costs (42-63%) with maximum reduction in rice (63%), wheat (55%) and lentil (42%) where intensive tillage operations are required (especially rice) before crop establishment. Another major savings in cost of cultivation was through reduced irrigation water requirement. On an average 19-20 reduction in irrigation application costs was observed in maize and wheat due to CRA technologies. With the introduction of mechanized seeding and crop establishment method which farmers previously did manually overall farmers are satisfied.

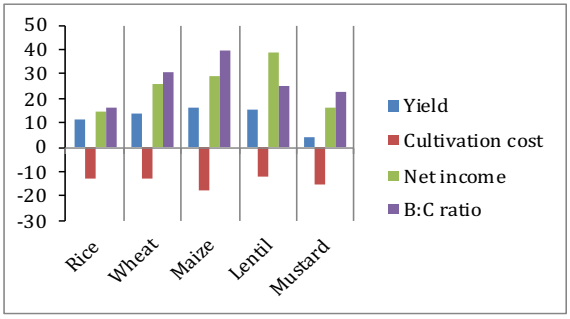
Table: *Percent change in crop performance over different agro-economic parameters for the district of Kishanganj*

Particular	Rice	Wheat	Maize
Yield	8.5	10.32	17.77
Cultivation cost	-10.83	-10.40	-14.18
Net income	26.57	18.4	28.53
B:C ratio	24.56	23.1	35.12
Seed requirement	-15.00	-18.18	-15.38
Fuel consumption	-3.23	0.00	-16.67
Crop duration	-7.64	0.00	-1.32
N fertilizer consumption	2.22	5.45	6.10
Pesticide use	25.00	33.33	-33.33
Land preparation	-44.66	-100.00	28.42
Crop Establishment	-63.64	-55.44	-42.21
Fertilizer & its application	3.87	4.97	2.21
Weed control	19.35	27.35	11.34
Irrigation	5.31	19.84	18.89

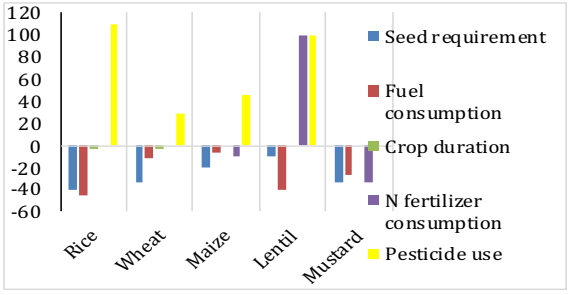
LAKHISARAI



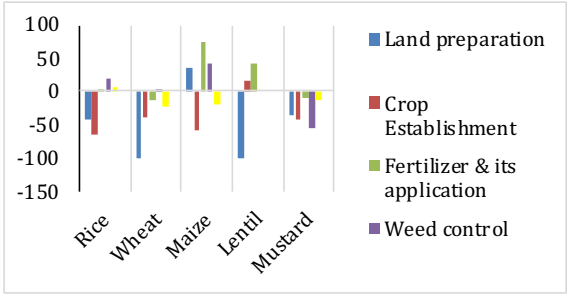
- The increment in yield of crops varied from 4-16% which was maximum in Maize (16%), Lentil (15%) and Wheat (14%) and maximum net income was found in maize (17%) & lentil (15%) crop while rice recorded relatively lower net income (14.69%) compared to other crops.
- Shifting from traditional crop establishment practices to CRA interventions resulted in 11-17% reduced cost of cultivation. This was mainly due to reduced requirement of inputs like seed (9-40%), fuel (5-45%) and fertilizer. The benefits of DSR were suppressed mainly due increased use of pesticides which was more than double to the quantity of pesticide being used in rice prior to CRA program.
- The savings in cost of production was mainly envisaged through reduced crop establishment costs (16-63%) with maximum reduction in rice (63%), maize (59%) and wheat (41%) where intensive tillage operations are required (especially rice) before crop establishment. Another major savings in cost of cultivation was through reduced cost in land preparation by 100% in wheat and lentil due to adoption of zero tillage sowing method and irrigation water requirement where in wheat crop 23% and maize crop 18% irrigation cost was reduced.



Graph-1: *Per cent change in agro-economic parameter*



Graph-2: *Per cent change in Resource utilization*

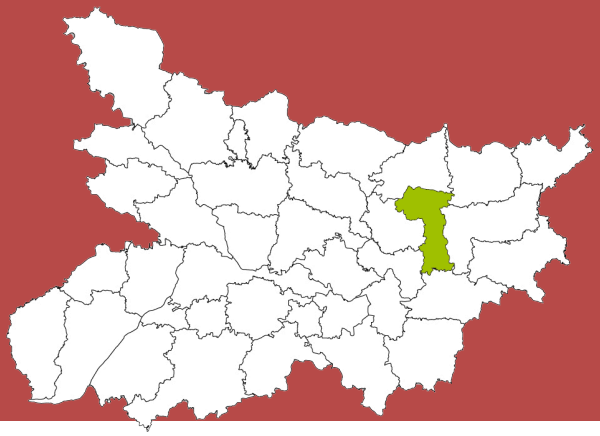


Graph-3: *Per cent change incost of farm operations*

Table: *Percent change in crop performance over different agro-economic parameters for the district of Lakhisarai*

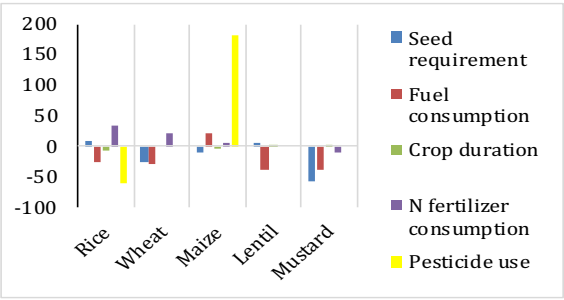
Particular	Rice	Wheat	Maize	Lentil	Mustard
Yield	11.5	14.08	16.07	15.38	4.35
Cultivation cost	-12.94	-12.91	-17.57	-11.97	-14.92
Net income	14.69	26.1	28.93	38.99	16.36
B:C ratio	16.40	31.0	39.68	25.37	22.65
Seed requirement	-40.00	-33.33	-20.00	-9.09	-33.33
Fuel consumption	-45.00	-12.12	-5.77	-40.00	-26.67
Crop duration	-3.45	-2.34	0.00	0.00	0.00
N fertilizer consumption	0.00	0.00	-9.09	100.00	-33.33
Pesticide use	110.00	28.57	45.00	100.00	0.00
Land preparation	-41.62	-100.00	35.06	-100.00	-34.92
Crop Establishment	-63.64	-39.13	-58.80	16.67	-41.56
Fertilizer & its application	3.87	-14.48	72.83	41.67	-10.11
Weed control	19.35	1.57	40.53	0.00	-56.33
Irrigation	5.31	-22.98	-18.36	0.00	-13.27

