



Climate adaptation in Nalanda, India

*Climate shocks, impacts, responses,
and adaptive capacity of local food
systems*

Data Note 18

December 2023

ABOUT THIS BRIEF | The Transforming Agrifood Systems in South Asia (TAFSSA) district agrifood systems assessments aim to provide a reliable, accessible, and integrated evidence base that links farm production, market access, dietary patterns, climate risk responses, and natural resource management with gender as a cross-cutting issue in rural areas of Bangladesh, India, and Nepal. They are designed to be a district-level multi-year assessments. Using data collected in February– March 2023, this brief describes experiences of climate shocks, perceived impacts and responses, and access to different types of resources that can contribute to the adaptive capacity of households. Here we use the term “climate shocks” to represent manifestations of climate variability and weather extremes that households perceive and respond to. This is one of a set of data notes that, together, provide a holistic picture of the agrifood system in the district.

Figure 1. Map showing surveyed villages in Nalanda, India

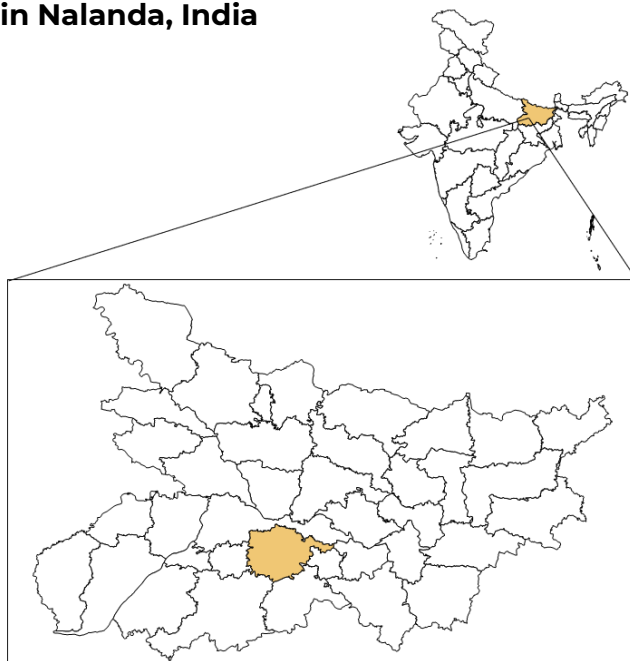


Figure 2. Highlights from this brief



44.1%

of households
report impacts
from climate
shocks in past 2
years



61.0%

of impacted
households
adopt response
strategies to
climate shocks



48.9%

households
access weather
forecast
information



49.6%

of households do
not own any land



99.8%

of farming
households have
some access to
irrigation

OVERVIEW OF CONTENTS |

This brief captures the experience and impact of climate shocks on households, along with the responses that households adopt to these shocks. It then provides a picture of access to different types of capitals that constitute the basis of households' adaptive capacity. In this brief we present 'generic' adaptive capacity (Mortreux and Barnett 2017) as an outcome of a households' access to five types of capital:

Natural capital - natural resources required to sustain a livelihood to enable adaptation

Physical capital – infrastructural support and technological solutions to impacts

Financial capital – required to bear the cost of adaptation

Social capital - social bonds and networks to assist adaptation

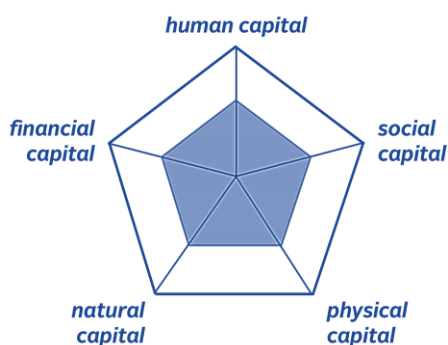
Human capital - the physical and mental resources to adapt

- Mortreux and Barnett (2017)

This conceptual framework of five capitals (Figure) emerges from the *sustainable livelihoods framework*, which is discussed in the Annex section to this brief along with the indicator selection.

Given the climate change focus of the brief, an added emphasis on 'access to climate information' has been included.

FIVE CAPITALS FRAMEWORK



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DISTRICT CLIMATE AND RESOURCE PROFILE

Table 1. Village resource regime

Sample villages (N)	49
LAND	%
Villages reporting land conversion -	
• From agriculture to built-up area	16
• From forest/water-body to agriculture	12
Villages reporting soil texture -	
• Sandy (light soil)	57
• Loamy and silt (medium soil)	86
• Clay (heavy soil)	78
WATER	%
Villages reporting decline in groundwater level over last 5 years	94
Villages reporting water quality issues:	
• Iron	59
• Salinity	27
Predominant source of agricultural water:	
• Groundwater	98
• Surface water	0
• Rainfed	0
Energy source for irrigation in village	
• >50% irrigation pumps in village run by diesel	18
• >50% irrigation pumps in village run by electric	82
• Villages with use of Solar pumps	6
COMMON PROPERTY RESOURCES	%
Villages with community ponds	57
Villages with community forest	2
Villages with pasture/grazing lands	16

Note: The values in this table are self reported by key village respondents through a structured community level questionnaire

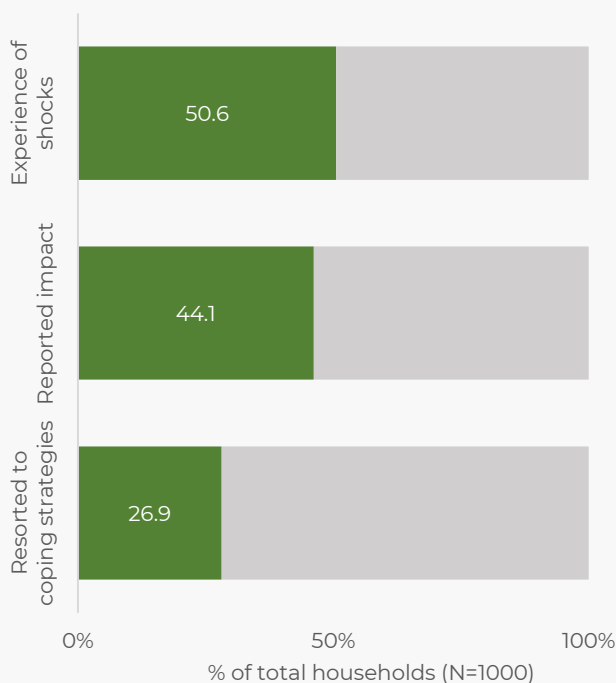
Table 2. Household characteristics

TOTAL HOUSEHOLDS (N)	1000
Owning land %	50
Operating land %	63
Cultivating crops %	62
Irrigating land %	62
Reporting experience of shocks %	51
Main source of income	
• Crop cultivation, %	39
• Business, %	10
• Wages, %	31

ASSESSING ADAPTATION |

Climate adaptation is defined by the Intergovernmental Panel on Climate Change (IPCC) as “the process of adjustment to actual or expected climate and its effects”. Here adaptation assessment is approached through three levels of related questions– whether respondents experienced any climate shocks in last two years, how were they impacted by these shocks, and how they responded to these shocks (immediate coping strategies and longer-term changes in farming practices). Perception or experience of shocks, and their impacts are a function of not only the biophysical incidence of climate shocks but also households’ preparedness and capacity to cope and adapt.

Figure 3. Experience, impact, coping to climate shocks



FINDINGS:

- ✓ Among the surveyed households, 50.6% reported experiencing climate shocks. Within this group, 87.2% indicated some level of impact, which corresponds to 44.1% of the total sample households. Furthermore, 61% of the households that were affected by these shocks reported employing various response strategies to cope with and adapt to them, accounting for 27% of the total sampled households.

