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Agricultural Frontiers: Mapping Infrastructure Accessibility and Adaptation in Jammu and Kashmir

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Abstract

The research explored the farmer's notions of local level 'infrastructure' from across twenty-one districts of Jammu and Kashmir. The study relied on a random sampling approach for the identification of rural areas across twenty-one districts comprising Jammu and Kashmir. The research was conducted in two distinct phases. In the first stage, the farmer's infrastructure accessibility was assessed, and in the next stage, the farmer's adaptation tendency was measured. The farmer's infrastructure availability was accessed with the aid of inputs availability (twelve sub-items), credit availability (four sub-items), information accessibility (twelve sub-items), transport infrastructure accessibility (six sub-items), and post-harvest infrastructure availability at the local level (six sub-items). The farmer's responses concentrated more in the 34-66 percent interval, signifying medium to moderate accessibility of the agriculture infrastructure facilities in the Jammu and Kashmir region. In terms of scope for adaptability to moderate infrastructure availability, the study undertook the opinion of the farmers with regard to variables: the ability to extend the existing farming contract (Extension Contract), the extent of local-level social participation (Social Participation), the length of farming experience (Farming Experience), and the diversity of income sources (Income-diversity). The regression modelling yielded that adaptation remains a crucial concern across farmer's mindsets, and getting habitual to low infrastructure availability takes time and seems to be driven by farmer's perceptions of extension of the existing farming contract, the extent of satisfaction with the current level of income diversity, the extent and depth of social participation, and their respective farming experiences as accumulated over years. Infrastructure accessibility in terms of input availability does seem to shape the real utility of agricultural infrastructure from a farmer's perspective.

Keywords: *Infrastructure accessibility, Farmer perceptions, adaptation, social participation, income diversity, climate change.*

Introduction

The availability of agricultural infrastructure plays a crucial role in facilitating the expansion of the agricultural sector. The development of infrastructure in rural regions not only contributes to the increase in food grain production but also plays a significant role in poverty reduction. Determinants such as irrigation, access to electricity, storage capacity, connectivity of communities via road networks, availability of tractors, and other related infrastructure factors have significant influence on agricultural output outcomes. The successful advancement of agriculture and the ability to react to regional and global market problems need a thorough examination of the factors that influence and characterize the accessibility of infrastructure for farmers at the local level. The use of

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perception monitoring to measure how accessible infrastructure is has a long history of being used to measure the availability of basic infrastructure at the local level in urban, rural, and agricultural settings (Hosseini, 2011). The literature on the accessibility of local infrastructure for farmers has consistently emphasized the importance of seamless usage and convenience. However, Swami (2020) emphasizes that the measurement of farmers' perceptions has always required adaptation. Additionally, according to Katuwal (2020) and Zulfiqar (2020), ensuring farmers' consistent participation and use of agricultural infrastructure is a crucial factor. The region under consideration is a segment of the North Western Himalayas, characterized by significant disparities in infrastructural development across its districts. Consequently, these disparities have a detrimental impact on the livelihoods of the local farmers. In light of the aforementioned context, the current research endeavours to ascertain the level of infrastructure accessibility among farmers and their inclinations towards adaptation across several districts in the region of Jammu and Kashmir.

Review of Literature

The literature review on accessibility emphasises the importance of considering the local availability, simplicity, and cost of infrastructure. This study focuses on the examination of agricultural infrastructure, specifically in relation to five main categories of explanatory factors. These categories are consistent with indicators that Amir (2020), Duval (2003), Hosseini (2011), Kale (2011), Fernandes (2008), and Saeed (1999) have previously examined in other studies. The comprehensive array of factors that are directly or indirectly linked to farm output and agricultural productivity can be categorized into five overarching categories: input, source of credit, information, transport infrastructure, and post-harvest infrastructure. These categories encompass a wide range of elements that play a crucial role in determining the success and efficiency of agricultural practices. The practical usefulness of agricultural infrastructure is greatly influenced by the accessibility of various components. These components include input availability, access to credible and reliable sources of agricultural information, transportation options, and post-harvest crop management and storage facilities. The level of accessibility that these vital components provide influences how farmers assess the importance of agricultural infrastructure. It is impossible to exaggerate the significance of farmers' capacity to adjust to varying degrees of infrastructure availability in their local environment.