MADHEPURA

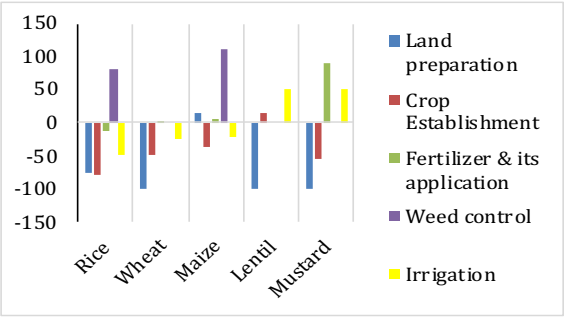


- With the implementation of the CRA program significant changes in agro – economic parameters for different crops was observed. The major interventions implemented through CRA program involved direct seeding in rice (DSR), zero tillage in wheat (ZTW), raised bed / ZT in maize (RBM/ ZTM) and zero tillage in lentil and mustard (ZTL and ZTMus). Due to CRA Technologies enhancement of yield was 11-16% with maximum enhancement recorded in Rice (16%) followed by maize (14%) and Wheat (12%) and net income (18-47%) which was maximum in maize (47%) followed by Wheat (32%), and Lentil (28%) while rice recorded relatively lower benefits (18%) in increased productivity and profitability as compared to other crops.
- Shifting from traditional crop establishment practices to CRA interventions resulted in (9-23%) percent reduced cost of cultivation. This was mainly due to reduced requirement of inputs like seed (6-57%), fuel (19-37%) and fertilizer up to 32%. The benefits of DSR were suppressed mainly due increased use of pesticides which was more than double to the quantity of pesticide being used in rice prior to CRA program. ZT also resulted in reducing

Graph-1: *Per cent change in agro-economic parameter*



Graph-2: *Per cent change in Resource utilization*



Graph-3: *Per cent change incost of farm operations*

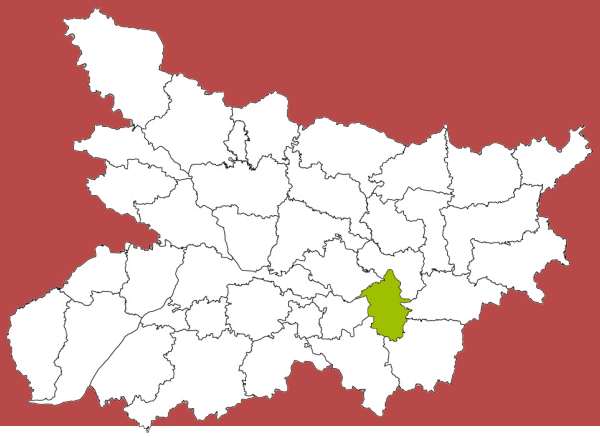
the crop duration by 8-10 days mainly in DSR in rice.

- The savings in cost of production was mainly envisaged through reduced crop establishment costs (14-80%) with maximum reduction in rice (80%), Mustard (56%), wheat (49%), and maize (38%) where intensive tillage operations are required (especially rice) before crop establishment. Another major savings in cost of cultivation was through reduced irrigation water requirement. On an average 22-50% reduction in irrigation application costs was observed due to CRA. However, in Madhepura, lentil crop recorded increased crop establishment, land preparation, fertilizer and weed control costs mainly due to introduction of mechanized seeding and crop establishment method which farmers previously did manually.

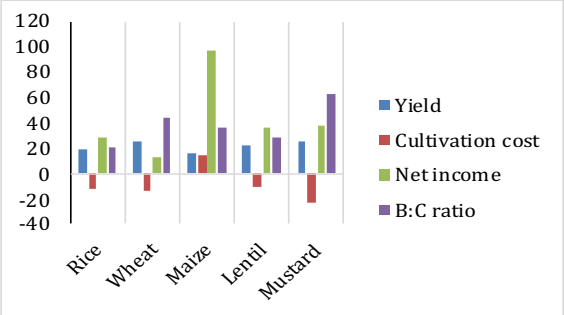
Table: *Percent change in crop performance over different agro-economic parameters for the district of Madhepura*

Particular	Rice	Wheat	Maize	Lentil	Mustard
Yield	16.2	12.26	13.99	11.76	11.11
Cultivation cost	-22.84	-16.09	9.26	-9.35	-11.31
Net income	18.17	32.1	47.40	28.61	18.12
B:C ratio	21.65	33.8	18.20	23.29	25.28
Seed requirement	8.33	-27.27	-11.11	6.67	-57.14
Fuel consumption	-27.27	-29.41	19.44	-37.50	-37.50
Crop duration	-8.15	0.00	-3.13	1.67	1.63
N fertilizer consumption	32.35	20.00	5.26	0.00	-10.00
Pesticide use	-60.00	0.00	182.22	0.00	0.00
Land preparation	-75.41	-100.00	15.44	-100.00	-100.00
Crop Establishment	-80.34	-49.72	-38.89	14.75	-56.25
Fertilizer & its application	-13.27	3.33	5.26	0.00	89.19
Weed control	79.82	0.00	111.11	0.00	0.00
Irrigation	-50.00	-25.00	-22.72	50.00	50.00

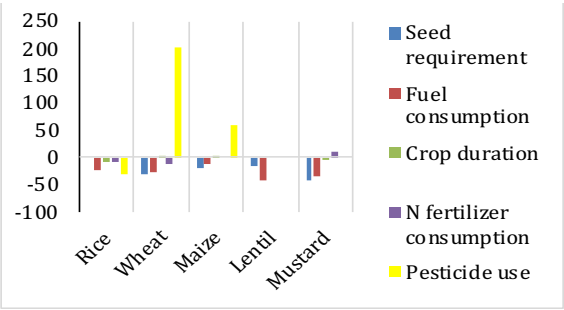
MUNGER



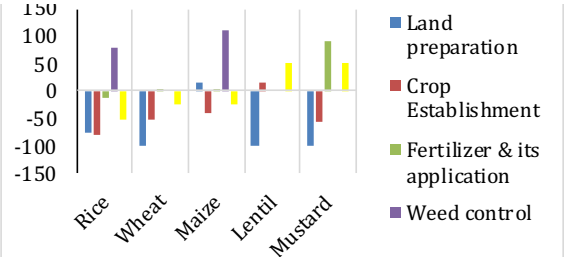
- With the implementation of the CRA program significant changes in agro – economic parameters for different crops was observed. The major interventions implemented through CRA program involved direct seeding in rice (DSR), zero tillage in wheat (ZTW), raised bed / ZT in maize (RBM/ZTM) and zero tillage in lentil and mustard (ZTL and ZTMus). Maximum increase in wheat yield (24%) and net income (97%) was recorded in Maize and rice crop while rice recorded relatively lower benefits (19%) in increased productivity and profitability as compared to other crops.
- Shifting from traditional crop establishment practices to CRA interventions resulted in 11–23 percent reduced cost of cultivation. This was mainly due to reduced requirement of inputs like seed (15-42%), fuel (12-43%) and fertilizer (10-12%). The benefits of DSR were suppressed mainly due increased use of pesticides which was more than double to the quantity of pesticide being used in rice prior to CRA program. Maximum crop duration reducing by 8 days in DSR rice.
- The savings in cost of production was mainly envisaged through reduced crop establishment costs (38 –80%) with maximum reduction in rice, followed bymustard, wheat



