Drought Impact Assessment in Bihar

Effects on Crop Production and Agricultural Practices

Research Note

August 2024

The Cereal Systems Initiative for South Asia (CSISA) is a regional initiative to sustainably increase the productivity of cereal-based cropping systems, thus improving food security and farmers' livelihoods in Bangladesh, India and Nepal. CSISA works with public and private partners to support the widespread adoption of resource-conserving and climate-resilient farming technologies and practices. The initiative is led by the International Maize and Wheat Improvement Center (CIMMYT), implemented jointly with the International Food Policy Research Institute (IFPRI), the International Rice Research Institute (IRRI), and the International Water Management Institute (IWMI) and is funded by the US Agency for International Development (USAID) and the Bill & Melinda Gates Foundation.

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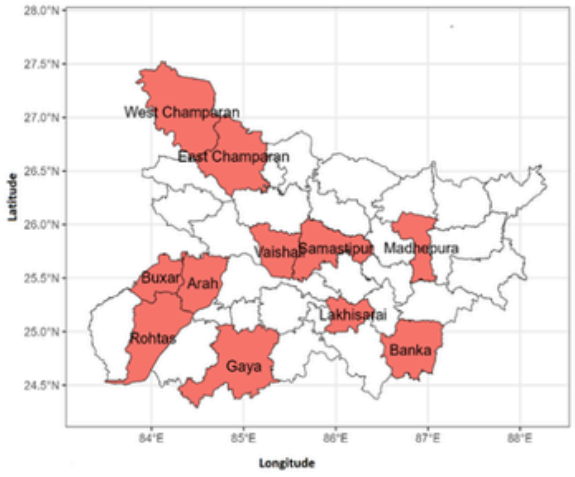
About this Research Note:

The Drought Impact Assessment survey (Saxena et al., 2024) by CSISA was implemented in 2022 and 2023. The survey collects crop yield and production practices data for paddy and wheat across north and south distirct of Bihar during the 2022-23 cropping seasons to understand the impact of drought on crop production and to facilitate evidencebased planning.

Figure 1: Districts covered under the survey



The survey design captures production practices from land preparation to harvesting, including irrigation methods, fertilizer use, weed control, and irrigation costs, by collecting data from randomly selected farmers within a KVK (Krishi Vigyan Kendra Knowledge Network) district.

This research note presents key insights into the impact of drought on livelihood opportunities and the increasing risks of food insecurity due to drought conditions.

Key insights from this study:

82%
of farmers affected by drought in the Kharif season.

61%
of farmers affected by drought in Rabi.

99.8%
of farmers access to irrigation in Kharif season.

49.4%
of farmers have access to electric pumps.

96.7%
of farmers own agricultural land.

OVERVIEW:

A drought impact assessment survey was conducted in Bihar in 2022-2023 during the kharif and rabi cropping seasons (Saxena et al., 2024). The study aimed at capturing and assessing the experience of farmers and the impact on their crop production practices due to drought. Drought and its severity have direct as well as indirect effects on the economic losses experienced in crop production (Khayyati and Aazami, 2016).

To understand the impact of drought on the livelihood of farmers, a livelihood assets framework approach was used to analyze the factors influencing crop productivity and its practice (Reed et al., 2013). In this context, livelihood assets frameworks are presented as an outcome of a farmer's access to five types of assets (Khayyati and Aazami, 2016). This survey categorized farmers' livelihood assets into natural, physical, social, human, and financial assets (Kuang et al., 2020). Livelihood assets are resources owned, controlled, claimed or accessed by the farmer. When these resources are affected by shocks and seasonality that are largely beyond farmers' control, it refers to a vulnerability context.

NATURAL ASSETS: Drought can reduce land productivity and cultivation area, increase fallow land, and impact land ownership types, drainage classes, and crop establishment processes, including plantation duration.

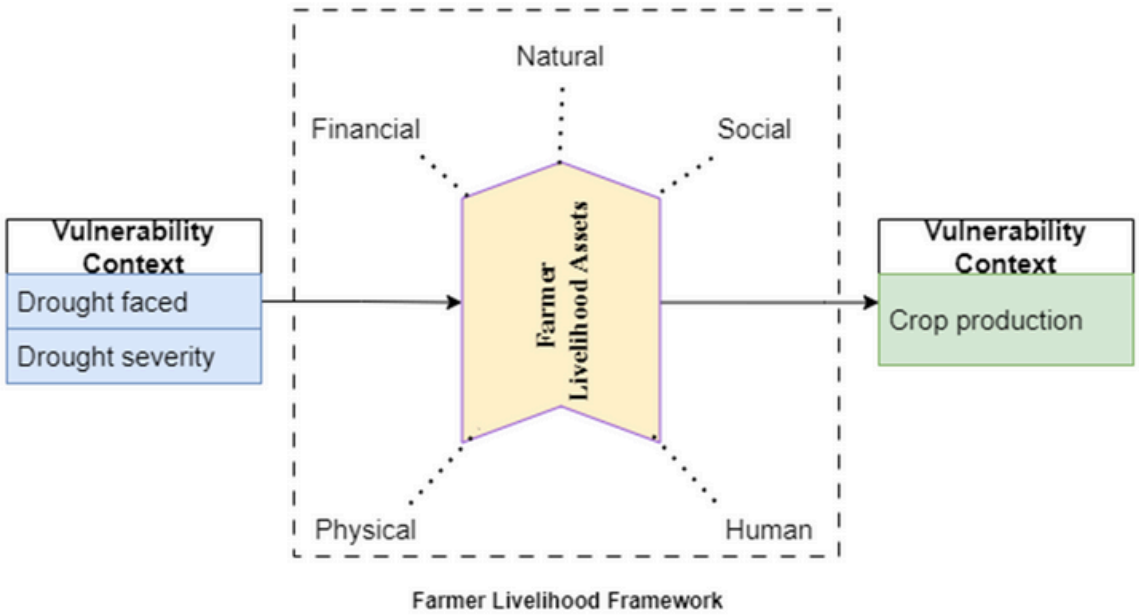
PHYSICAL ASSETS: Drought impacts irrigation systems, including the frequency and use of irrigation pumps, water sources, and weeding control systems, and other tangible assets.

FINANCIAL ASSETS: Drought can lead to crop failure, increased irrigation costs, and decline in both the selling price and quantity of the main product and straw.

HUMAN ASSETS: Drought can cause water shortages, reduce farmers' productivity, and limit their participation in cultivating waterintensive crops.

SOCIAL ASSETS: Drought can increase investment risk due to ineffective communication and could negatively impact gender participation.

Figure 2: Livelihood framework



Farmer Livelihood Framework

LIST OF CONTENT

Several districts in Bihar face moderate to high severity drought-like situations in four out of five years.

In 2022 alone, during paddy and wheat cultivation, 63% of farmers (175 out of 279) faced drought conditions. Among these, 45.1% experienced high drought severity, while 54.3% experienced medium drought severity.