The existing literature on the accessibility of agricultural infrastructure in Jammu & Kashmir is deficient in empirical investigations, hence underscoring a notable research void. The evaluation lacks a context-specific examination of infrastructure components, instead emphasising factors such as local availability, simplicity, and affordability. Furthermore, there is a notable absence of a comprehensive qualitative investigation of the lived experiences and perspectives of farmers residing in the area. The evaluation fails to consider possible regional variations in terms of accessibility and neglects to evaluate the effects of current policies on the accessibility of agricultural infrastructure. The review also exhibits a dearth of research pertaining to farmers' perspectives on the availability and accessibility of infrastructure, as well as the adaptation strategies employed by farmers to navigate the current infrastructure challenges. Consequently, this underscores the necessity for a more comprehensive comprehension of the accessibility of agricultural infrastructure in the region. Therefore, following objectives are targeted through this study.

- To evaluate the farmers' perception of infrastructure accessibility in rural Jammu and Kashmir.
- To analyse the determinants affecting farmers' ability to adapt to the existing infrastructure.

Research Design

Infrastructure accessibility was quantified on a scale of one to five, where five denotes adequate availability and one denotes non-availability of infrastructure. The instrument for the quantification of the farmer's accessibility of infrastructure is comprised of forty variables or subscale items (twelve representing agriculture infrastructure, four variables representing the source of credit, twelve variables representing the information infrastructure, six variables for transport, and six variables signifying the post-harvest infrastructure) in Jammu and Kashmir. The research was conducted in two distinct phases. In the first stage, the farmer's infrastructure accessibility was assessed and in the next stage, the farmer's adaptation tendency was measured. The primary data was obtained from a random selection of households, which were chosen using a multi-stage sampling technique. In the preliminary phase, the chosen districts were categorized into two areas based on their agricultural investment in infrastructure potential: one region with a high potential for investment and the other region with a low potential for investment in infrastructure. In the subsequent phase of this study, distinct towns or villages were chosen, ultimately resulting in the selection of around 640 households from the aforementioned towns or villages. This corresponds to a scale in which the number of assertions being investigated is multiplied by ten for analytical purposes. The study's design adopted a random sampling technique.

Tool for data collection

The instrument for the quantification of the farmer's accessibility of infrastructure comprised forty variables or subscale items (twelve representing agriculture infrastructure, four variables representing the source of credit, twelve variables representing the information infrastructure, six variables for transport, and six variables as signifying the post-harvest infrastructure) in Jammu and Kashmir. The maximum score that a farmer can quote is five and the minimum that can be quoted is one. In a nutshell, the forty variables can attract a minimum score of forty or a maximum score of two hundred. As such the sum of the score of all variables representing local-level agricultural infrastructure availability was calculated which in other words represents the individual agriculture availability scoring for an individual local farmer.

Table 1: Description of variables used in the study

Item	Explanatory variables of agriculture infrastructure availability	Variable Description
A	Input	
A1	Good Quality Seed	Good quality seed are critical for healthy and sustainable crop. Such seeds are either brought from nearby market, or from inventory kept from the previous yield last time
A2	Compost/Manure	Compost or manure are essential for the growth of sapling and plants and their availability in rural level ensures timely maturing of plants
A3	Fertilizers	Fertilizers provide the sodium, potassium, and phosphate ingredients to plant growth and their accessibility ensures the ability of the crop to yield more outcomes
A4	Insecticides	Insecticides and pesticides are critical for safeguarding plants from insect-borne attacks or diseases. The local availability of town-based availability is essential to protect the crop
A5	Pesticides	
A6	Labors	The agricultural workforce and its local availability and cost structures do shape the sowing patterns and later on crop