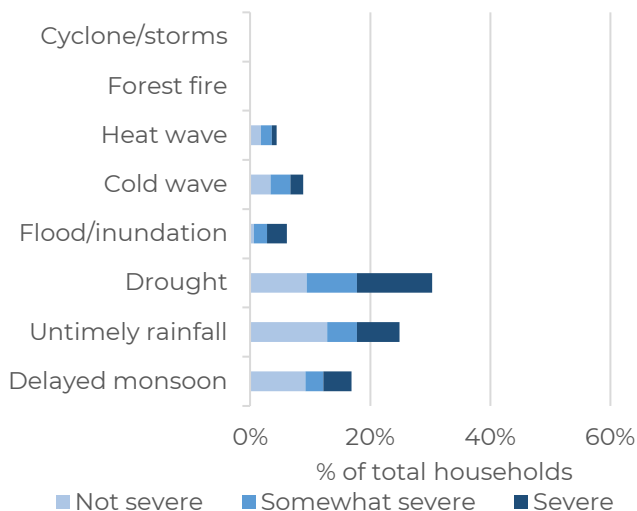


44% of households report impacts from climate shocks in past 2 years; 27% of households report adoption of specific coping and adaptation strategies



EXPERIENCE AND IMPACT OF CLIMATE SHOCKS

Figure 4. Perceived experience of climate shocks and severity of impact (2021-2022)

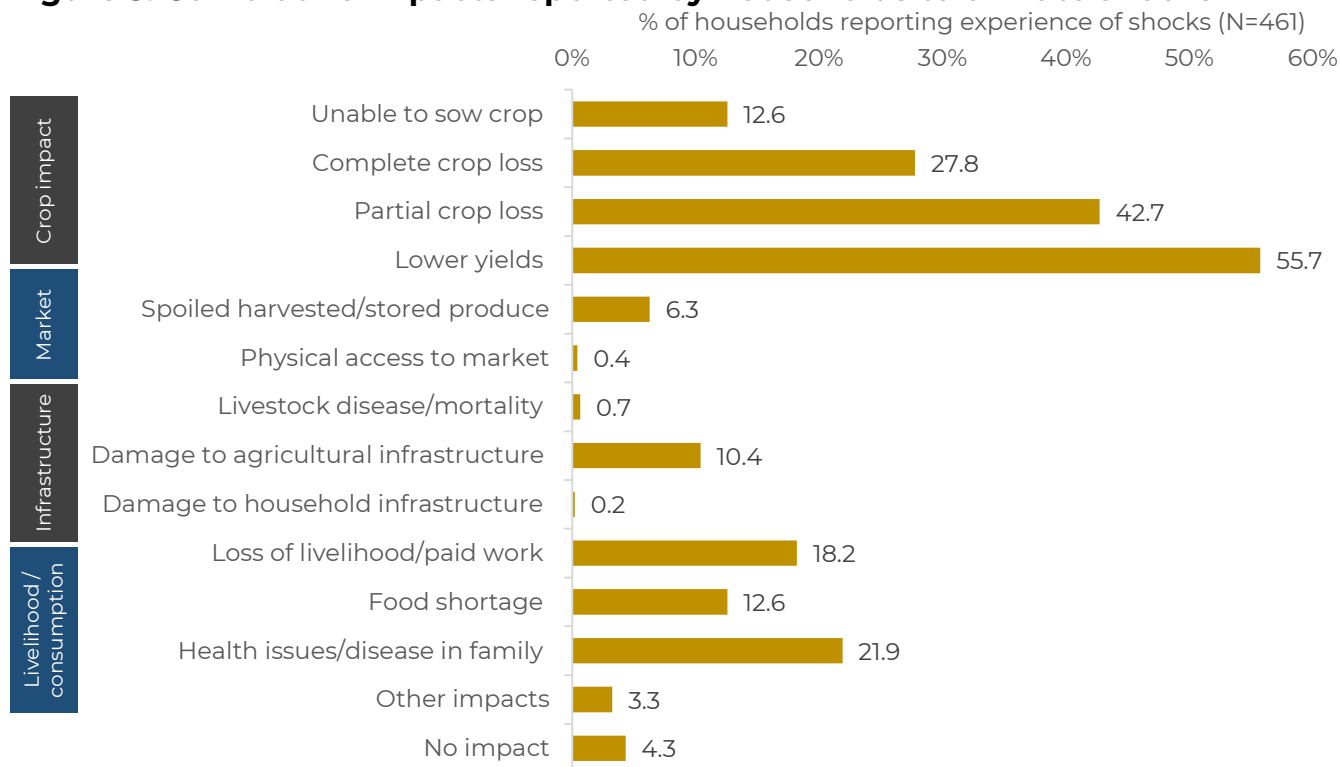


IMPACTS AND RESPONSE |

To explore the impacts of climate shocks, households were asked about (1) the perceived severity level of the impact on the household's economic condition, and (2) the type of impact(s). Response strategies included both immediate coping as well as changes in farming practices. A range of categories of response options were offered to survey participants based on literature and validated surveys.

Impacts and responses are presented at two levels – disaggregated by different climate shocks (Fig. 6 and Fig. 8), and cumulative across different climate shocks (Fig 5 and Fig. 7). The 'cumulative' assessments provide the overview picture for different impact and response categories across all shocks affecting the household i.e. at least one valid response for a particular impact or response strategy across all of the shocks experienced by that household.

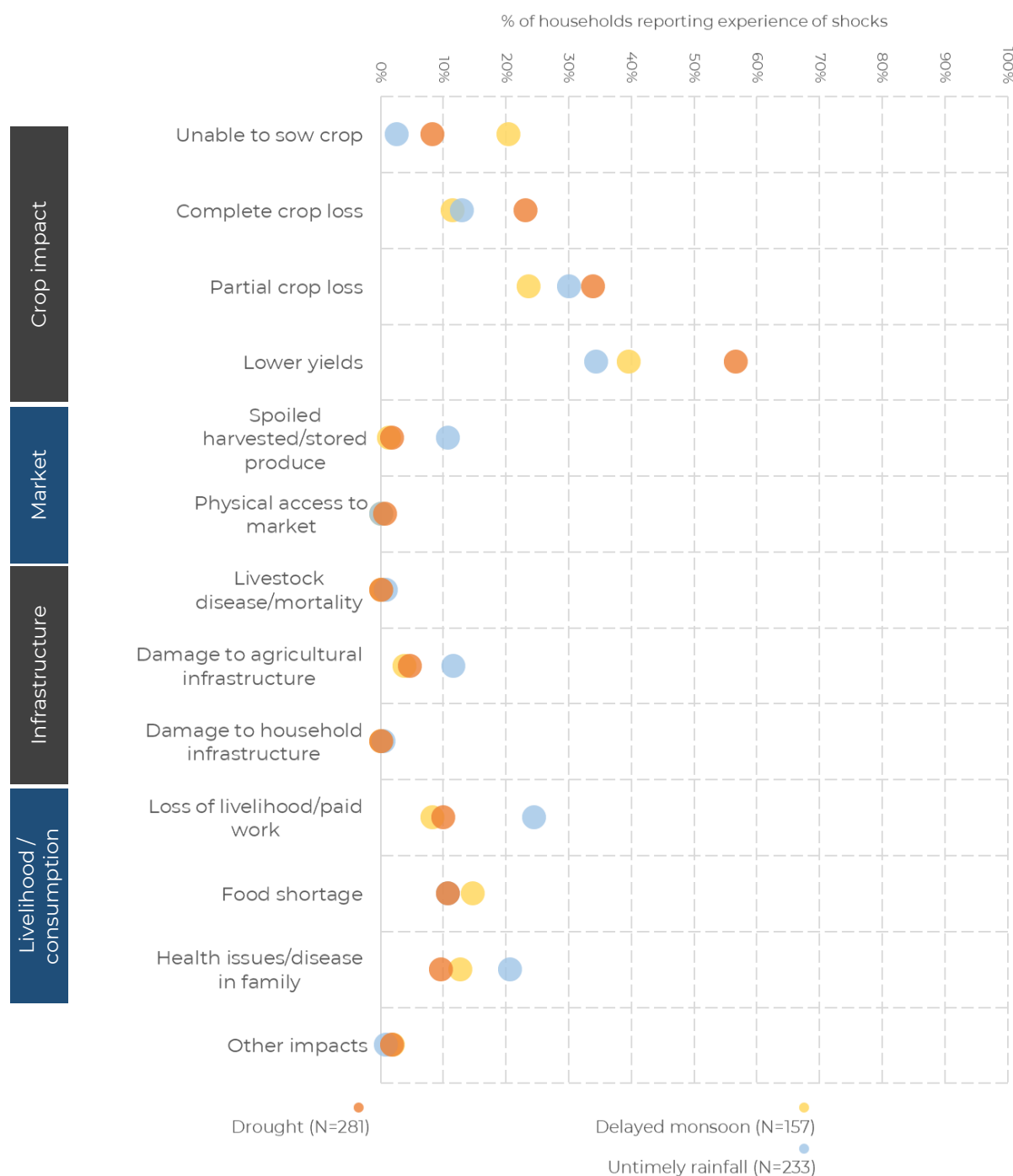
Figure 5. Cumulative impacts reported by households to climate shocks