Figure 3. Number of farmers covered district-wise

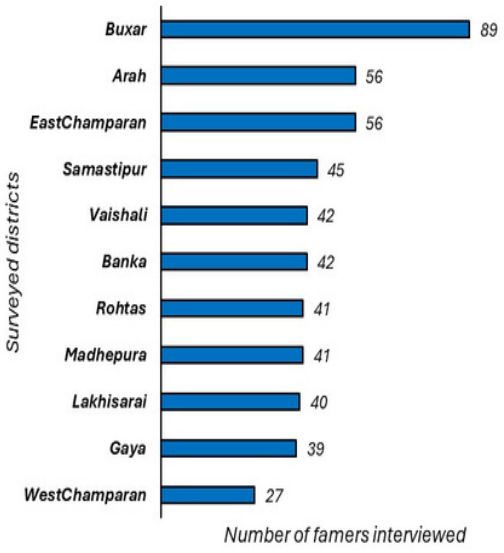


Table 1. Farmer particulars

Variable	Number of farmers	Mean value
(1.) Land use *(in acres)*		
1. Average operational landholding in 2022	519	4.954
2. Average paddy cultivation area in 2022	519	3.769
3. Average paddy cultivation area in 2021	519	4.246
4. Average fallow land in 2022	519	0.908
5. Share of fallow land (4th/1st)	519	0.203
Reasons for fallow land (number, %)	317, 61%	
Poor labor availability	20	6.3
Lack of irrigation access	22	7.1
Waterlogged plot	75	24
Waiting for rain	199	62.8
Other reasons	1	0.3
Type of land ownership (number, %)	519, 100%	
Leased-in	65	12.5
Owned	454	87.5
Drainage class of the land (number, %)	510, 100%	
Low land	97	18.9
Medium land	389	75
Upland	32	6.2
Very low land	1	0.2

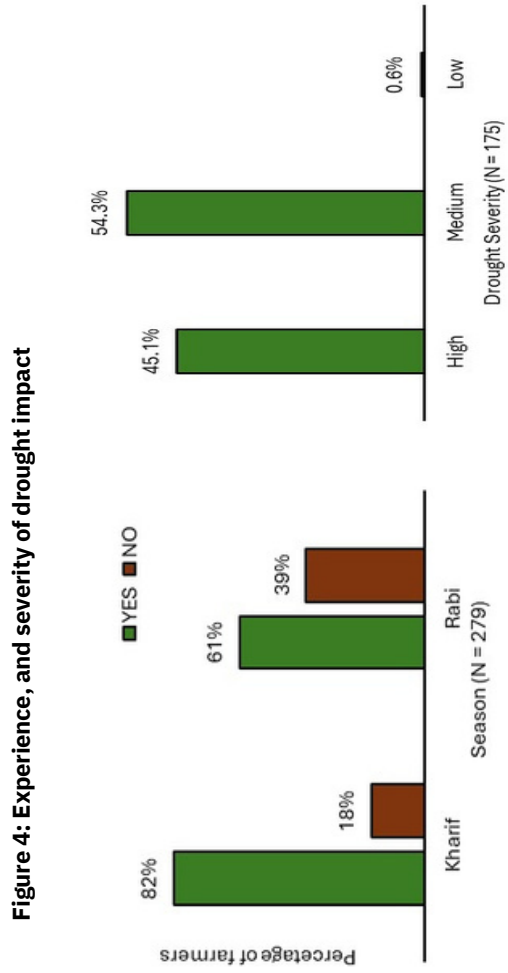


Figure 4: Experience, and severity of drought impact

Why is it important to assess the impact of drought in Bihar?

Bihar is one of the most rural states in India, with 76% of its population dependent on agriculture as the main source of livelihood (Department of Agriculture, Government of Bihar). Due to its semi-arid climate, most districts in Bihar frequently experience droughts, severely impacting rural livelihoods and aggravating economic poverty. The severity and frequency of droughts have increased in recent years, adversely affecting small and medium-scale farmers, reducing productivity, and causing economic losses due to high production costs (Nageswararao et al., 2016; Singh et al, 2022; Omaid et al., 2018).

Several districts in Bihar face moderate to severe drought conditions four out of every five years (Kishore et al., 2014). The high cost of irrigation further exacerbates the state's vulnerability to drought (Kishore et al., 2019). In 2022, most villages in Bihar were affected by drought (Government of Bihar, 2022).

CSISA conducted two surveys in 2022-23 for the Kharif and Rabi agricultural seasons to assess drought impact on crop production practices in 11 districts (39 blocks and 79 villages) of Bihar.

Findings:

- **In Bihar, paddy cultivation, a Kharif crop, is highly water-intensive and increasingly vulnerable to drought.**
- **During the Kharif season, over 50% of farmers experiencing drought reported medium severity, leading to changes in cropping practices and delays in wheat planting.**

Figure 5: Reasons for lower or higher yields in 2022 compared to typical paddy & wheat cropping years

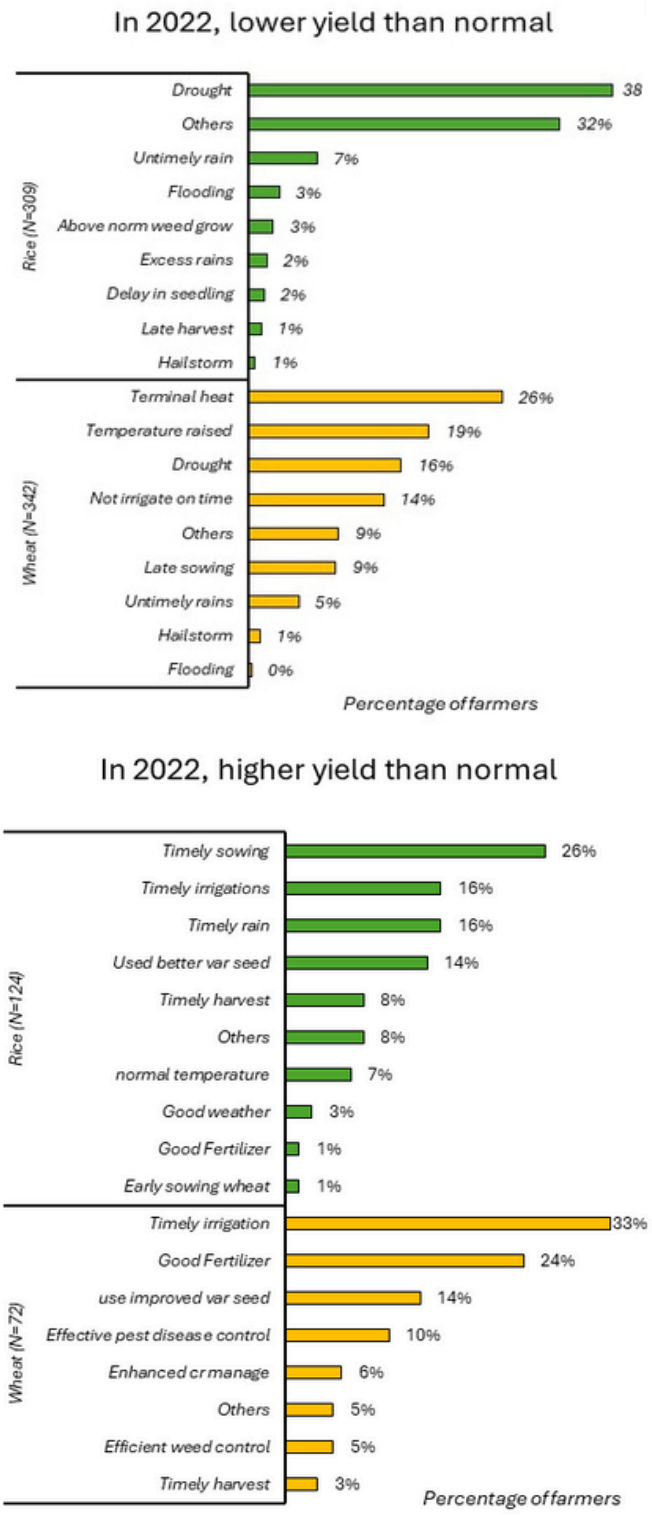


Figure 6: Usage of different pump types by farmers in wheat and paddy irrigation practices, with and without drought conditions