Graph-1: *Per cent change in agro-economic parameter*



Graph-2: *Per cent change in Resource utilization*



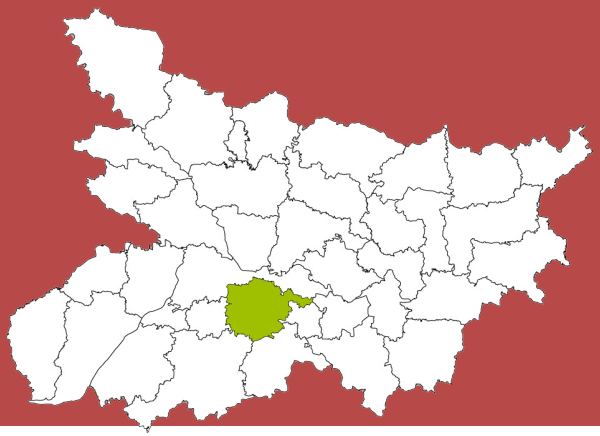
Graph-3: *Per cent change incost of farm operations*

and maize where intensive tillage operations are required (especially rice) before crop establishment. Another major savings in cost of cultivation was through reduced irrigation water requirement. On an average 22-50% reduction in irrigation application costs was observed due to CRA. However, in Munger, maize crop recorded increased crop establishment, land preparation, fertilizer and weed control costs mainly due to introduction of mechanized seeding and crop establishment method which farmers previously did manually.

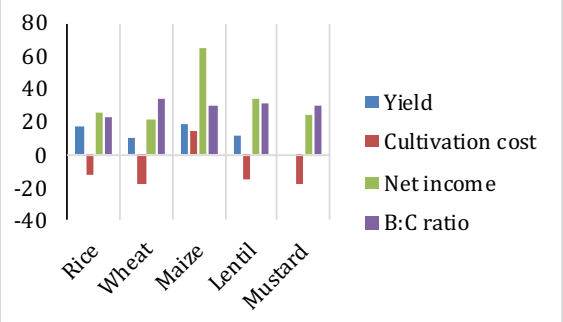
Table: *Percent change in crop performance over different agro-economic parameters for the district of Munger*

Particular	Rice	Wheat	Maize	Lentil	Mustard
Yield	18.5	24.58	16.33	21.95	24.49
Cultivation cost	-11.29	-13.55	14.22	-11.26	-23.21
Net income	28.31	12.80	97.24	36.70	37.38
B:C ratio	19.98	44.10	35.90	28.56	62.11
Seed requirement	0.00	-30.36	-20.00	-15.79	-42.86
Fuel consumption	-25.37	-27.66	-12.50	-43.24	-36.36
Crop duration	-8.22	2.90	3.77	0.00	-1.46
N fertilizer consumption	-10.64	-12.50	0.00	0.00	9.38
Pesticide use	-31.31	200.00	60.26	0.00	0.00
Land preparation	-75.41	-100.00	15.44	-100.00	-100.00
Crop Establishment	-80.34	-49.72	-38.89	14.75	-56.25
Fertilizer & its application	-13.27	3.33	5.26	0.00	89.19
Weed control	79.82	0.00	111.11	0.00	0.00
Irrigation	-50.00	-25.00	-22.72	50.00	50.00

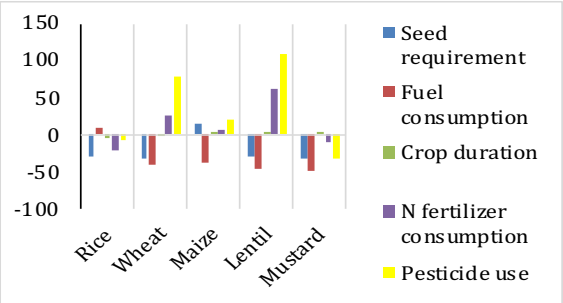
NALANDA



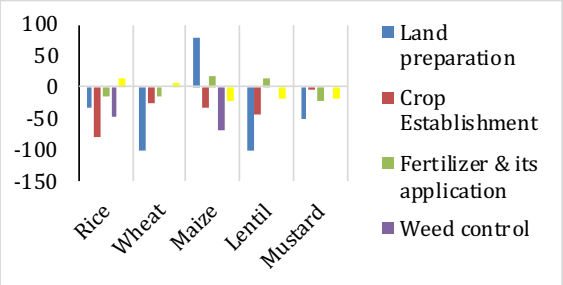
- With the implementation of the CRA program significant changes in agro – economic parameters for different crops was observed. The major interventions implemented through CRA program involved direct seeding in rice (DSR), zero tillage in wheat (ZTW), raised bed / ZT in maize (RBM/ZTM) and zero tillage in lentil and mustard (ZTL and ZTMus). Maximum increase in yield (18%) and net income (64%) was recorded in maize crop while rice recorded relatively lower benefits (22%) in increased productivity and profitability as compared to other crops.
- Shifting from traditional crop establishment practices to CRA interventions resulted in 11–18 percent reduced cost of cultivation. This was mainly due to reduced requirement of inputs like seed (29-33%), fuel (37-50%) and fertilizer (11-22%). The benefits of DSR were suppressed mainly due increased use of pesticides which was 108% to the quantity of pesticide being used in rice prior to CRA program. Maximum crop duration reducing by 4 days in DSR rice.
- The savings in cost of production was mainly envisaged through reduced crop establishment costs (4– 77%) with maximum reduction in rice, lentil, maize,wheat, and