FINDINGS:

- ✓ Partial crop loss and lower crop yields were the most predominant impacts of climate shocks reported by households, with significant percentage also reporting livelihood, food and health impacts
- ✓ Shocks related to precipitation uncertainties were most experienced shocks in last two years

Figure 6. Impacts reported by households under different climate shocks (top 3 shocks by percentage of households experiencing shock)



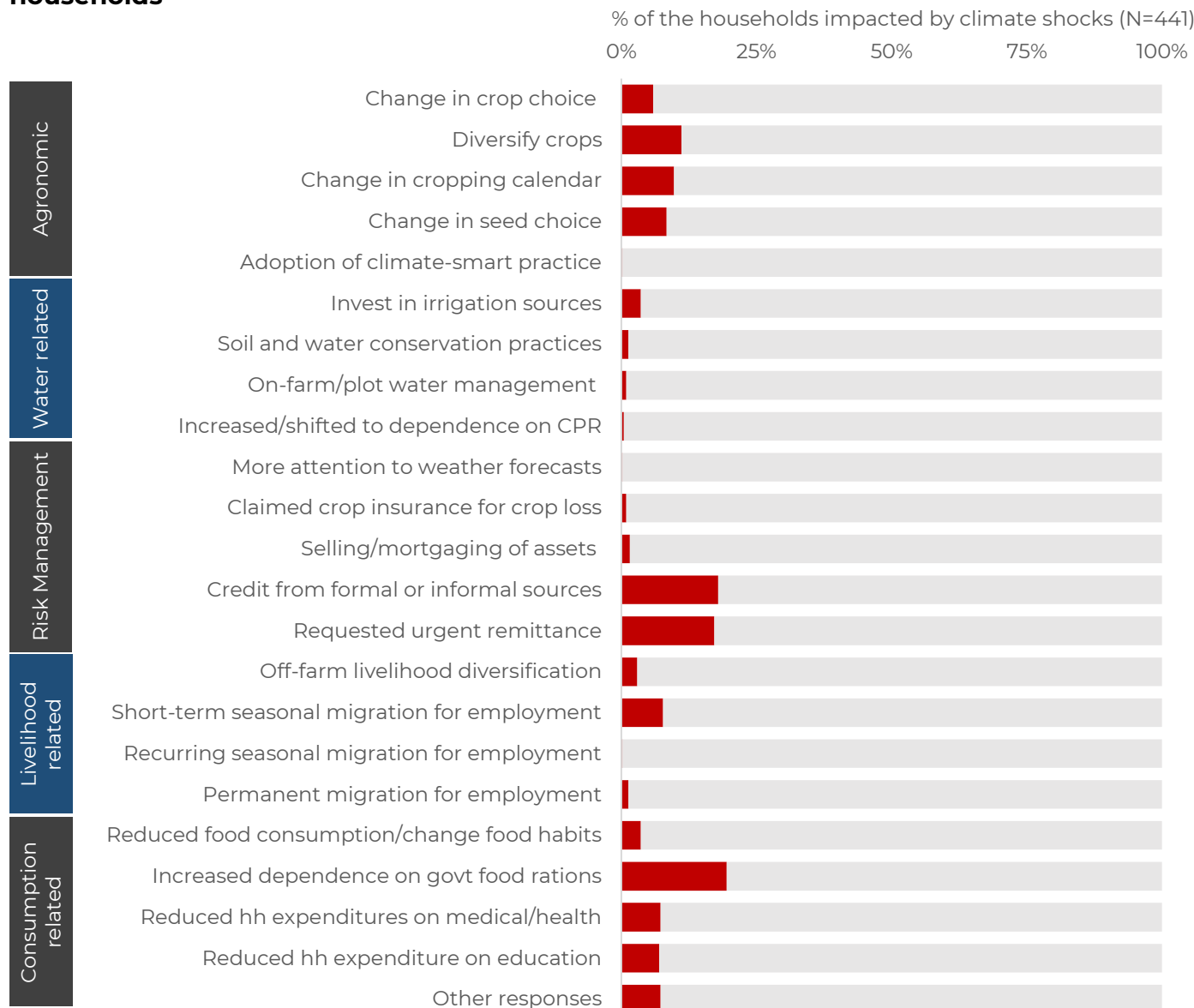
Note: Cyclone/storms, forest fires, cold waves, heat waves,, flood/inundation have not been included in this list since percentage of households reporting experience of these shocks are below 30% of households reporting any experience of a shock.

FINDINGS :

- ✓ In general, the most frequently reported shocks in this region are related to crop-related impacts. These impacts are predominantly identified as the primary consequences of droughts.
- ✓ Market, livelihood and consumption related impacts are cited most often as key climate risks as a result of untimely rainfall.

RESPONSE STRATEGIES TO CLIMATE SHOCKS

Figure 7. Cumulative response strategies to any climate shocks adopted by households



Note: Cumulative: At least one valid response for a household for a particular response strategy option for any shock experienced by that household

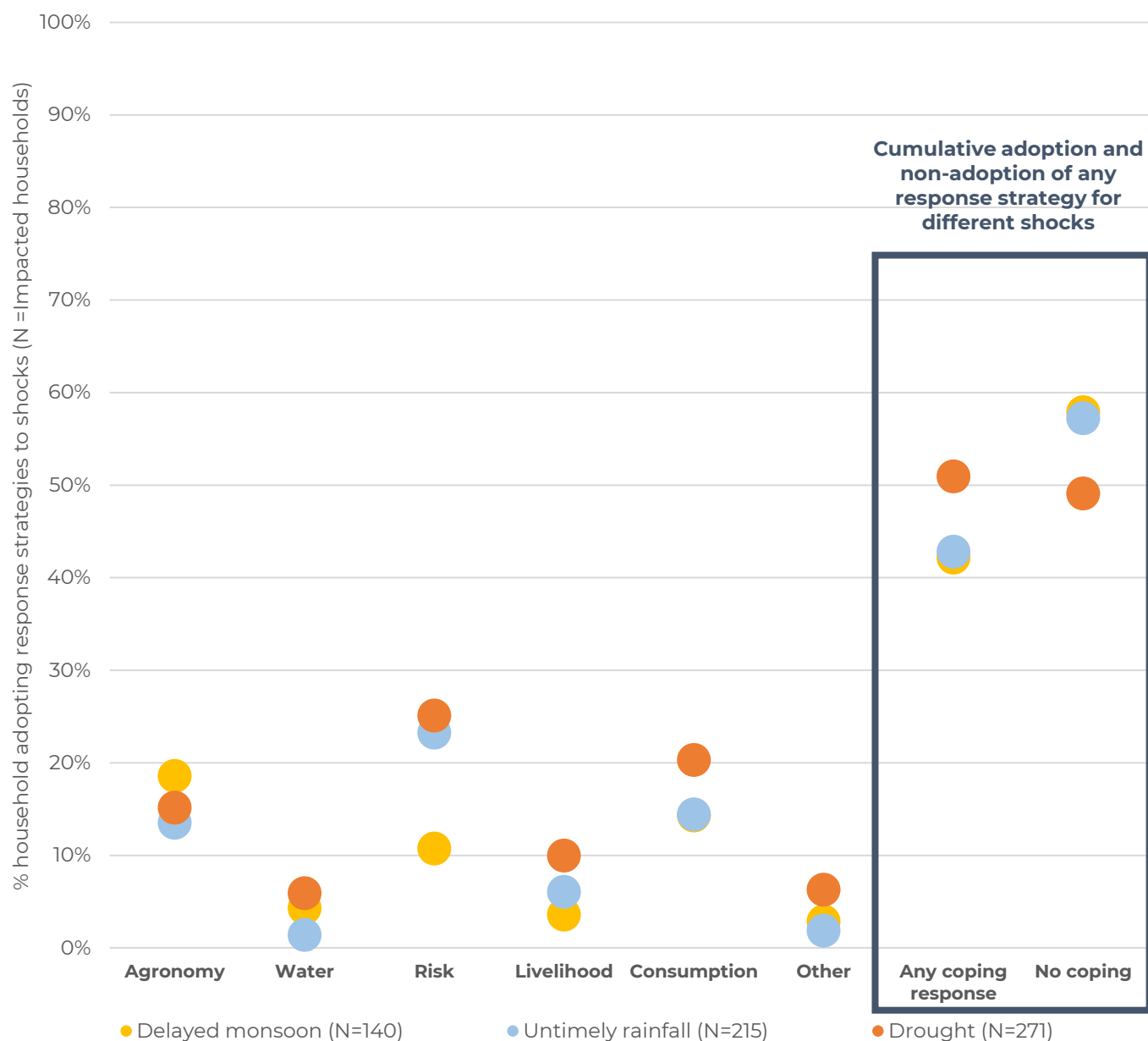
The coping strategies may reflect broader groups of strategies which were highlighted in the questionnaire as examples