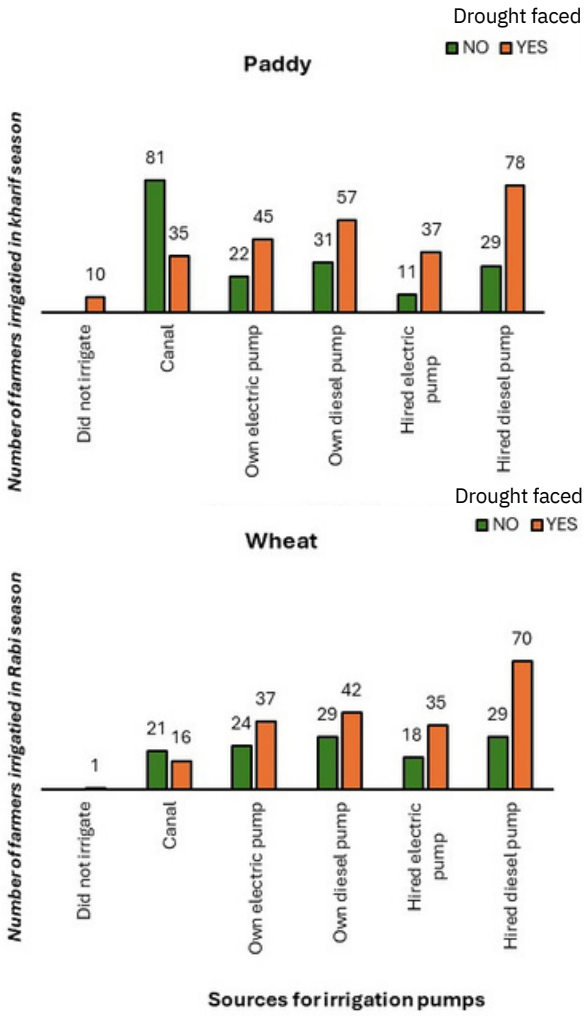
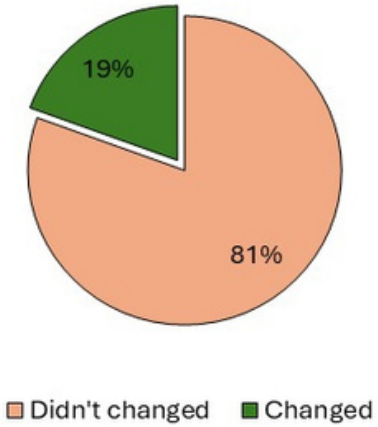


Figure 7: Change in irrigation pump sources during the Kharif season in 2022 compared to 2021

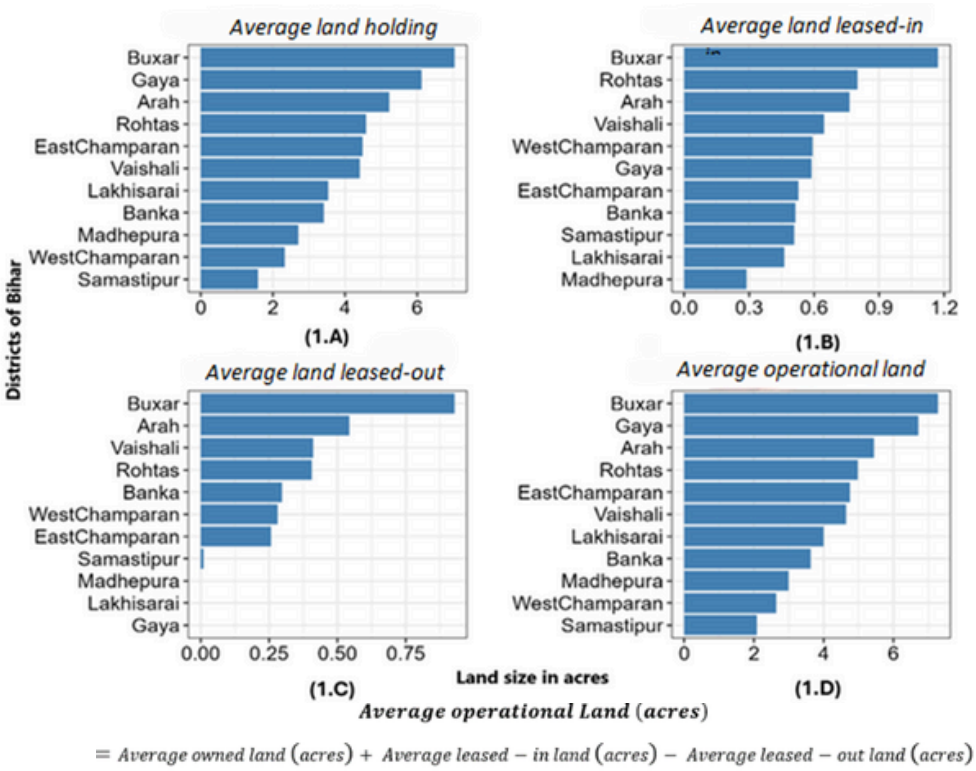


Findings:

- **In 2022, nearly one-fourth of farmers changed their use of irrigation pumps compared to 2021, with no shift between the Kharif and Rabi seasons. Most reported lower yields due to Kharif season droughts and Rabi season terminal heat.**
- **However, those who achieved higher productivity did so through timely sowing, effective irrigation, and favourable rainfall, indicating that best practices can mitigate climatic risks.**
- **Farmers in these districts tend to favor diesel pumps, particularly rented ones, over electric pumps. Meanwhile, those relying on canal irrigation reported not experiencing drought conditions in 2022.**