Graph-1: *Per cent change in agro-economic parameter*



Graph-2: *Per cent change in Resource utilization*



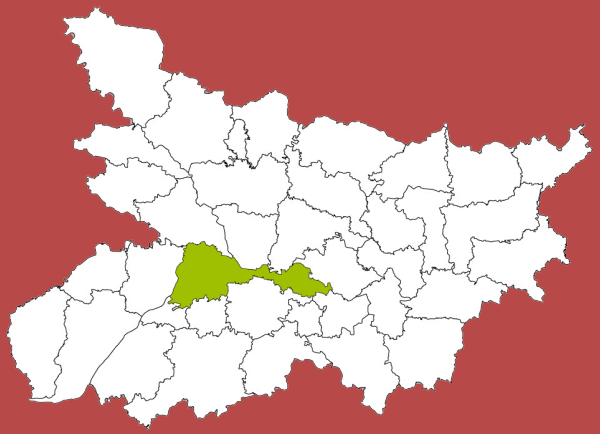
Graph-3: *Per cent change incost of farm operations*

mustard where intensive tillage operations are required (especially rice) before crop establishment. Another major savings in cost of cultivation was through reduced irrigation water requirement. On an average 18-21% reduction in irrigation application costs was observed due to CRA. However, in Nalanda, maize crop recorded increased crop establishment, land preparation, fertilizer and weed control costs mainly due to introduction of mechanized seeding and crop establishment method which farmers previously did manually.

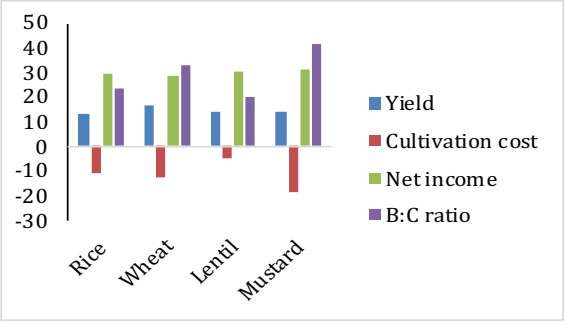
Table: *Percent change in crop performance over different agro-economic parameters for the district of Nalanda*

Particular	Rice	Wheat	Maize	Lentil	Mustard
Yield	17.4	9.70	18.65	12.00	0.00
Cultivation cost	-11.83	-18.31	14.02	-14.83	-17.76
Net income	25.13	21.4	64.79	33.52	23.74
B:C ratio	22.12	34.3	29.53	31.50	29.35
Seed requirement	-29.41	-33.33	14.29	-29.17	-33.33
Fuel consumption	9.38	-41.94	-37.78	-47.37	-50.00
Crop duration	-4.38	-1.52	3.05	0.83	0.82
N fertilizer consumption	-22.95	26.23	4.69	60.00	-11.11
Pesticide use	-8.66	77.33	20.83	108.78	-33.33
Land preparation	-33.58	-100.00	79.97	-100.00	-50.55
Crop Establishment	-77.98	-26.20	-32.58	-44.00	-4.72
Fertilizer & its application	-12.56	-15.10	16.58	14.69	-23.08
Weed control	-45.82	0.00	-66.46	0.00	0.00
Irrigation	13.85	7.84	-21.57	-18.75	-19.39

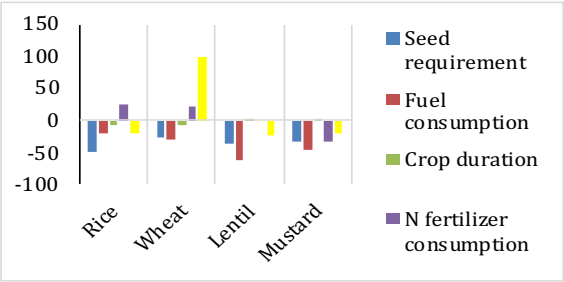
PATNA



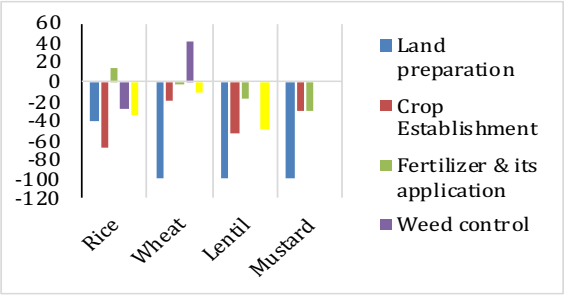
- With the implementation of the CRA program significant changes in agro – economic parameters for different crops was observed. The major interventions implemented through CRA program involved direct seeding in rice (DSR), zero tillage in wheat (ZTW), raised bed / ZT in maize (RBM/ZTM) and zero tillage in lentil and mustard (ZTL and ZTMus). Enhance of yield due to CRA technologies was recorded from (13-16%) which was maximum in wheat (>16%) and >14% in lentil and mustard however net income was increased from 28-31% which Was maximum in mustard (>31%), lentil (>30%), Rice (29%) and Wheat (28%).
- Shifting from traditional crop establishment practices to CRA interventions resulted in reduced cost of cultivation up to 19%. This was mainly due to reduced requirement of inputs like seed (28-50%), fuel (22-62%) and fertilizer up to 32%. The benefits of DSR and zero tillage were suppressed mainly due increased use of pesticides which was more than double to the quantity of pesticide being used in rice prior to C RA program. ZT also resulted in reducing the crop duration by 5-8 days mainly in DSR in rice and ZT Wheat.
- The savings in cost of production was



Graph-1: *Per cent change in agro-economic parameter*



Graph-2: *Per cent change in Resource utilization*



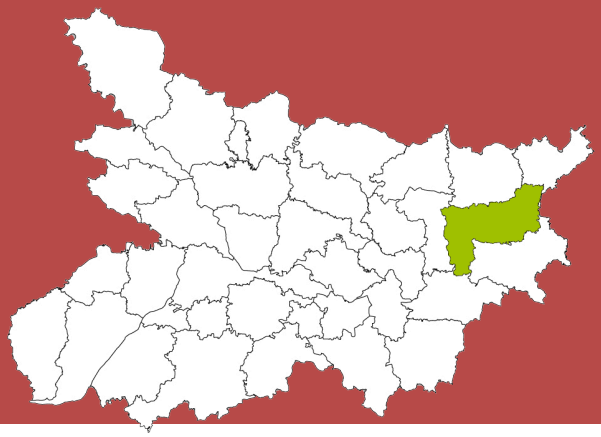
Graph-3: *Per cent change incost of farm operations*

mainly envisaged through reduced crop establishment costs (20 – 70%) with maximum reduction in rice, wheat, lentil and mustard where intensive tillage operations are required (especially rice) before crop establishment. Another major savings in cost of cultivation was through reduced irrigation water requirement. On an average 50% reduction in irrigation application costs was observed due to CRA. However, in Patna, with the introduction of CRA technologies income of farmers increased due to decrement of cost involved in crop establishment, land preparation, fertilizer and weed control costs mainly due to introduction of mechanized seeding and crop establishment method which farmers previously did manually.