- CPR – Common Property Resources (public/community land and water resources)
- Climate-smart practices – crop establishment regimes such as zero-tillage, intercropping, direct seeded rice etc.
- On farm/ plot water management - increase irrigation, decrease irrigation, drip/ sprinkler etc
- Those not reporting any response strategies either depend more on personal savings, increase dependence on production from their own farm for self-consumption, or they did not report severe impacts

FINDINGS :

- ✓ The most common short-term urgent responses used by households include reliance on credit, remittances, and dependence on government rations.
- ✓ 61% of impacted households are resorting to some response mechanisms.

Figure 8. Response strategies to climate shocks reported by households under different climate shocks (top 3 shocks by percentage of households experiencing shock)



Note: The X-axis represents grouping of detailed response strategies under five broad categories as presented in Figure 5. Please refer to Figure 5. for the different types of responses under these broad categories presented. Cyclone/storms, forest fires, cold waves, heat waves,, flood/inundation have not been included in this list since percentage of households reporting experience of these shocks are below 30% of households reporting any experience of a shock.

FINDINGS :

- ✓ Despite droughts being primarily associated with crop-related impacts, it appears that the coping responses used by households are more focused on financial risk management and consumption-related strategies rather than agronomic and water management-related approaches.
- ✓ Household coping responses are predominantly adopted in response to droughts, whereas there are considerably fewer coping responses in response to untimely rainfall and delayed monsoon impacts.

ADAPTIVE CAPACITY – NATURAL CAPITAL

Figure 9. Land access by size of landholding (owned and operational)

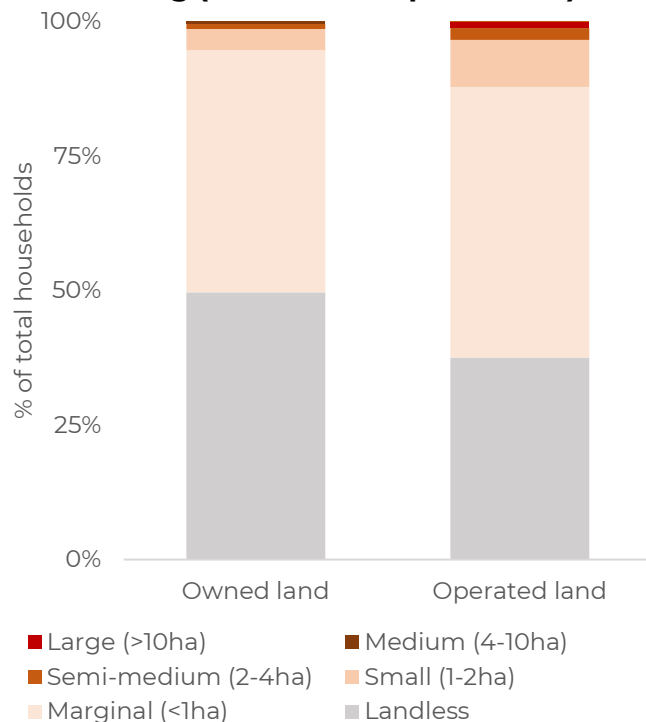


Figure 10. Access to land by type of ownership

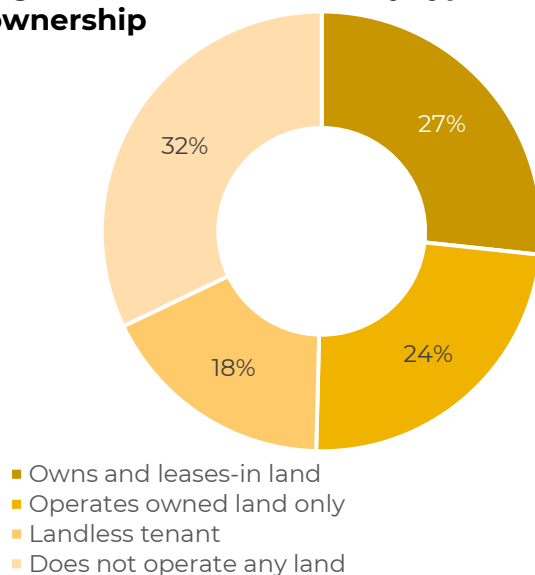
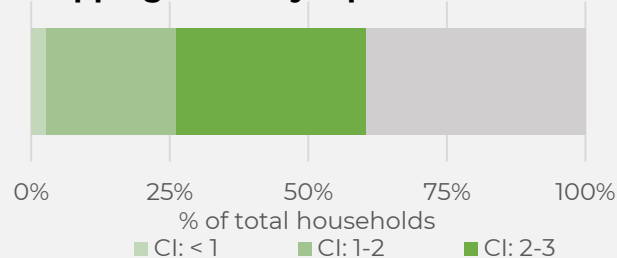


Figure 11. Cultivated land by farm cropping intensity reported



Note: Cropping intensity (CI) = Net Sown Area / Gross Cropped Area

Figure 12. Access to irrigation

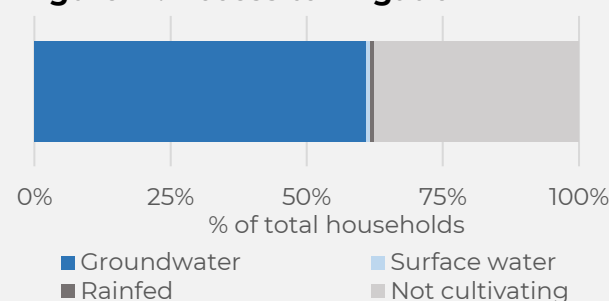


Table 3. Water insecurity

IRRIGATION WATER		% of cultivating households
Cultivating land but not irrigating		1.4
Reporting labor scarcity for irrigation		37.5
Reporting poor access to irrigation among their two most important challenges in agriculture		49.5
HOUSEHOLD WATER		% of total households
Reporting worry about not having enough water for all household needs (sometimes/often/always)*		14.7
Reporting worry about having to change schedules/plans because of problems with water situation (sometimes/often/always)*		15.9

* Variables compiled from HWISE categories: Sometimes (3-10times), Often (11-20 times), Always (>20 times)

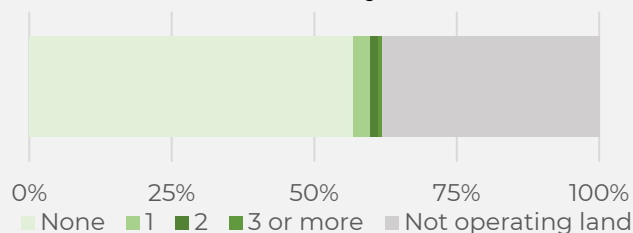
FINDINGS :

- ✓ A large portion of households lack tenure, with 49.6% experiencing this condition, which restricts their income generation opportunities and access to rural loans. Additionally, 17.5% of households rely entirely on tenant farming arrangements for their livelihoods.
- ✓ Nearly all households engaged in cultivation practice irrigation, primarily relying on groundwater sources. However, many of these households report challenges related to the quality of their irrigation access.