		management
A7	Bullocks	The bullocks are meant for plowing the fields and are more effective when agricultural mechanization has not been initiated
A8	Farm machinery and implements	Farming machinery, implements, tools, and accessory and their local availability ensures timely ploughing, pre-harvest, and post-harvest efficiency
A9	Sprayers, dusters	These are essential for treating the plants with chemicals or for ensuring protective coating over plants in terms of sprays and to checking bacterial or fungi-based growth
A10	Irrigation waters	Irrigation waters, canal mechanisms, or on-site pumps ensures quick and seamless irrigation
A11	Electricity for farm operations	On farm access to power supply not only fuels pumps but also open up options for irrigation management and operation of other farming tools and implements
A12	Watershed development works	Water shed works ensures management of resources in effective manner
B	Source of credit	
B1	Cooperative Society	Cooperative societies in agricultural credit ensures low rate-based disbursal of loans and advances at local level or at farm site perspective
B2	Land Development Bank	Land development banks enable pooling of agricultural resources and credit allocation
B3	Nationalized Bank	The presence of or access to nationalized banks and financial inclusion could ensure better rates and competitive access to farm credit
B4	Local Money Lender	The presence of local money lenders could offer opportunistic rates yet offer the prospects for convenient payback
C	Information	
C1	Radio	Radio is a powerful means of agricultural information dissemination and sharing of practices. Access to the radio could enable better and faster dissemination of crop-related and agricultural practices related information
C2	Television	Television ensures audio-visual agricultural information exchanges. Local-level availability in terms of cable, DTH or national broadcasting is crucial for agricultural change management
C3	Mobile	Mobile accessibility at the local rural level and ownership of mobile handsets ensures faster awareness and change management
C4	Library	Published literature/books and magazines availability at local library ensures consistent broadening of the outlook for agricultural betterment
C5	Information from a local center	Information of agricultural matters from local centers regarding cropping, crop choices, protection, and harvesting

		precautions
C6	Availability of knowledge and technical information from university	University-local tie-ups and knowledge dissemination platforms up till grass root level
C7	Krishi seva kendra	Exclusive information dissemination centers dedicated to agriculture
C8	Newspapers	Access to daily, weekly or biweekly newspapers for awareness and sensitization with trends and search for better practices and inducing the change management
C9	Veterinary clinic	Veterinary clinics for cow and other livestock health issue management
C10	Computer/Internet	Access to computer and internet for access to global market information
C11	Agricultural Publications	Specialized publications on agricultural issues and challenges in local dialects
C12	Local SHG	Local-level self-help groups cater to the need for local power aggregation for faster decision-making on issues of agricultural interests
D	Transport Infrastructure	
D1	All-weather road connectivity	Road connectivity from house to market ensures and from farm to house and from farm to markets ensures all-weather mobility
D2	Government buses	Access to government-owned subsidized means of transport ensures local usage when own vehicles are lesser in number or negligible
D3	Private vehicles	Ownership of personal, commercial, or goods vehicles ensures independence
D4	Cart/Bullock cart	Cart with traditional emphasis ensures ploughing as well as transportation requirement fulfillment
D5	Own tractor	Tractor leads to agricultural mechanization in a controlled manner
D6	Own LCV, lorry, tempo	Ownership of lorries, tempo, or light commercial vehicles ensures mobility and control over the movement of goods from farm to market and vice versa
E	Post-Harvest Infrastructure	
E1	Godowns	Godowns ensure all weather storage in the post-harvest phase
E2	Cold Storage units	Cold storage usage leads to all-weather storage and preservation of fragile or perishable produce like fruits, vegetables and commercial crops
E3	Rural agriculture-based industries and processing units	Agricultural or produce processing units for ensuring conversion of fresh produce into value-added, marketable product
E4	Market availability/linkages	The linkages to the market in the local vicinity in terms of institutional and logistical support

E5	Soil testing facilities	Soil alkalinity and fertility testing setup
E6	Milk collection systems	Milk collection mechanisms with emphasis on the preservation of product consistency, freshness and perishability

Source: Subscale items from (Amir, 2020; Duval, 2003; Hosseini, 2011; Kale, 2011; Fernandes, 2008; Saeed, 1999)

To get an idea of the accessibility of infrastructure in the rural areas of Jammu and Kashmir, the present study makes use of the accessibility index. The farmer's agriculture infrastructure accessibility index was constructed with the formula as mentioned here:

AIAI = (SA-AIAS/MPS) *100

where AIAI= Farmer's Agriculture Infrastructure Accessibility Index

SA-AIAS= = self-assessed agriculture infrastructure accessibility score

MPS= Maximum possible score

Further, the research followed the principle of equal interval for the assessment of farmer-wide self-assessed differences in sustainable access to local-level agricultural infrastructure. Hence, intervals were devised as 0-33, 33-66, and 66-99. The rationale was to tripartite the outcomes in order to assign them as either low accessibility, moderate accessibility, or high accessibility of local agricultural infrastructure.