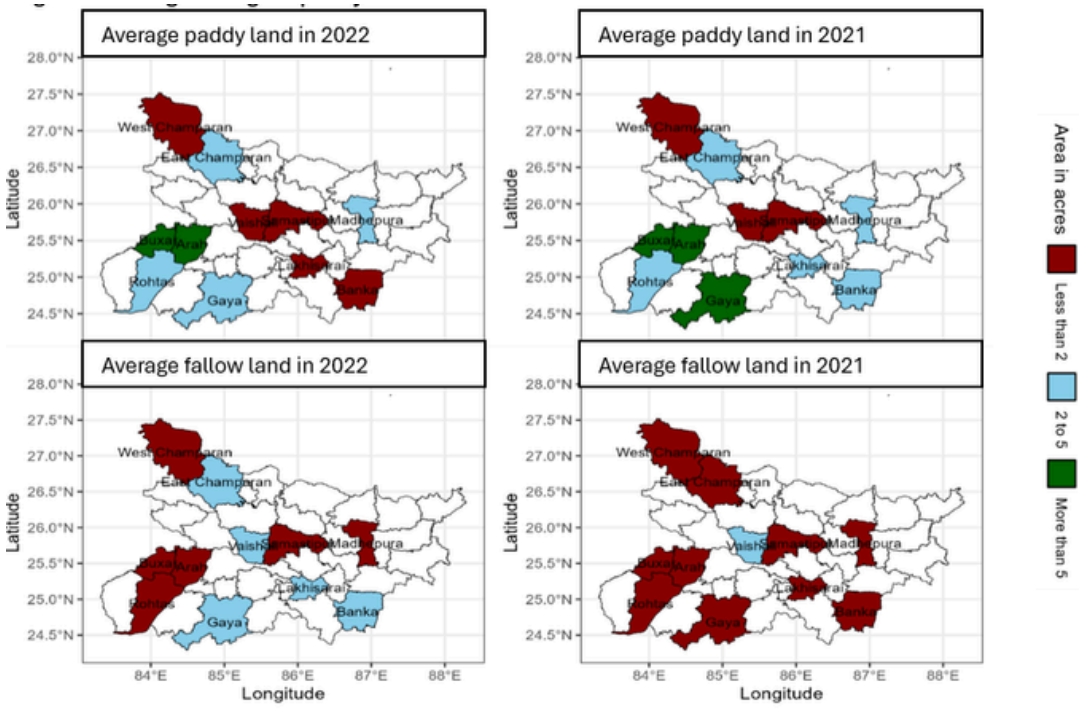
NATURAL ASSETS

Figure 8: District wise land use in Bihar in Kharif 2022



Note: Here, four different graphs represent district-wise land use and land type, (1.A) Average land holdings, (1.B) Average leased-in land, (1.C) Average leased-out land , (1.D) Average operational land.

Figure 9: Average change in paddy cultivation and fellow land area at districts level in 2022 and 2021 of Bihar



Findings:

- **In 2022, Buxar district led in diverse land use and ownership, while farmers in Gaya did not lease out their land.**
- **Drought-affected districts in Bihar saw a significant reduction in paddy cultivation area, dropping from 5 acres to 2-5 acres compared to 2021.**
- **Farmers reliant on timely rainfall for irrigation were forced to leave their land fallow due to drought conditions unlike the previous year.**

Figure 10: Percentage of farmers accessing land by ownership type, both overall and by district

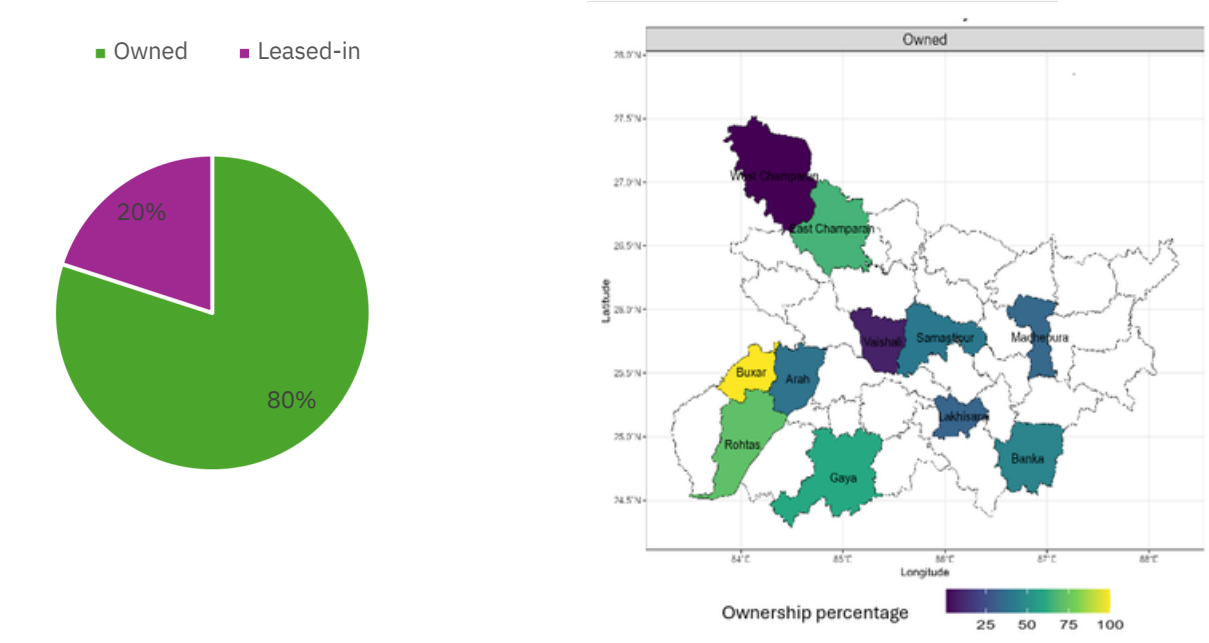


Figure 11: Distribution of drainage classes

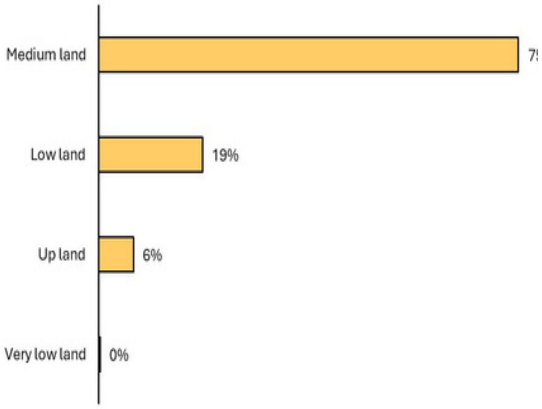


Figure 12: Factors contributing to the increase in fallow land in 2022

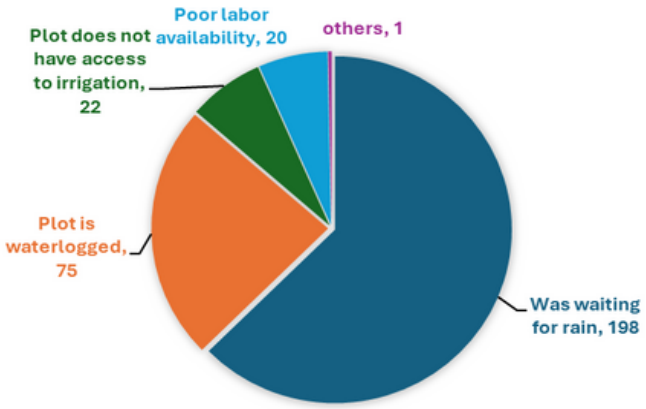


Table 2: Crop establishment and irrigation practices

Crop Establishment	*Percentage of farmers (N = 518)*
In 2022, nursery transplanted paddy	60%
In 2022, farmers late planted of paddy	50%
Reason for the late planting, due to delay in rain	42%
Irrigation supply	
Reported farmers irrigated in the Kharif 2022	99%
Farmer uses own pump for irrigation (Diesel + Electric)	53%
Farmer used electric pumps for irrigation (Own + Hired)	49%
Farmer depends on tubewell	65%
Farmer depends on canal	31%
Irrigation done when needed	81%
Remaining 19% (N = 91), didn't irrigate due to	
High cost of irrigation	44%
Water not released in the canal	17%
Water table is too deep	34%

Findings:

- **Eighty percent of farmers owned their land for agricultural practices. In Buxar, the majority ownership allowed farmers greater control over production choices.**
- **However, with 40% of farmers (N = 518) transplanting rice very late (July to late August in 2022), resulted in yield penalties compared to those with better irrigation sources (Baloch et al., 2006).**