ADAPTIVE CAPACITY – PHYSICAL CAPITAL

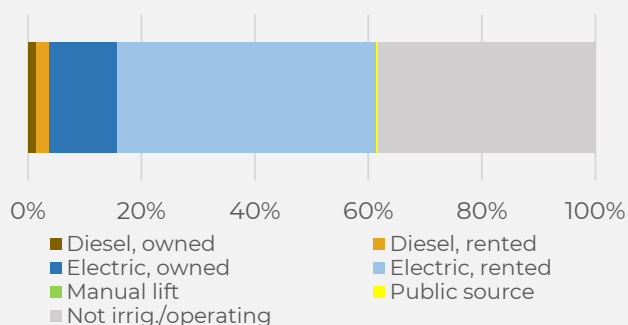
Figure 13. Ownership of productive assets

13a. AGRICULTURAL EQUIPMENT

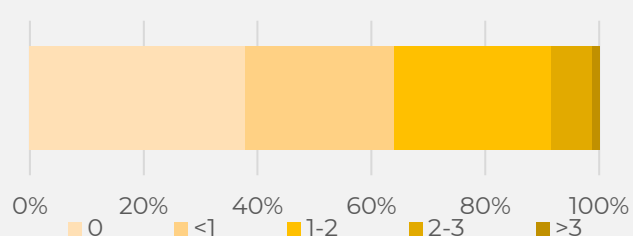


Note: The legend categories show how many types of key agricultural machines are owned by the household among the following: 2-wheel tractor / 4-wheel tractor with rotavator / 4-wheel tractor with cultivator / Thresher / Combine harvester / zero tillage/seed drill with 4-wheel tractor / Potato transplanter

13b. IRRIGATION ENERGY SOURCES

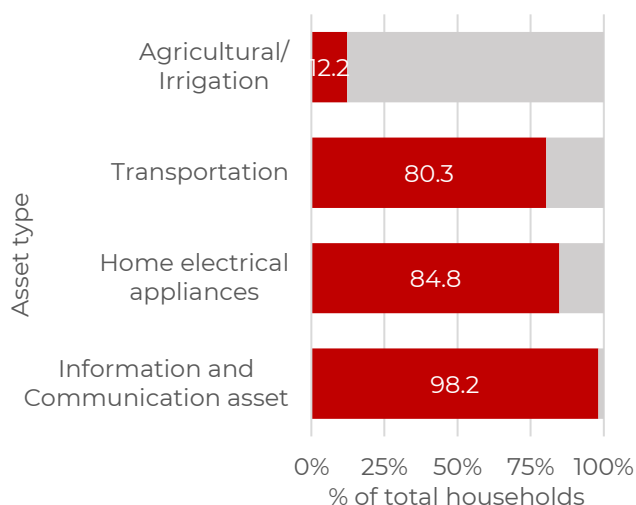


13c. LIVESTOCK UNITS



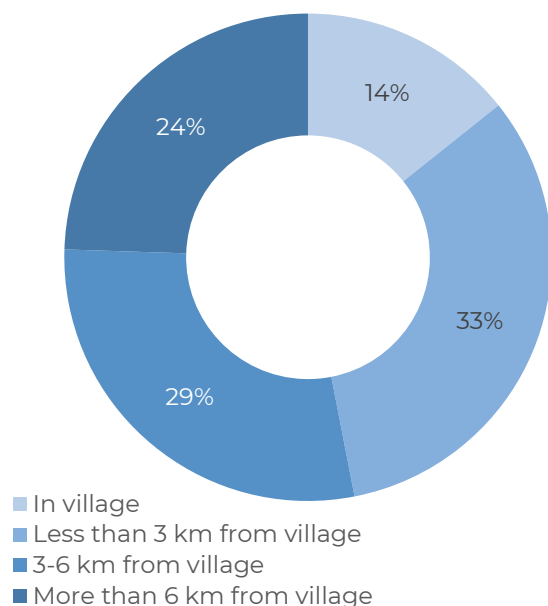
Note: Livestock Units - an 'exchange ratio' among livestock species and obtained by converting the body weight into the metabolic weight, which is multiplied by the units of animals owned by the household (Chilonda and Otte, 2006; FAOSTAT, 2022). Cow in USA is used as the reference species

Figure 14. Ownership of household assets



Note: Agricultural - include thresher, tractor and water pump
Transportation - bicycle, motorcycle/scooter, animal drawn cart, rickshaw, car
Communication - radio, TV, phone, internet, computer

Figure 15. Distance to market



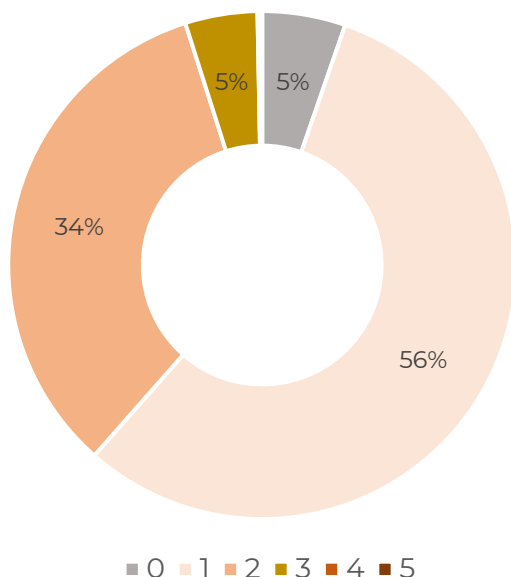
Note: The chart presents % of households in villages at different distance categories from nearest market

FINDINGS :

- ✓ Ownership of agricultural and irrigation assets is relatively low, with most households depending on rented equipment for their farming operations.
- ✓ About 62% households own livestock which provide income as well as a livelihood option under shocks.
- ✓ There is good access to transport assets in Nalanda, and the majority of sampled households reside in villages located within a 6 km radius from the market.

ADAPTIVE CAPACITY – FINANCIAL CAPITAL

Figure 16. Household occupational/livelihood diversity



Note: Number of different **primary** occupations (longest time spent during last 365 days) household members are involved in