Table 2: Benchmark as used for standardising the response concentration

Calculated local agricultural infrastructure index	Response Observation	Outcome
	If observed as between 0-33	Low accessibility at the local level
	If observed as between 33 and 66	Moderate accessibility at the local level
	If observed as between 66 and 99	High accessibility at the local level

Further, for measuring the adaptation tendency, the present study has tried to take the perception of the selected respondents with regard to extension of existing contract, social participation, farming experience, income diversity and adaptation on the scale as mentioned below on the following variables as presented in Table 3.

Table 3: Description of indicator variables for adoption assessment

Extension of existing Contract	1=As usual, 2=With modification, 3=Refused
Social Participation engaged in	1=Yes, 2= No, and 3 = cannot say
Farming Experience	1=Considerable, 2=modification
Income Diversity	1=Not satisfactory; 2= moderately satisfactory.
Adaptation tendencies	1=Yes, 2=No, and 3= cannot say

Further, linear regression was used to predict 'adaptation' based on extension contracts, social participation, farming experience, and income diversity.

The proposed model is:

Adaptation $=\beta_0+\beta_1$ Extension Contract + β_2 income diversity+ β_3 Social Participation + β_4 Farming Experience

Results of the Study

The results of the study have been presented in detail under different subheadings based on the objectives of the research. The findings provide valuable insights into the topic and shed light on various aspects related to it. The analysis and interpretation of the results have been done meticulously to ensure accuracy and reliability. Overall, the results of the study are significant and contribute to the existing knowledge on the subject.

Infrastructure Accessibility in the Rural Area of J&K

The local-level infrastructure accessibility from the Jammu and Kashmir perspective as mapped, revealed these insights. Infrastructure accessibility seems to be significant in shaping perceptions. As discussed in Table 4, the response evaluation showed that none of the five main categories had any low accessibility responses or responses at all, except for "financial and credit infrastructure." Responses also did not fall into the high accessibility category. The farmer's responses concentrated more in the 34–66 percent interval, signifying medium to moderate accessibility of the agriculture infrastructure facilities in the Jammu and Kashmir region. This categorically points to nominal or moderate accessibility of installed agriculture infrastructure and calls for the identification of extensive barriers restraining farmers' access to agricultural, storage, inputs, and post-harvesting infrastructure at the grassroots level.

Table 4: Response Concentration: Infrastructure Accessibility

	Explanatory variables of agriculture infrastructure availability	High Accessibility (67-99)	Medium Accessibility (34-66)	Low Accessibility (0-33)
A	Input	%	%	%
A1	Good-quality seed	5	95	0
A2	Compost/Manure	5	95	0
A3	Fertilizers	5	95	0
A4	Insecticides	6	94	0
A5	Pesticides	2	98	0
A6	Labors	5	95	0
A7	Bullocks	3	97	0
A8	Farm machinery and implements	5	95	0
A9	Sprayers, dusters	5	95	0
A10	Irrigation waters	5	95	0
A11	Electricity for farm operations	5	95	0
A12	Watershed development works	5	95	0
B	Source of credit			
B1	Cooperative Society	95	5	0
B2	Land Development Bank	94	6	0
B3	Nationalized Bank	95	5	0
B4	Local Money Lender	94	6	0
C	Information			