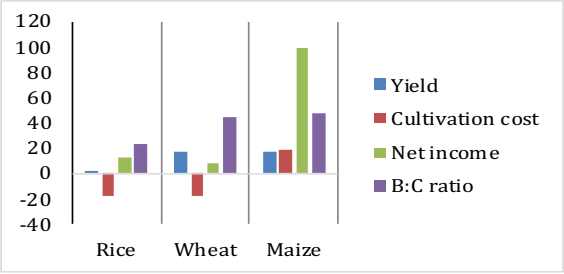
Table: *Percent change in crop performance over different agro-economic parameters for the district of Patna*

Particular	Rice	Wheat	Lentil	Mustard
Yield	13.3	16.25	14.29	14.29
Cultivation cost	-10.80	-12.56	-5.03	-18.95
Net income	29.50	28.5	30.64	31.29
B:C ratio	23.21	32.9	20.33	41.01
Seed requirement	-50.00	-28.57	-36.00	-33.33
Fuel consumption	-22.22	-31.25	-62.50	-47.83
Crop duration	-6.94	-7.14	3.08	0.84
N fertilizer consumption	23.44	20.00	0.00	-32.00
Pesticide use	-20.00	100.00	-25.00	-20.00
Land preparation	-40.14	-100.00	-100.00	-100.00
Crop Establishment	-67.24	-19.49	-53.33	-30.00
Fertilizer & its application	12.96	-3.55	-16.67	-31.25
Weed control	-27.56	40.11	0.00	0.00
Irrigation	-33.68	-11.11	-50.00	0.00

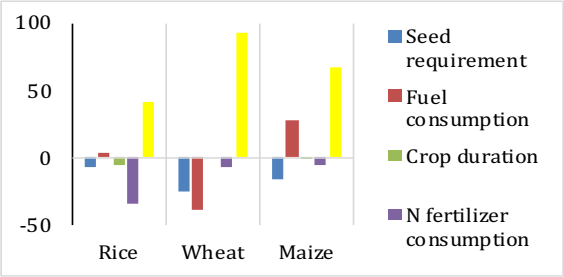
PURNEA



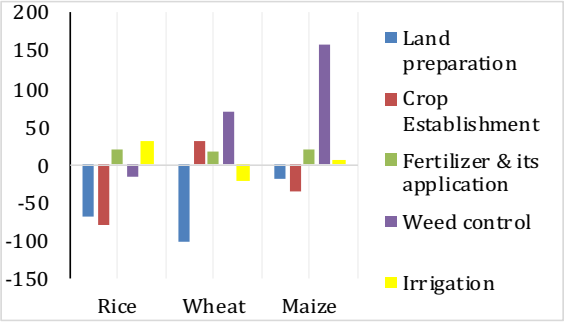
- With the implementation of the CRA program significant changes in agro – economic parameters for different crops were observed. The major interventions implemented through CRA program involved direct seeding in rice (DSR), zero tillage in wheat (ZTW), raised bed / ZT in maize (RBM/ZTM) and zero tillage in lentil and mustard (ZTL and ZTMus). Maximum increase in yield (17%) in wheat and net income (98%) was recorded in maize crop while rice recorded relatively lower benefits (23%) in increased productivity and profitability as compared to other crops.
- Shifting from traditional crop establishment practices to CRA interventions resulted in up to 18 percent reduced cost of cultivation. This was mainly due to reduced requirement of inputs like seed (7-25%), fuel (39%) and nitrogenous fertilizer (6-34%). The benefits of DSR were suppressed mainly due increased use of pesticides which was 41% to the quantity of pesticide being used in rice prior to CRA program.
- The savings in cost of production was mainly envisaged through reduced crop establishment costs (35-78%) with maximum reduction in rice followed by maize where intensive tillage operations are required



Graph-1: *Per cent change in agro-economic parameter*



Graph-2: *Per cent change in Resource utilization*



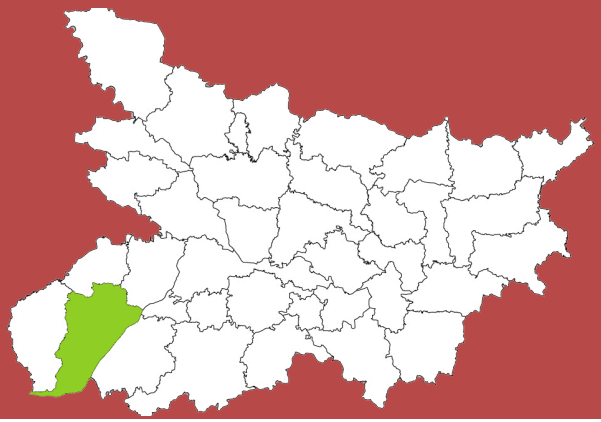
Graph-3: *Per cent change incost of farm operations*

(especially rice) before crop establishment. Another major savings in cost of cultivation was through reduced irrigation water requirement. On an average 22% reduction in irrigation application costs was observed in wheat due to CRA. However, in Purnea, maize crop recorded increased crop establishment, land preparation, fertilizer and weed control costs mainly due to introduction of mechanized seeding and crop establishment method which farmers previously did manually.

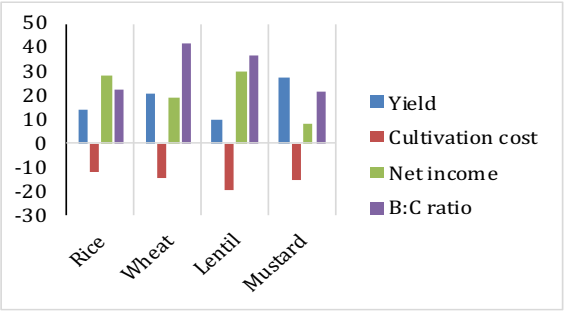
Table: *Percent change in crop performance over different agro-economic parameters for the district of Purnea*

Particular	Rice	Wheat	Maize
Yield	1.1	17.55	16.44
Cultivation cost	-18.75	-18.22	19.02
Net income	12.77	7.4	98.20
B:C ratio	23.10	43.7	47.02
Seed requirement	-7.69	-25.00	-16.67
Fuel consumption	3.70	-39.13	27.59
Crop duration	-5.84	0.00	-0.66
N fertilizer consumption	-34.00	-7.81	-6.25
Pesticide use	41.86	92.60	66.67
Land preparation	-67.83	-100.00	-18.47
Crop Establishment	-78.76	31.25	-35.00
Fertilizer & its application	19.88	16.98	19.88
Weed control	-16.75	70.11	157.14
Irrigation	31.76	-22.08	7.02