Figure 17. Primary and secondary sources of income of household

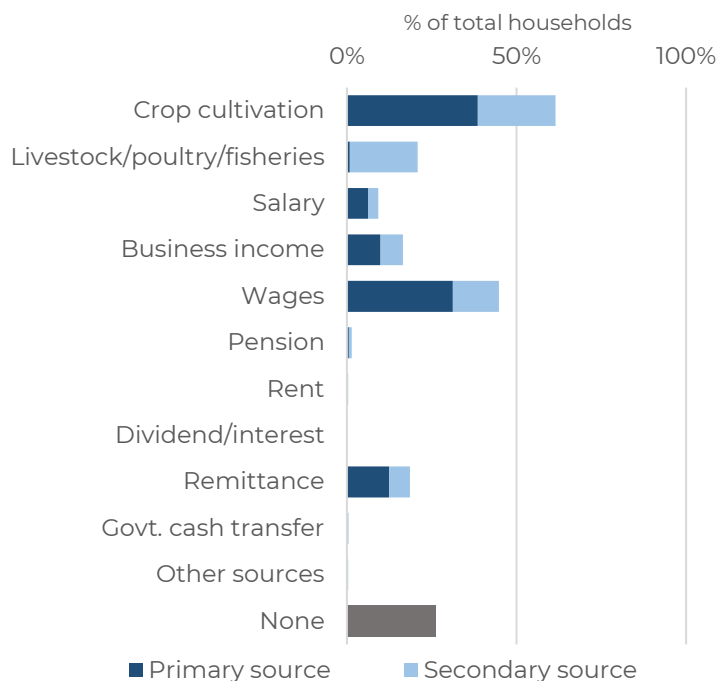


Figure 18: Outstanding loan and credit source

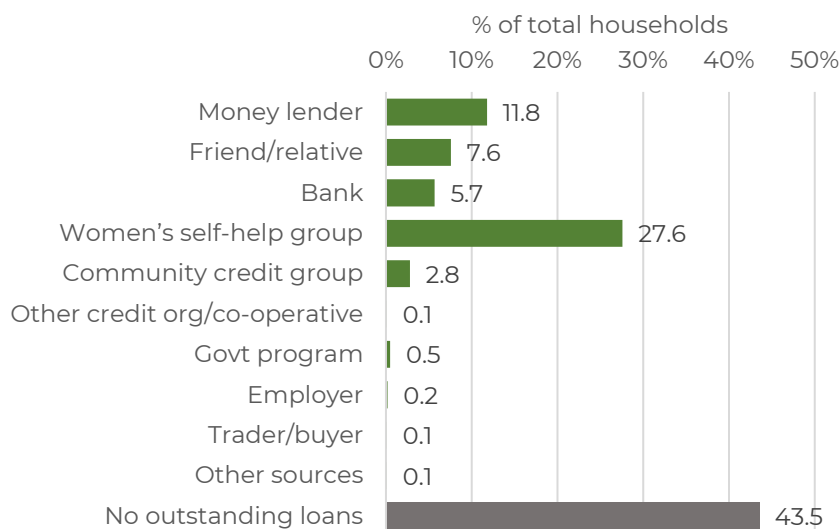


Table 4: Access to formal credit and insurance services

	% hhs
Bank account	98.8
Kisan credit card	8.0
Life insurance	23.5
Crop insurance	9.4
Livestock/poultry/fish insurance	2.9
Health insurance	21.0

FINDINGS :

- ✓ More than 60% of households exhibit low occupational diversity, with approximately 5% having no primary occupation, and over 55% relying solely on one primary occupation.
- ✓ Wages for labour and crop cultivation are the most predominant income sources
- ✓ Self-help groups are the most important source of credit despite most survey respondents having high access to banking services
- ✓ Access to insurance services are low

ADAPTIVE CAPACITY – HUMAN CAPITAL

Figure 19. Education level of Household

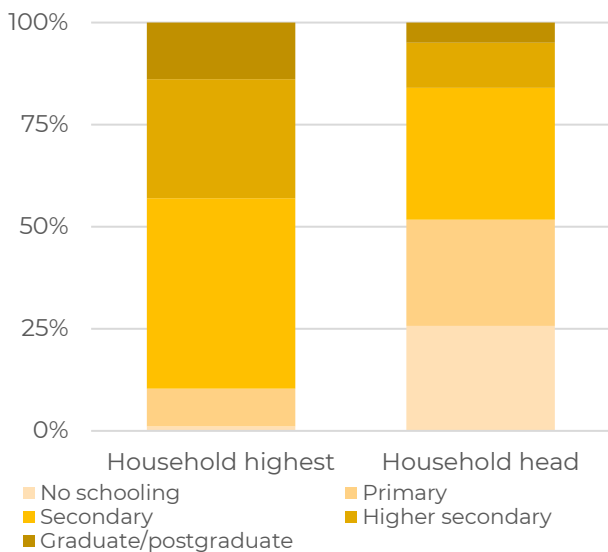
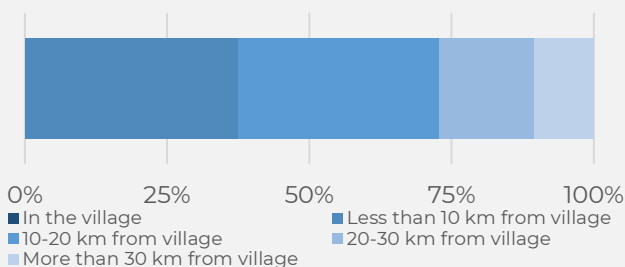
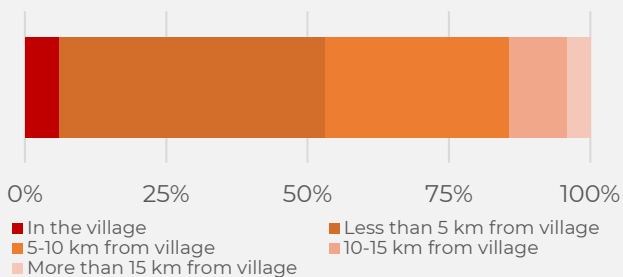


Figure 20: Access to Health facilities

20a. DISTANCE TO GOVERNMENT HOSPITAL

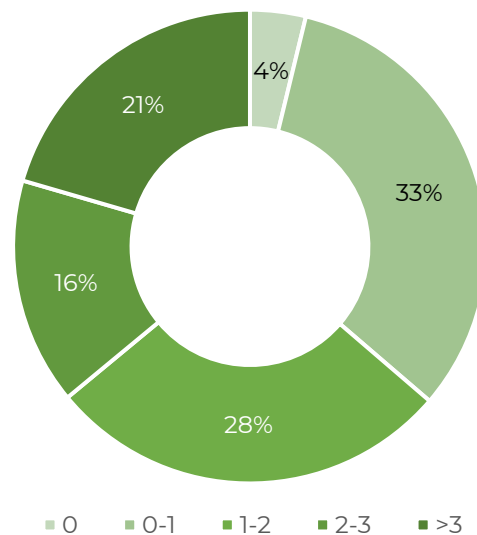


20b. DISTANCE TO PRIMARY HEALTH CENTRE



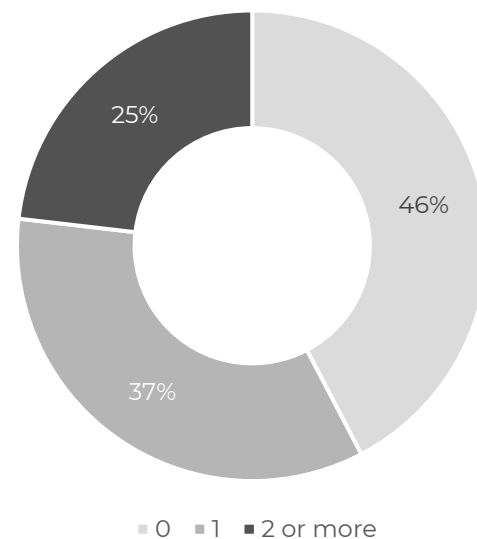
Note: The two charts present % of households in the villages in different distance categories from nearest hospital/PHC

Figure 21. Working members dependency



Note: The dependency ratio is calculated as the number of non-working members in the household per working member.

Figure 22. Family labour in Agriculture



Note: The chart shows the number of family members in the household involved in agriculture as their primary occupation

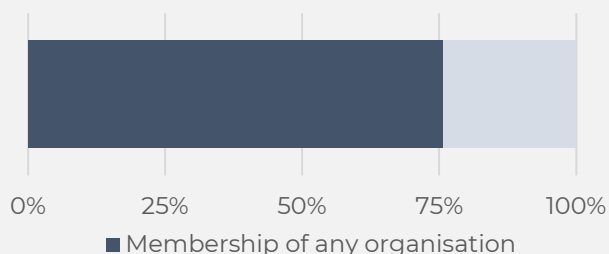
FINDINGS :

- ✓ Although primary health centers are accessible to most households and villages within a 5-kilometer radius, it's worth noting that the distance to government hospitals exceeds 10 kilometers for the majority of sampled households and villages.
- ✓ Over 50% of households have heads with low education levels
- ✓ 37% households have more than two persons dependent on each working member