C1	Radio	15	85	0
C2	Television	15	85	0
C3	Mobile	15	85	0
C4	Library	15	85	0
C5	Information from a local center	15	85	0
C6	Availability of knowledge and technical information from the university	15	85	0
C7	Krishi seva Kendra	15	85	0
C8	Newspapers	15	85	0
C9	Veterinary clinic	15	85	0
C10	Computer/Internet	15	85	0
C11	Newspaper	15	85	0
C12	Local SHG	15	85	0
D	Transport Infrastructure			
D1	All weather road connectivity	0	100	0
D2	Government buses	0	100	0
D3	Private vehicles	0	100	0
D4	Cart/Bullock cart	0	100	0
D5	Own tractor	0	100	0
D6	Own LCV, lorry, tempo	0	100	0
E	Post-Harvest Infrastructure			
E1	Godowns	1	99	0
E2	Cold Storage units	1	99	0
E3	Rural agriculture-based industries/processing units	1	99	0
E4	Market availability/linkages	1	99	0
E5	Soil testing facilities	1	99	0
E6	Milk collection systems	1	99	0

Source: Authors own calculations using primary data

Farmer's adaptation tendency regarding infrastructure availability

The adaptation tendency assessment constitutes stage two of the research and was assessed in the aftermath of the infrastructure accessibility of agriculture infrastructure in local and regional perspectives. Accessibility and adaptation bear a direct relationship as evident in the literature on the subject matter (Koshti, 2013). The accessibility of local infrastructure has been observed as forming the basis for the intent to adopt or not to adapt to current levels of infrastructure availability. The local farmer's adaptation prospects were explored to ascertain the scope for their sense of adjustment or adaptation to consistent low to medium-level accessibility of agricultural infrastructure at the local level (Manjunatha, 2018). The farmers' perceptions of infrastructure accessibility are

vital as they are widely believed to shape their opinions of infrastructure usage, potential realization, and coping strategy determination in times of drought disaster, or climate change. The research hence explored the prospects of farmers' ability to accommodate or incorporate change as their part of decision-making. The research intent was to ascertain the preparedness and habitual orientation of the farmers to adapt to low infrastructure usage or local-level infrastructure availability (Olowogbon, 2019). The gradual adjustment of farmers to moderate infrastructure availability is a matter of research and analysis across developing economies (Rakotobe, 2016). The farmer's ability to cope up with lesser access to qualitative agricultural infrastructure is alarming, as this induces the tendency to underproduce as per existing potential ((Bahinipati, 2014; Josling, 2004) and often leads to under realization of gains from agriculture as an economic practice. The farmer's ability to cope with uncertainties emerging from inconsistent availability of infrastructure has been measured with these variables.

Table 5: Adaptation Perception Assessment of Respondents

Dependent Variable	Independent Variable	Mean	Std. Deviation	CV (%)
Adaptation	Extension Contract	1.30	.623	47.92
	Social Participation	1.55	.650	41.93
	Farming Experience	1.38	.485	35.14
	Income Diversity	1.41	.492	34.89

Source: Authors own calculations using primary data

The study undertook the opinion of the farmers with regard to variables: the ability to extend the existing farming contract (Extension Contract), the extent of local-level social participation (Social Participation), length of farming experience (Farming Experience), and diversity of income sources (Income diversity). The aforementioned variables were chosen from a review of the literature regarding farmers' adaptation potential and readiness to accept change in agricultural modes and practices. The variable 'extension of contract' maps the ability of the farmer to ensure renewal or continuity of the existing contract despite the changes and challenges that the farmer is facing on account of dismal access to economic and transport-based infrastructure at the local rural level. The variable 'social participation' maps the ability of the farmer to participate in social activities or to abstain from social participation. Social participation not only induces changes yet also leads to faster assimilation of better agricultural practices. The variable 'farming experience' maps the ambit of a farmer's work experience or farming experience that enables him to devise a corrective strategy in times of water shortages, drought, road blockages, disasters, landslides, and likewise contingencies. The variable 'income diversity' captures the extent of diversity of income sources that the incumbent farmer is relying on.

Farmer's ability to adapt and cope with existing agriculture infrastructure availability

This section discusses the determinants of farmer's ability to adapt and cope with existing agriculture infrastructure availability. For this, the linear regression was calculated to predict 'Adaptation' through variables like Extension in Contract, Social Participation, Farming Experience, and Income diversity.