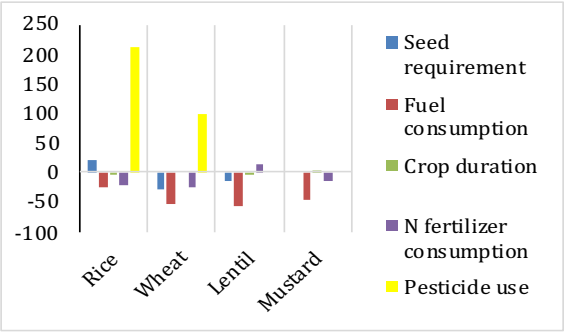
ROHTAS



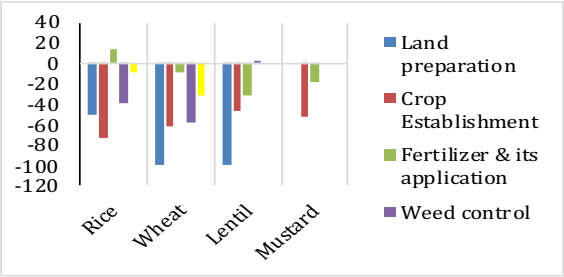
- With the implementation of the CRA program significant changes in agro–economic parameters for different crops was observed. The major interventions implemented through CRA program involved direct seeding in rice (DSR), zero tillage in wheat (ZTW) and zero tillage in lentil and mustard (ZTL and ZTMus). Maximum increase in yield (27%) in mustard and net income (30%) was recorded in lentil crop while mustard recorded relatively lower benefits (21%) in increased productivity and profitability as compared to other crops.
- Shifting from traditional crop establishment practices to CRA interventions resulted in 11-19 percent reduced cost of cultivation. This was mainly due to reduced requirement of inputs like seed (13-27%), fuel (25-55%) and fertilizer (9-31%). The benefits of DSR were suppressed mainly due increased use of pesticides which was more than double to the quantity of pesticide being used in rice prior to CRA program. Maximum crop duration reducing by 5 days in DSR rice.
- The savings in cost of production was mainly envisaged through reduced crop establishment costs (46-72%) with maximum reduction in rice, wheat, mustard and lentil where intensive tillage operations are required



Graph-1: *Per cent change in agro-economic parameter*



Graph-2: *Per cent change in Resource utilization*



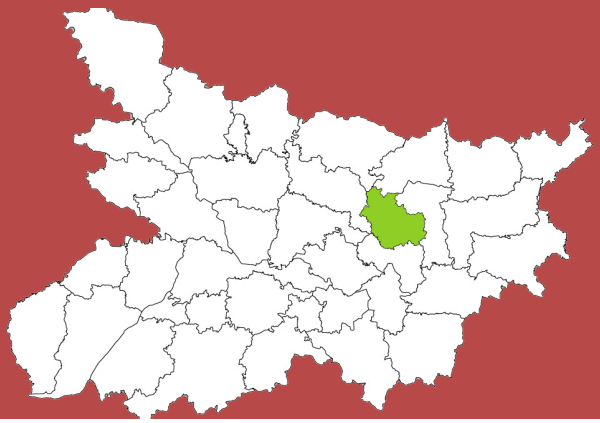
Graph-3: *Per cent change incost of farm operations*

(especially rice) before crop establishment. Another major savings in cost of cultivation was through reduced irrigation water requirement. On an average 9-30% reduction in irrigation application costs was observed due to CRA. However, in Rohtas, lentil crop recorded increased crop establishment, land preparation, fertilizer and weed control costs mainly due to introduction of mechanized seeding and crop establishment method which farmers previously did manually.

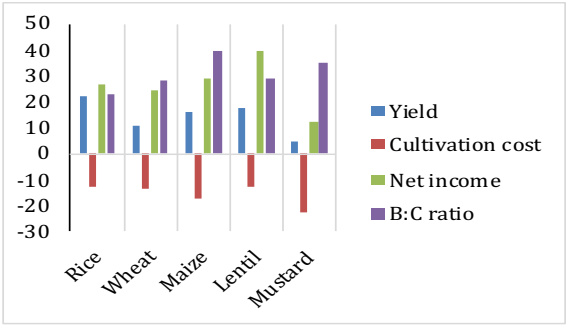
Table: *Percent change in crop performance over different agro-economic parameters for the district of Rohtas*

Particular	Rice	Wheat	Lentil	Mustard
Yield	13.8	20.57	10.00	27.66
Cultivation cost	-11.91	-14.78	-19.46	-15.73
Net income	28.17	18.8	30.20	8.44
B:C ratio	22.34	41.5	36.58	21.11
Seed requirement	20.00	-27.12	-13.04	0.00
Fuel consumption	-25.00	-52.63	-55.56	-47.06
Crop duration	-5.59	0.00	-2.44	2.36
N fertilizer consumption	-23.19	-25.61	12.50	-14.29
Pesticide use	212.50	100.00	0.00	0.00
Land preparation	-49.85	-100.00	-100.00	0.00
Crop Establishment	-72.91	-61.77	-46.15	-51.72
Fertilizer & its application	14.54	-9.28	-31.25	-18.52
Weed control	-38.46	-57.44	0.60	0.00
Irrigation	-9.72	-30.88	0.00	0.00

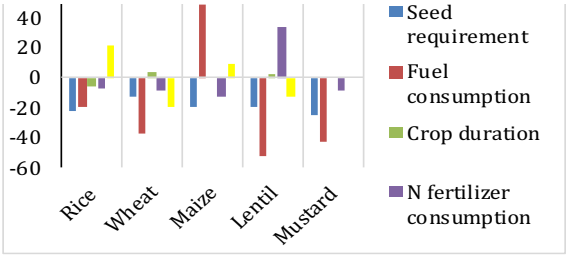
SAHARSA



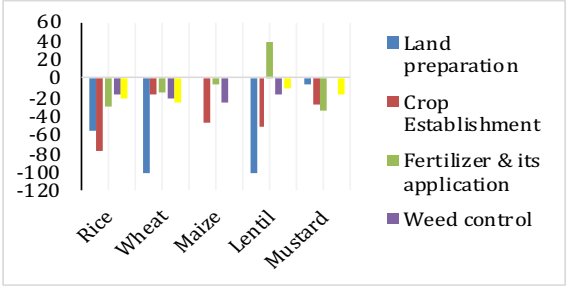
- With the implementation of the CRA program significant changes in agro – economic parameters for different crops was observed. The major interventions implemented through CRA program involved direct seeding in rice (DSR), zero tillage in wheat (ZTW), raised bed / ZT in maize (RBM/ZTM) and zero tillage in lentil and mustard (ZTL and ZTMus). By the adoption of CRA Technologies around 22% yield increment was found in rice followed by lentil (17%) and maize (15%) crop but maximum increment in net income was recorded in lentil (39%), maize 28% and rice 26%.
- Changing from traditional practices to CRA interventions resulted in 12 – 22% reduced cost of cultivation. This was mainly due to reduced requirement of inputs like seed (12-25%), fuel (20-52%) and fertilizer (8-33%). The benefits obtained through DSR were suppressed by the excess use of pesticides which was two times higher than the traditional practices.
- Maximum irrigation costs savings was observed in rice and wheat crops ranging within 22-26% due CRA interventions like zero tillage in wheat and DSR in rice.