PHYSICAL ASSETS

Figure 13: Irrigation frequency distribution among paddy and wheat farmers

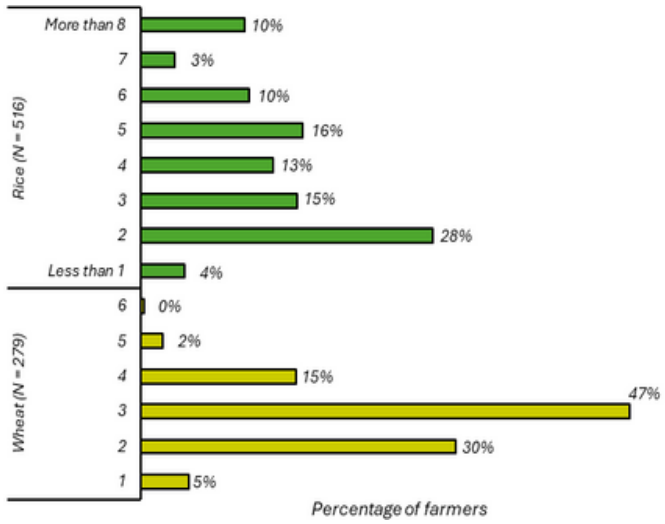


Figure 14: District-wise distribution of irrigation pump usage during the Kharif season

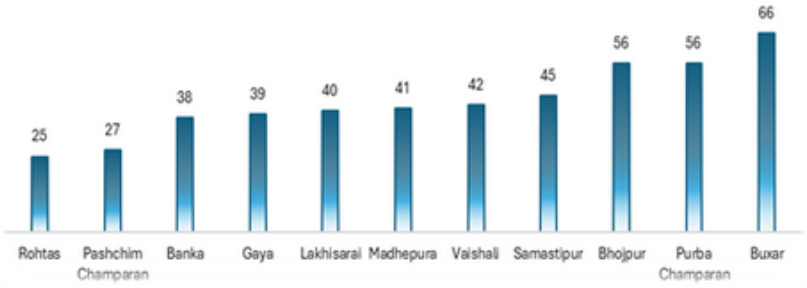
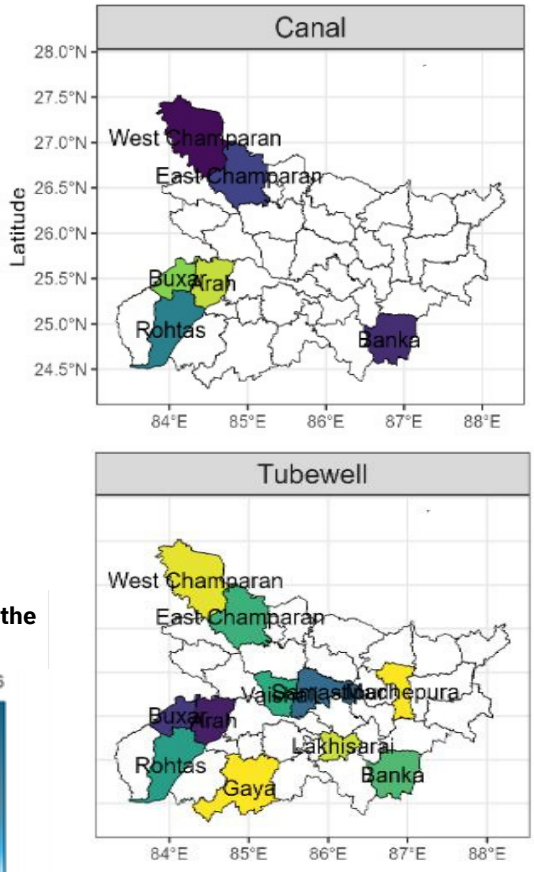
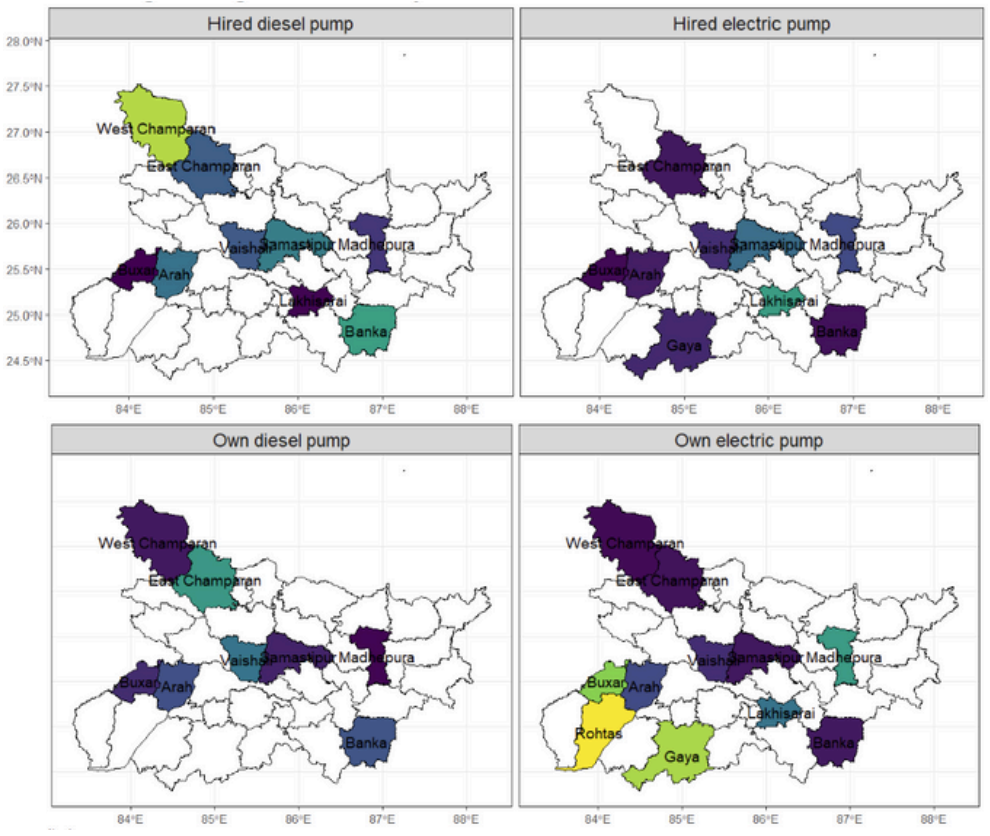


Figure 15: District-wise distribution of irrigation sources during the Kharif season