Table 6: Determinants affecting farmer's ability to adapt and cope with existing agriculture infrastructure availability

Variables	Estimates
Constant	.748*

Extension contract	.121[NS]
Social Participation	.410*
Farming experience	.163*
Income Diversity	-.125
R	0.417
R-Square	0.174
Adjusted R- Square	0.163

Note: *Significant at 5% and [NS]: Non-significant

Source: Author's own calculations

The observed R-value for this equation was 0.417. The provided data indicate that the degree of freedom is 1. The equation yielded a significant result (F (1) = p < 0.000), with an R-value of 0.417. The participants in the study made predictions about the weight variable, which was estimated using a linear regression model. The equation for this model was as follows: weight =.748 + 0.121 (Extension Contract) + 0.410 (Social Participation) + 0.163 (Farming Experience) - 0.125 (Income Diversity). The R, also known as the multiple correlation coefficient, is often seen as an indicator of the accuracy of predicting the dependent variable, namely the farmer's adaptation in this particular context. The recorded value of 0.417 might be considered an acceptable indicator of the multiple correlations. The R2, also referred to as the coefficient of determination, quantifies the amount of variability in the dependent variable that the independent variables can explain. The R-squared value of 0.174 indicates that the independent factors can account for about 17.4% of the variability in the dependent variable.

Thus, Adaptation = 0.748+ 0.121 (Extension Contract) + 0.125 (income diversity) + 0.410 (social participation) + 0.163 (Farming Experience)

The farmer's ability to adapt and cope with existing agriculture infrastructure availability was observed as comprising the elements of a contract extension, the extent of the farmer's consistent social participation, patterns of farming experience, and the obvious income diversity being undertaken. The results yielded that the adaptation remains a crucial concern across farmer's mindsets, and getting habitual to low infrastructure availability takes time and seems to be driven by farmer's perceptions of extension of the existing farming contract, the extent of satisfaction with the current level of income diversity, the extent and depth of social participation, and their respective farming experience as accumulated over years. This marks a critical determinant of the farmer's intent to become used to less infrastructure usage. This could have severe implications for levels of agricultural growth and development in the short and long run.

Conclusion and Discussion

This research investigates the accessibility ratings of agricultural facilities and their capacity to accommodate restricted infrastructure within a particular region. This study offers valuable perspectives on the difficulties encountered by farmers and the approaches they use to surmount these hurdles. The results of this study have the potential to inform the development of policies and interventions aimed at enhancing infrastructure support for farmers living in comparable geographic regions. This research highlights the need to consider farmers' intents to adjust to the reduction in structure utilisation, as well as their desire for alternative approaches and technology. This understanding can help improve the understanding of farmers' cognitive framework and their ability to adapt to a dynamic infrastructural environment. This study analysed the feasibility of implementing change

management strategies in the context of agricultural infrastructure, highlighting the challenges and opportunities in this setting. The potential implications of this scenario could significantly impact the advancement and progression of agriculture in the immediate and long term. This underscores the need for deliberate deliberation and proactive actions in order to alleviate any adverse consequences. Additional discourse and examination are imperative in order to comprehensively comprehend the ramifications and investigate prospective remedies for guaranteeing the longevity of agricultural methodologies. In summary, the manner in which farmers adapt holds considerable consequences across several domains.

This pertains to the response shown by individuals towards disasters, the occurrence of climate change, their capacity to access markets, and the income derived from the trade of their agricultural commodities. The aforementioned concerns highlight the need of comprehending and addressing the challenges faced by farmers in their endeavours to adjust to evolving circumstances. By considering these consequences, policymakers and stakeholders possess the capacity to develop strategies targeted at assisting farmers and protecting their resilience against these challenges. In conclusion, the potential consequences of these concerns include the likelihood of a postponement or constrained adoption of innovative agricultural approaches, ongoing disruptions in the distribution of indigenous knowledge, and constrained access to global markets. The aforementioned results underscore the need to tackle these obstacles to foster sustainable agricultural advancement. In summary, the absence of adaptability within the agricultural sector may have noteworthy ramifications for farmers and their resource utilisation practises. The possible consequences of this might lead to the disruption of established patterns and directions in factor utilisation. The recognition of the significance of adaptation is vital for farmers and policymakers to guarantee the long-term viability and robustness of the agricultural sector. By adopting adaptive practices, agricultural practitioners may effectively manage the obstacles presented by evolving environmental circumstances and ensure the sustainability of their livelihoods in the future.

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