Graph-1: *Per cent change in agro-economic parameter*



Graph-2: *Per cent change in Resource utilization*



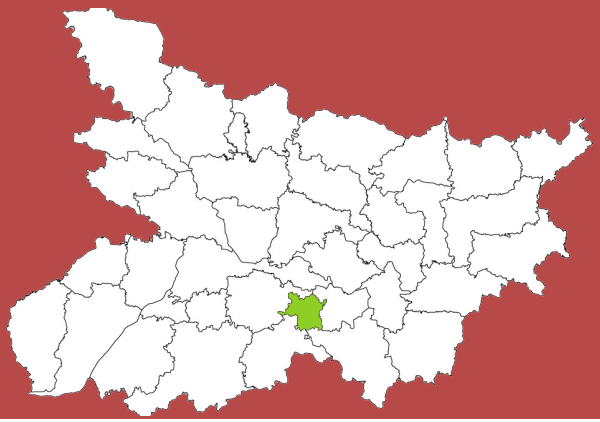
Graph-3: *Per cent change incost of farm operations*

- The savings in cost of production was mainly predicted through reduced cost of crop establishment varied from 16-78% with maximum reduction in Rice (78%) because in conventionally farmers practiced heavy tillage and puddling operation, followed by in order of rice followed by lentil (52%) and maize (46%). Another major savings in cost of cultivation was through reduced cost in land preparation which 100% cut down in wheat and lentil due to adoption of zero tillage sowing method. and in rice (55%) because of DSR technology. Saving also occurred in another practices like weed control practices up to 25%, and irrigation practices up to 26% under CRA program.

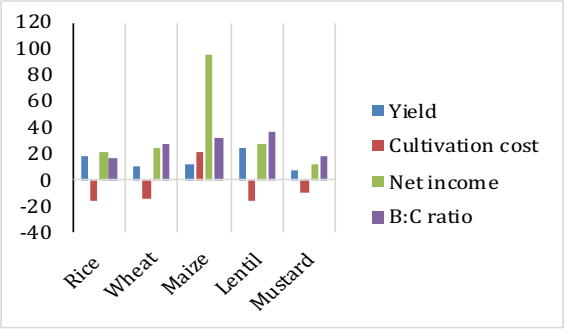
Table: *Percent change in crop performance over different agro-economic parameters for the district of Saharsa*

Particular	Rice	Wheat	Maize	Lentil	Mustard
Yield	22.0	10.42	15.73	17.50	4.44
Cultivation cost	-13.11	-13.54	-17.57	-12.49	-22.77
Net income	26.85	24.1	28.93	39.67	12.43
B:C ratio	23.12	27.7	39.68	29.07	35.24
Seed requirement	-23.08	-12.50	-20.00	-20.00	-25.00
Fuel consumption	-20.00	-37.50	52.00	-52.94	-43.75
Crop duration	-5.88	3.85	0.00	1.64	0.00
N fertilizer consumption	-7.84	-9.23	-12.73	33.33	-8.57
Pesticide use	22.00	-19.94	8.42	-13.21	0.00
Land preparation	-55.69	-100.00	0.00	-100.00	-7.14
Crop Establishment	-77.94	-16.67	-46.30	-52.54	-27.90
Fertilizer & its application	-30.84	-15.13	-6.67	38.96	-35.20
Weed control	-17.53	-21.70	-25.00	-18.16	0.00
Irrigation	-22.52	-25.80	0.00	-11.82	-16.76

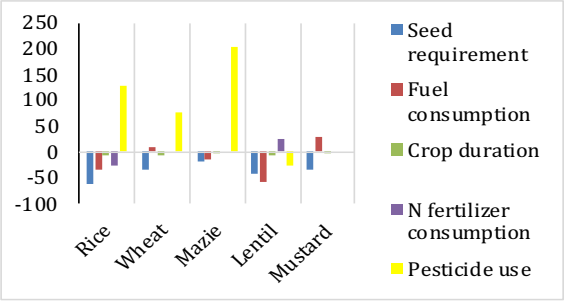
SHEIKHPURA



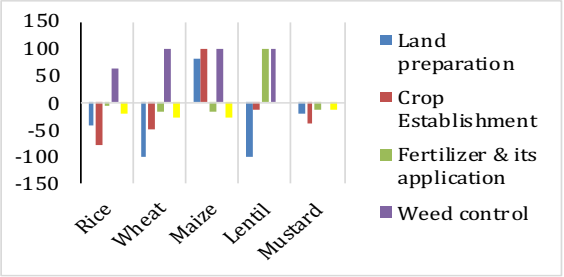
- With the implementation of the CRA program significant changes in agro – economic parameters for different crops was observed. The major interventions implemented through CRA program involved direct seeding in rice (DSR), zero tillage in wheat (ZTW), raised bed / ZT in maize (RBM/ZTM) and zero tillage in lentil and mustard (ZTL and ZTMus). Here maximum increment occurred in yield of lentil crop (24%) followed by rice (17%) and wheat (13%) and found maximum net return was recorded in maize (94%) with highest B:C ratio (37%) in lentil crop due to low cost of cultivation as compared to other crops.
- Shifting from traditional crop establishment practices to CRA interventions resulted in 21, 16, 16 and 15 percent reduced cost of cultivation in maize, rice, wheat and lentil crop respectively. This was mainly due to reduced requirement of inputs like seed, fuel and fertilizer. The benefits of DSR were suppressed mainly due excess use of pesticides, weedicides which was high in comparison to the quantity of pesticide used in rice prior to CRA program. CRA techniques also reduce the crop duration by 5-8 days than the conventional practices.