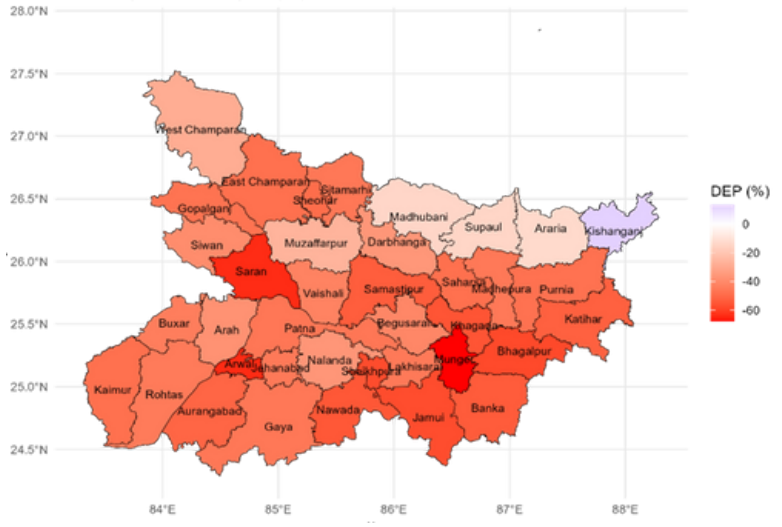
North Bihar

- *West Champaran*
- *East Champaran*
- *Vaishali*
- *Samastipur*
- *Madhepura*

South Bihar

- *Lakhisarai*
- *Banka*
- *Gaya*
- *Rohtas*
- *Arah*
- *Buxar*

Figure 16: District wise average percentage of deviation from June to August 2022



North Bihar

- West Champaran
- East Champaran
- Vaishali
- Samastipur
- Madhepura

South Bihar

- Lakhisarai
- Banka
- Gaya
- Rohtas
- Arah
- Buxar

Source: Government of Bihar, Directorate of Economics and Statistics, District-wise Rainfall Pattern, Kharif (June to August 2022)

Figure 17: District wise types of irrigation

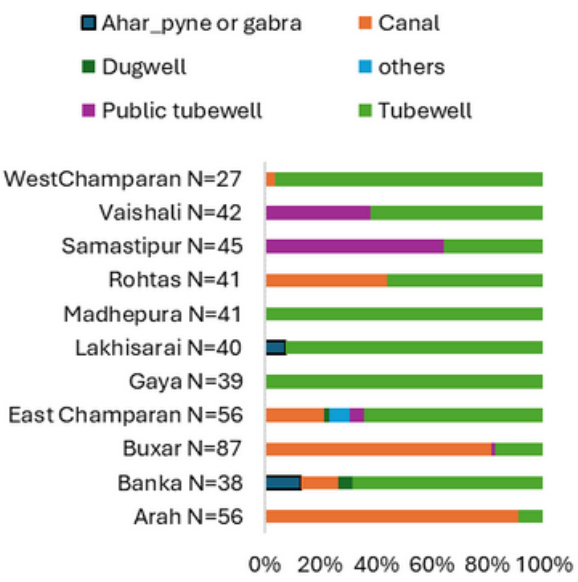


Figure: 18 District wise types of irrigation

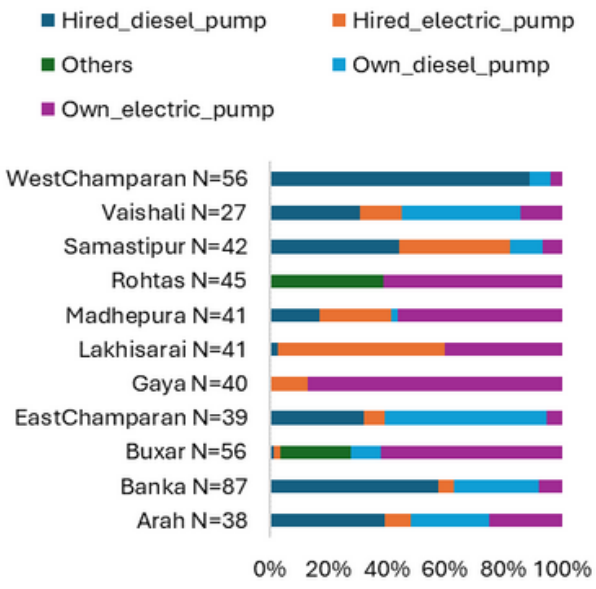
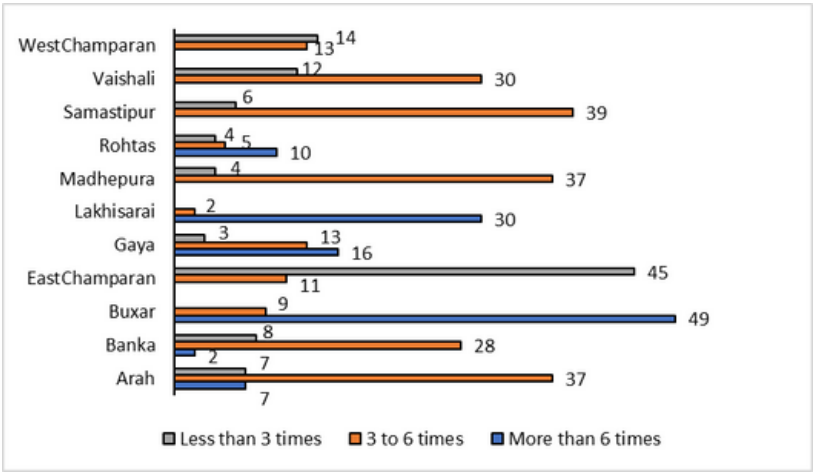


Figure 19: District wise number of times irrigation provided for paddy



Findings:

- In 2022, 23% of farmers had to irrigate their crops six or more times due to drought conditions.
- Irrigation sources varied across Bihar, with 75% of farmers in West Champaran relying on hired diesel pumps, which significantly raised irrigation costs.
- In Gaya, Madhepura, and West Champaran, all farmers dependent on private tubewells were severely affected by the drought.
- Integrated weeding methods, combining manual labor and herbicides, demonstrated greater resilience to climate risks compared to single-method weeding approaches.

Due to irrigation and drought challenges, 62% of farmers cultivating paddy in 2022, uncertain about paddy in 2023 while 27% of wheat farmers switched to other crops.