ADAPTIVE CAPACITY – SOCIAL CAPITAL

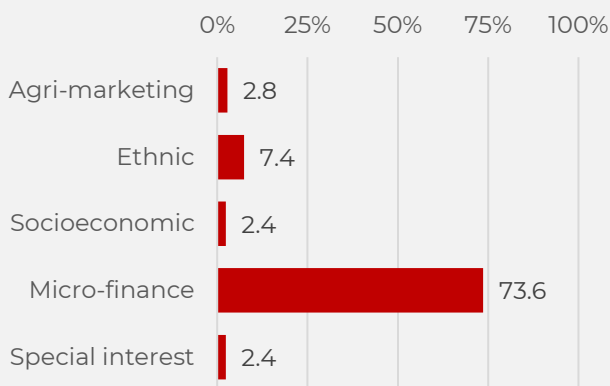
Figure 23. Membership of village/community organizations and groups

24a. MEMBERSHIP STATUS



24b. TYPE OF ORGANISATION/GROUP

% of total households

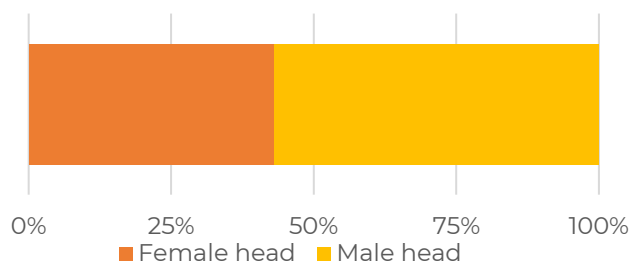


Note: The categorisation of organisation/group types include the following:

- Agri marketing - Farmer producer organization or collective (FPO/FPC); Agricultural, milk, or another co-operative
- Ethnic - Religious or social group or festival society; Caste association
- Socioeconomic - Youth club, sports group, or reading room; Development group/NGO
- Micro-finance - Self Help Group (Women Groups); Credit or savings group
- Special interest - Trade union, business, or professional group; Community forest user group; Farmer's union

Figure 24. Social category of household

23a. WOMEN-HEADED HOUSEHOLDS



23b. SOCIAL GROUP OF HOUSEHOLD

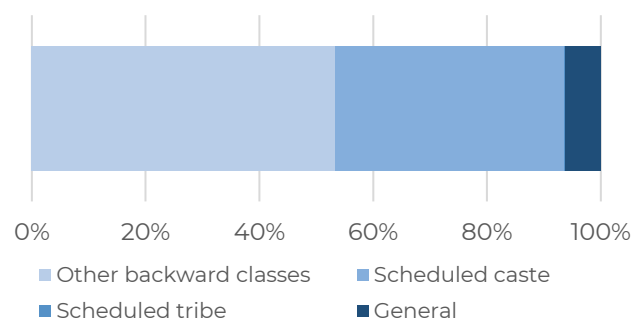
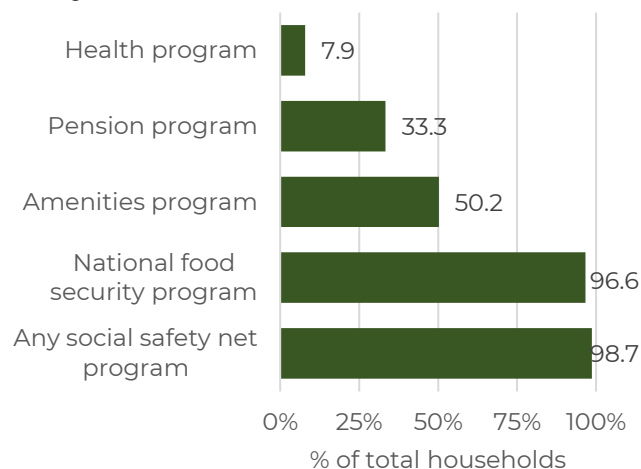


Figure 25. Access to government social safety nets



FINDINGS :

- ✓ Membership in community groups is high, and is primarily in microfinance groups.
- ✓ A significant majority, more than 90%, of households belong to so-called 'backward' castes, and nearly 45% of households are headed by women. This demographic composition can have a negative impact on social capital within the context of caste-based and patriarchal social structures.
- ✓ Access to government support is high for food programs but low for other safety net policies.

ADAPTIVE CAPACITY – CLIMATE INFORMATION SERVICES

Figure 26. Access to weather forecast, technical advisory, and adoption

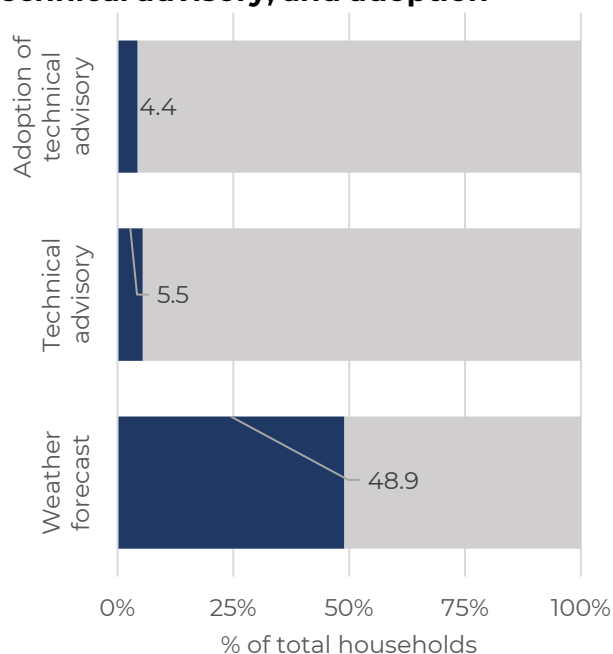


Figure 27. Source of weather information

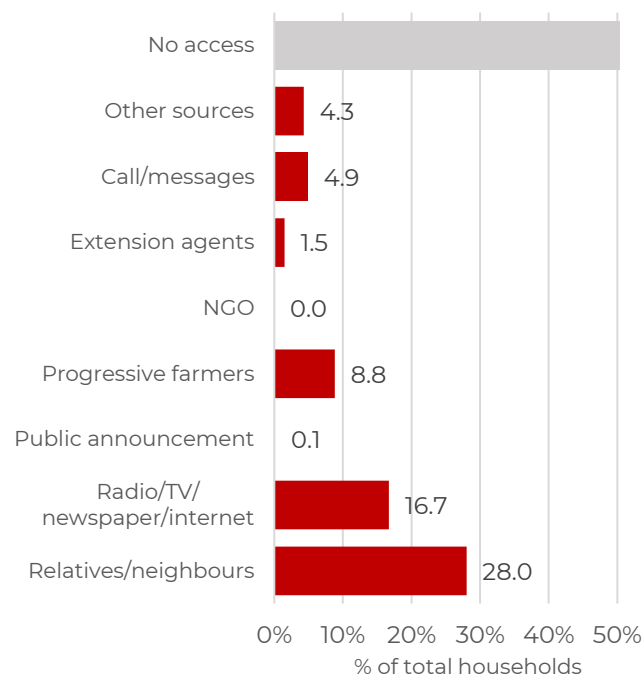
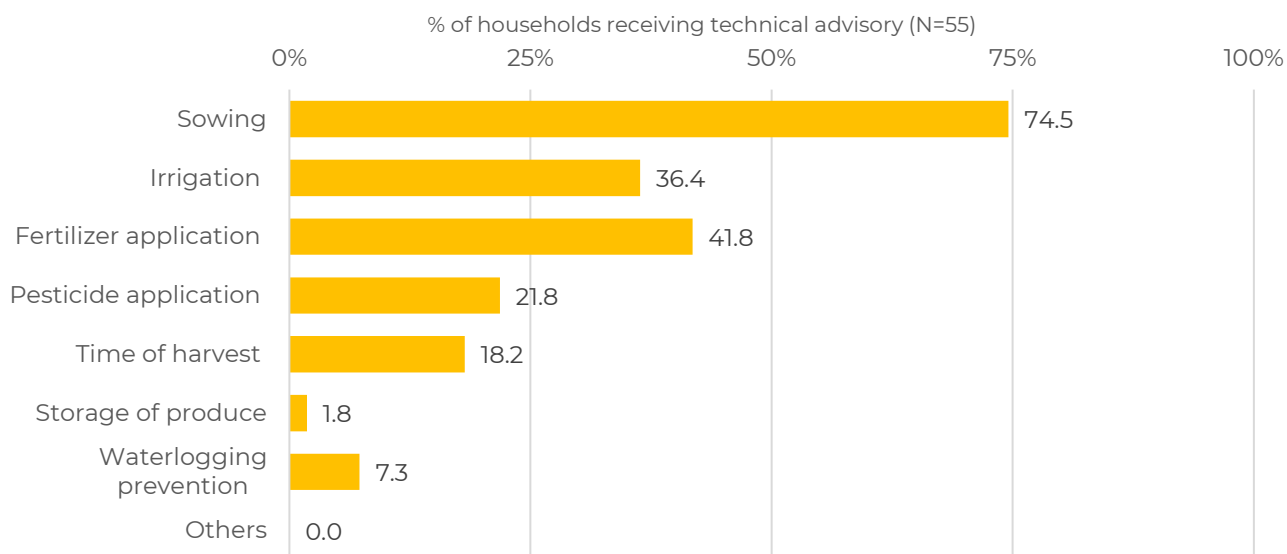