Graph-1: *Per cent change in agro-economic parameter*



Graph-2: *Per cent change in Resource utilization*



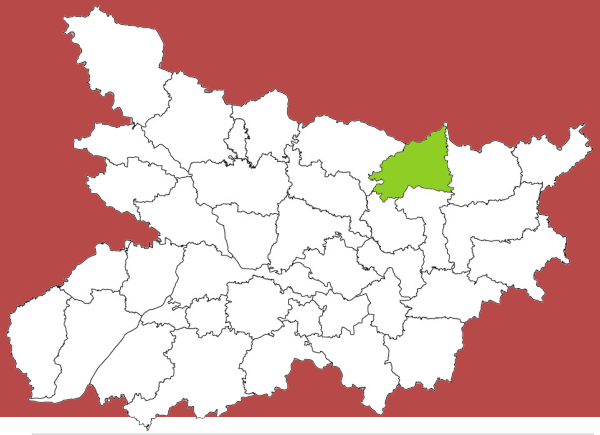
Graph-3: *Per cent change incost of farm operations*

- The savings in cost of production was mainly due to reduction in crop establishment costs (12.5-100%) with maximum reduction was occurred in what and lentil due sowing of crop without any tillage operation followed by rice where intensive tillage operations are required. Another major savings in cost of cultivation was through reduction in the cost of land preparation and seed requirement. On an average 11-29% reduction in irrigation application costs was observed due to CRA. However, in Sheikhpura, maize crop recorded increased crop establishment, land preparation, fertilizer and weed control costs mainly due to introduction of mechanized seeding and crop establishment method which farmers previously did manually.

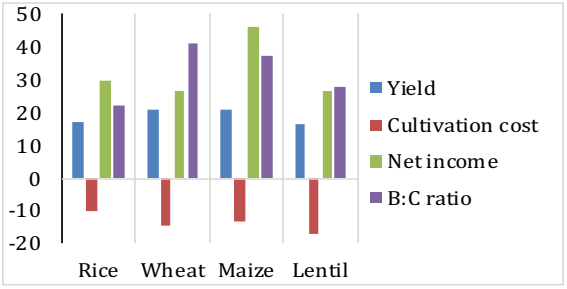
Table: *Percent change in crop performance over different agro-economic parameters for the district of Sheikhpura*

Particular	Rice	Wheat	Maize	Lentil	Mustard
Yield	17.6	13.2	11.71	24.24	7.32
Cultivation cost	-16.1	-15.7	20.95	-15.50	-9.57
Net income	21.5	20.3	94.67	27.45	12.38
B:C ratio	16.3	23.1	31.64	37.19	18.68
Seed requirement	-60.00	-33.33	-16.67	-42.31	-33.33
Fuel consumption	-35.71	11.11	-14.29	-57.14	30.43
Crop duration	-8.33	-5.22	-3.70	-6.40	-1.60
N fertilizer consumption	-25.00	0.00	0.00	25.00	0.00
Pesticide use	126.67	78.00	203.57	-25.00	0.00
Land preparation	-41.49	-100.00	81.48	-100.00	-21.95
Crop Establishment	-78.38	-49.40	100.00	-12.50	-39.66
Fertilizer & its application	-5.39	-16.47	-16.67	100.00	-13.51
Weed control	63.64	100.00	100.00	100.00	0.00
Irrigation	-21.39	-28.95	-29.17	0.00	-11.50

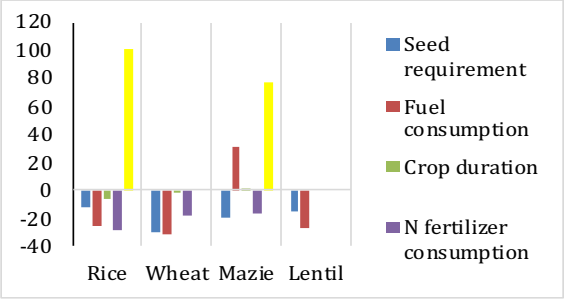
SUPAUL



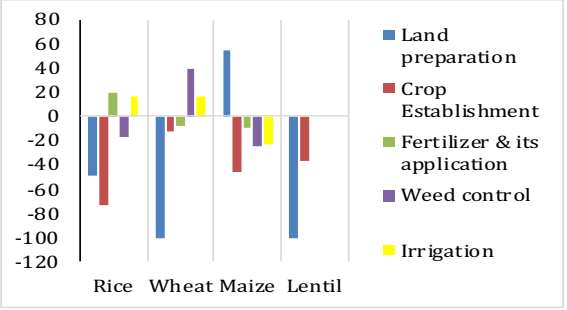
- With the implementation of the CRA program significant changes in agro – economic parameters for different crops was observed. The major interventions implemented through CRA program involved direct seeding in rice (DSR), zero tillage in wheat (ZTW), raised bed / ZT in maize (RBM/ZTM) and zero tillage in lentil and mustard (ZTL and ZTMus). CRA interventions helped increase in yield from 16-21% which was maximum in wheat amd maize (21%), whereas net income enhancement was 26-46% which was maximum in Maize (>46%), Rice (30%) and 26% in wheat and lentil crop while rice recorded relatively lower benefits (>22%) in increased productivity and profitability as compared to other crops.
- Shifting from traditional crop establishment practices to CRA interventions resulted in 10-16% reduced cost of cultivation. This was mainly due to reduced requirement of inputs like seed (12-29%), fuel (25-31%) and fertilizer up to 28%. The benefits of DSR were suppressed mainly due increased use of pesticides which was more than double to the quantity of pesticide being used in rice prior to CRA program. ZT also resulted in reducing the crop duration by 5-8 days mainly in DSR in rice.



Graph-1: *Per cent change in agro-economic parameter*



Graph-2: *Per cent change in Resource utilization*



Graph-3: *Per cent change incost of farm operations*

- On an average 23% reduction in irrigation application costs was observed in maize due to CRA interventions.
- The savings in cost of production was mainly envisaged through reduced crop establishment costs (12-73%) with maximum reduction in rice (73), maize (46%), and lentil (36%) where intensive tillage operations are required (especially rice) before crop establishment. Another major savings in cost of cultivation was through reduced irrigation water requirement. However, in Supaul, maize crop recorded increased crop establishment, land preparation, fertilizer and weed control costs mainly due to introduction of mechanized seeding and crop establishment method which farmers previously did manually.

Table: *Percent change in crop performance over different agro-economic parameters for the district of Supaul*

Perticular	Rice	Wheat	Maize	Lentil
Yield	17.2	20.98	20.93	16.4
Cultivation cost	-10.09	-14.21	-13.27	-16.7
Net income	30.01	26.9	46.36	26.8
B:C ratio	22.49	41.0	37.14	28.14
Seed requirement	-12.50	-29.82	-20.00	-15
Fuel consumption	-25.58	-31.37	31.58	-26.4
Crop duration	-6.76	-1.46	0.84	0
N fertilizer consumption	-28.57	-17.81	-16.67	0
Pesticide use	100.00	0.00	77.32	0
Land preparation	-49.83	-100.00	54.55	-100.00
Crop Establishment	-72.99	-12.40	-46.14	-36.36
Fertilizer & its application	19.71	-7.84	-9.07	0.00
Weed control	-17.76	39.25	-24.60	0.00
Irrigation	16.67	16.61	-23.04	0.00

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