FINANCIAL ASSETS

Figure 20: Average cost of different weeding methods

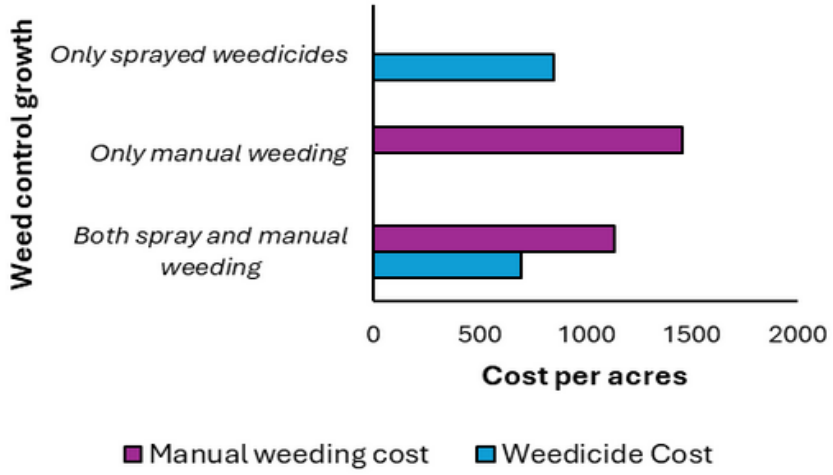


Figure 21: Comparison of average irrigation costs across crop types

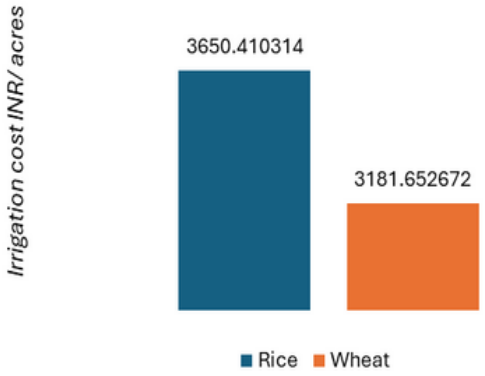


Figure 22: Comparison of average selling prices across crop types

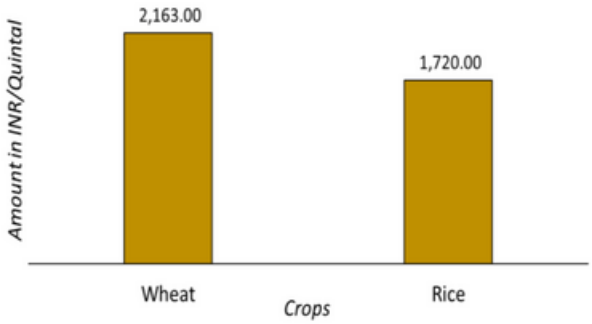
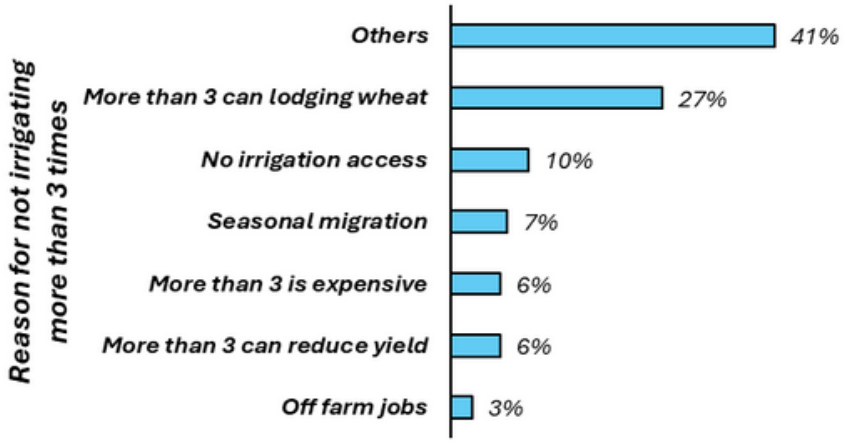


Figure 23: Reasons for limiting irrigation to three or fewer times



Findings:

- **Manual weeding costs around INR 1,400 per acre, nearly double the INR 800 per acre cost of using herbicides due to its time and labour-intensive nature.**
- **In 2022, high irrigation costs during the Kharif season forced some farmers to leave land fallow in the Rabi season.**
- **Paddy cultivation yields lower profits compared to wheat due to higher input costs from frequent irrigation.**

HUMAN ASSETS

Figure 24: Percentage of farmers cultivating different crops during the Rabi season

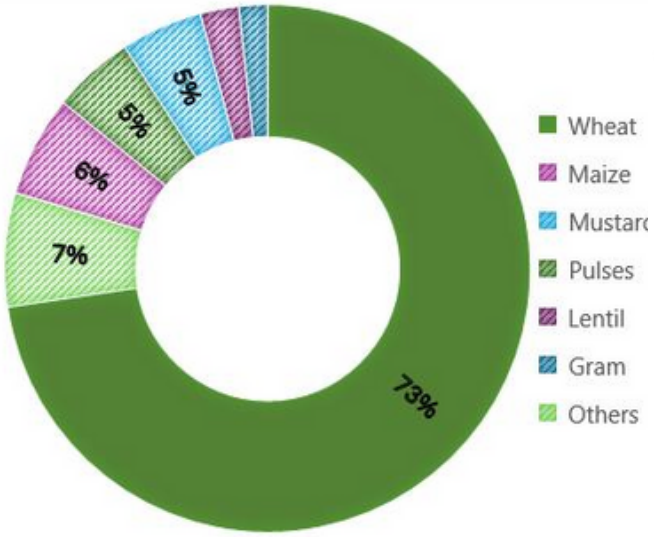
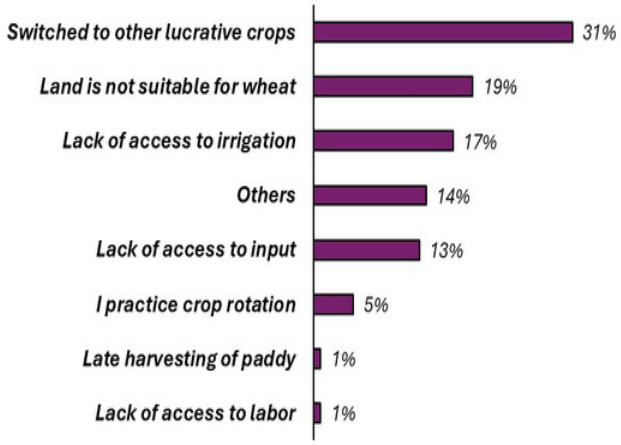


Figure 25: Reasons for farmers not cultivating wheat in 2022



Findings:

- **In 2022, 62% of paddy farmers affected by drought were uncertain about growing rice in 2023.**
- **Additionally, 27% of farmers switched from wheat to other crops, citing unsuitable land and irrigation challenges as primary reasons.**

SOCIAL ASSETS

Figure 26: Gender-wise distribution of farmers

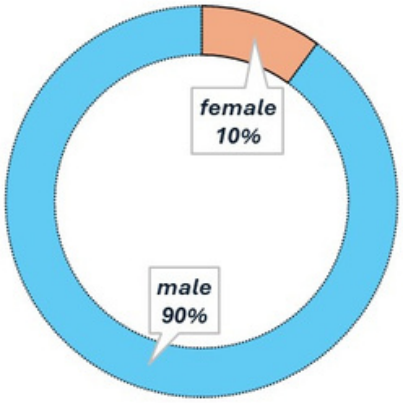
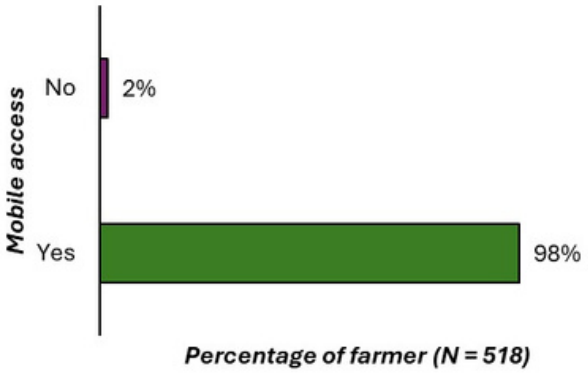