Figure 28. Subject of technical advisory based on weather forecast



FINDINGS :

- ✓ Close to 50% of households have access to weather forecast information, but only a very small percentage receive any technical advisory based on these forecasts.
- ✓ Despite limited access to technical advisory services, the adoption of advisory recommendations by these households is notably high.
- ✓ Most weather forecast information are received from informal sources, and predominantly from relatives/neighbours



49% of households receive weather forecasts through various sources, but only 5.5% of households receive technical advisories for agriculture based on weather forecasts

KEY TAKEAWAYS

1. Climate shocks have been reported by approximately half of the households in the region. The perception of these shocks is closely associated with preparedness and sensitivity to them. Several critical aspects of capital access could play a role in enhancing adaptive capacity and reducing sensitivity to shocks in Nalanda, including:
 - Nearly 100% coverage of irrigation among farming households
 - High cropping intensity of cultivated land
 - High access to social safety net policies
 - Access to markets nearby
 - Microfinance (Self Help Groups) provide access to credits
2. Approximately 44% of households report experiencing the impact of shocks, with 43.7% of these households indicating severe impacts from at least one of the shocks. These households are in need of substantial support to enhance their adaptive capacities and reduce sensitivity to shocks. Several aspects of low capital access could restrict the adaptive capacity of these households, including:
 - High incidence of landlessness among households
 - Very low ownership of agricultural/irrigation assets. and high dependence on rental markets
 - Low access to weather forecasts and only 5% of households receiving technical advisories based on weather forecasts
 - Despite high irrigation coverage, there are significant constraints to security or irrigation access (e.g., due to labour issues)
 - High percentage of female-headed households and backward caste households in the region with social limitations in access to resources
 - Despite the development of numerous climate smart agriculture technologies and practices, their adoption is very low

KEY AREAS FOR ACTION: QUESTIONS FOR CONSIDERATION

1. What are the potential policy provisions for secure employment opportunities in the face of loss of agricultural labour opportunities due to climate and market uncertainties?
2. How can actual use of banking services to access secure credits be improved?
3. How can weather forecast services be integrated with associated technical advisories be improved?
4. What are the potential policy direction for supplementing supply driven irrigation/water interventions with efforts to overcome access constraints and enablers in informal markets for irrigation markets, and low use of water conservation strategies to adapt to shocks?
5. How can we leverage the large number of available climate smart agriculture strategies for better adoption?
6. What is the role of government and other safety net programs in buffering the impact of climate shocks?
7. How do social inclusion and community structure influence adaptability to climate shocks? What social and community actions that play a protective role?

ANNEXURE: CONCEPT OF ADAPTIVE CAPACITY

ADAPTIVE CAPACITY |

Adaptive capacity is defined as “*The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.*” In this data note, we present adaptive capacity through an assessment of access to different types of capital (Five Types of Capital Framework): natural capital, physical capital, financial capital, human capital, and social capital. These five types of capital form the basis of ‘generic’ adaptive capacity to a range of threats (Mortreux and Barnett 2017). In addition, because of the climate change focus of this brief, we emphasized access to climate information.

This framework is often used as the basis for adaptive capacity assessments. However, research initiatives employ different indicators depending on the particular context, level of assessment (household/local/sub-national/national), and availability of information, and different methods for prioritization of sub-indicators (Prabhakar and Srinivasan 2011, Siders 2018). Therefore, in this brief, the goal is not to produce a final set of sub-indicators, but to provide a picture of the access to each type of capital through several indicators that the TAFSSA local food systems assessment offers. Common indicators/groups of similar indicators were categorized based on a review of the literature on adaptive capacity assessments at the household scale and focused on the South Asia context.

FIVE CAPITALS FRAMEWORK FOR SUSTAINABLE LIVELIHOODS

The *sustainable livelihoods framework*, building on the work of Chambers and Conway (1992), provides a structure of ‘five capitals’ pentagon, access to which are linked to sustainability of livelihood outcomes in a vulnerability context. Mortreux and Barnett (2017) summarize their role in adaptation as:

“ **Natural capital** - to provide the natural resources necessary to sustain a livelihood to adapt (such as land, water, and vegetation for farming practices)

Physical capital – to provide the necessary infrastructural support (such as roads and irrigation) and technological solutions to impacts.

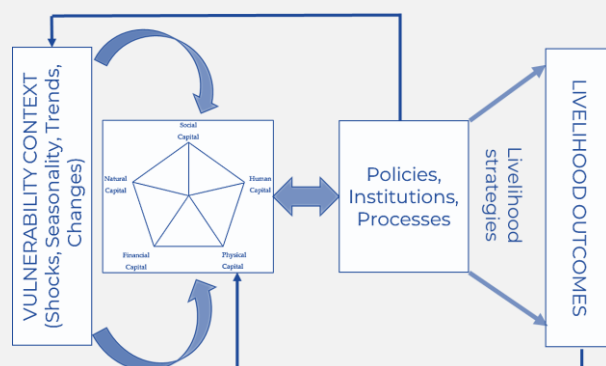
Financial capital - to pay for adaptation

Social capital - to provide the social bonds and networks to assist adaptation,

Human capital - to provide the physical and mental resources to adapt (education and health). “

- Mortreux and Barnett (2017:2)

SUSTAINABLE LIVELIHOODS FRAMEWORK



ANNEXURE: INDICATOR DOMAINS OF ADAPTIVE CAPACITY

Based on reviewed literature (Datta & Behera, 2022; Sardar et.al.2019; Brown et.al 2019; Maharjan et.al 2021; Khanal & Wilson 2019; Sam et.al 2019; Venus et.al 2022; Aryal et.al 2021; Devkota et.al 2021) we identified numerous household level variables that are used to represent the access to different capitals for the assessment of adaptive capacity in South Asia. These may be grouped under the following common and recurring indicator categories:

NATURAL CAPITAL

- Land size
- Type of land ownership
- Land/soil quality/fertility
- Cultivated area
- Irrigation/water resources

PHYSICAL CAPITAL

- Type of irrigation
- Road access
- Distance to markets
- Household asset ownership
- Agricultural equipment
- Livestock ownership

FINANCIAL CAPITAL

- Income source diversification
- Access to credit/insurance
- Total income/Household expenditure

HUMAN CAPITAL

- Farming experience/Family labour
- Education level
- Health access
- Dependency ratio/working members
- Age of Household head

SOCIAL CAPITAL

- Membership/leadership in networks/groups
- Dependence on family and friends
- Access to government/NGO/market services and support
- Social category of Household (gender, caste)
- Training access and information

CLIMATE SPECIFIC KNOWLEDGE AND INFORMATION

- Belief/perception of climate change
- Access to information about climate change and weather forecast
- Access to extension/training

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ABOUT TAFSSA

TAFSSA (Transforming Agrifood Systems in South Asia) is a CGIAR Regional Integrated Initiative that supports actions improving equitable access to sustainable healthy diets, that boosts farmers' livelihoods and resilience, and that conserves land, air, and water resources in a climate crisis..

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