Figure 27: Percentage of farmers with access to mobile phones

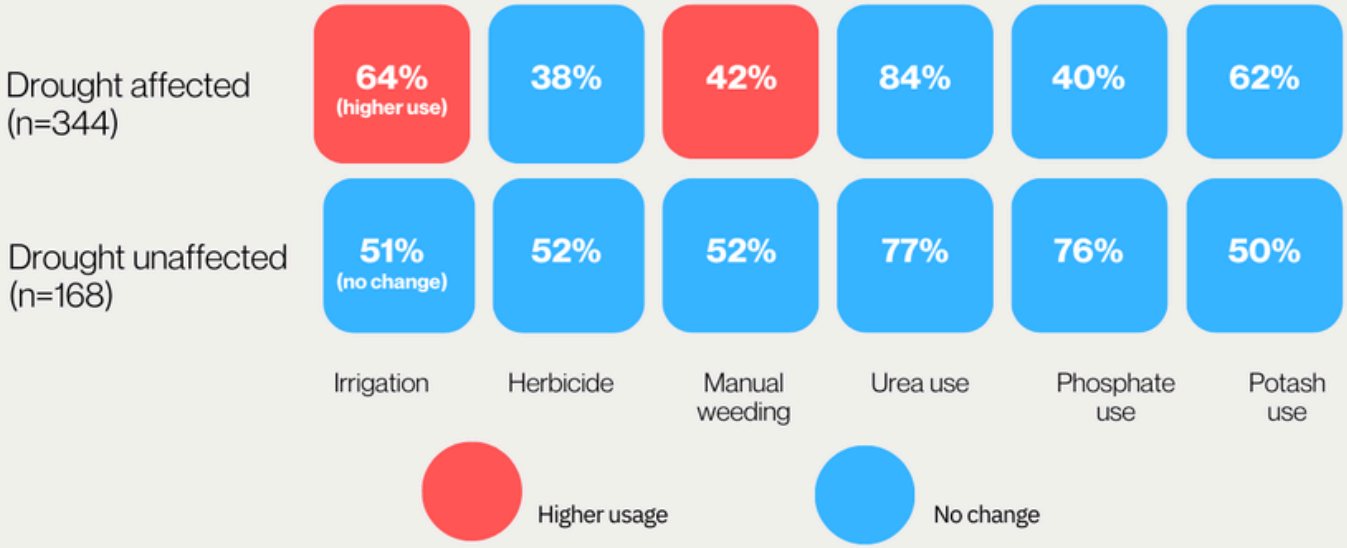


Findings:

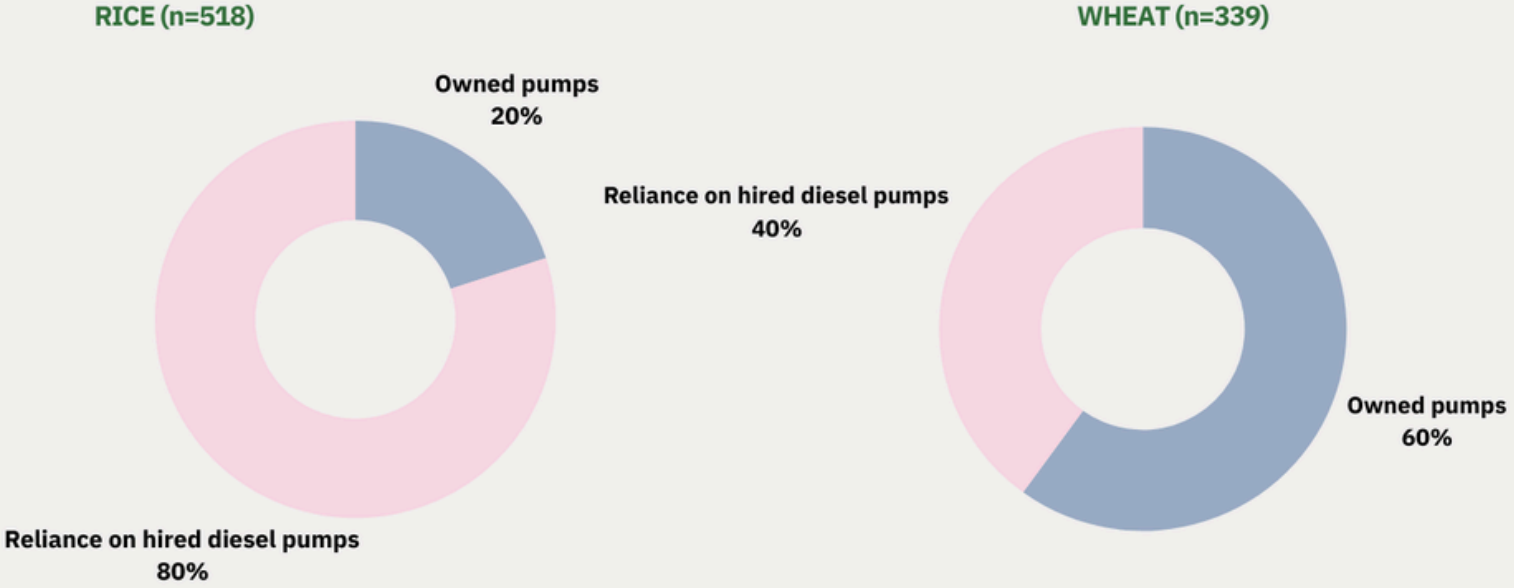
- **Agriculture remains a male-dominated sector, with 90% of surveyed farmers for this study being male and only 10% female, reflecting significant gender disparity (Singh et al., 2020). However in Punjab and Haryana, the disparity is even more significant.**
- **While nearly all farmers surveyed use mobile phones for communication, data suggests these devices are commonly shared within households.**

FARMERS PERCEPTIONS

Responses by farmers surveyed in 2022 regarding crop production practices in comparison to 2021.



Key Highlights



Paddy Yield (Kharif season)

1. **Farmers who experienced lower paddy yields during the kharif season attributed it to drought conditions. About 80% of these farmers relied on rented or hired diesel pumps for irrigation.**
2. **Conversely, those who reported higher paddy yields in 2022 compared to a normal year primarily used electric pumps, enabling timely irrigation.**

Wheat Yield (Rabi season)

1. **Wheat farmers who saw a drop in yields during the rabi season compared to a normal year were mainly those who depended on diesel pumps for irrigation, with 40% renting or hiring these pumps.**
2. **Among the farmers who reported higher wheat yields in 2022, there was no significant difference in the type of pumps used, though a larger percentage still relied on rented or hired diesel pumps.**

KEY AREAS FOR FURTHER DISCUSSION AND RESEARCH

1. Delayed Rice Nursery Raising Due to Monsoon Uncertainty

Farmers typically begin nursery raising as the monsoon season approaches, but unpredictable monsoon rains often cause delays. The lack of accurate predictions regarding the onset of monsoons exacerbates the problem. Inaccurate forecasts can be more detrimental than beneficial, leading to delayed transplanting and reduced yield potential.

2. Impact of drought on Cultivation Costs and Yield

During drought years, farmers face increased cultivation costs after crop transplantation, which become their primary concern. With limited flexibility to adjust expenses, funds saved for family welfare are redirected to saving the current crop. The combination of high cultivation costs and potential yield losses creates significant financial strain. While yield losses are critical, this study did not document them, indicating the need for further investigation.

3. Underutilization of Monsoon Rains

Due to delayed crop transplanting, largely driven by monsoon timing uncertainty, 40-50% of monsoon rains go unutilized. Future policies should prioritize increasing access to affordable irrigation systems, such as electric and solar-powered tube wells, to reduce dependency on timely monsoons and improve water management practices.

4. Policy Recommendations for Improved Irrigation Access

Further research should explore policy reforms to improve the availability and availability and affordability of irrigation systems, particularly in regions vulnerable to unpredictable monsoons and drought. Better irrigation access will help reduce climate variability risks.

ACKNOWLEDGEMENTS

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Data set and survey results in CSISA Dataverse
Data on assessment of impacts of drought in Bihar during 2022:
https://data.cimmyt.org/dataset.xhtml?persistentId=hdl:11529/10549011

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