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Research Article

Gendered Impact of Financial Inclusion on Climate Change Adaptation among Rural Rice Farmers in Nepal

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Abstract

The present paper examines the gendered impact of financial inclusion on climate change adaptation among rural rice farmers across seven Nepalese districts through an odds-ratio-based binary logistic regression analysis. Primarily the study indicates that the availability of loans makes female farmers 7.6 times (significant) more likely to adopt climate change adaptation, whereas, in the case of male farmers, access to loans does not have a significant impact; and access to phone plays a significant role (odd ratio of 1.9) in encouraging female farmers to undertake climate change adaptation. Thus, from a policy perspective, there is need to increase loan availability to rural Nepalese female rice farmers to facilitate climate change adaptation. Specific schemes targeting this section need to be formulated and implemented. Moreover, mobile phone-based innovative applications could be used as a potent tool by banks for achieving financial inclusion along with significant associated positive externalities for the environment.

Keywords: Climate Change, Adaptation, Financial Inclusion, Female Rural Rice Farmers, Binary Logistic Regression

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1. Introduction

The existence of gender inequalities is bound to render the experience of climate change markedly different for men and women, which is more prominent in developing countries. According to UNDP (2013), gender-differentiated exposure to climate change can be primarily attributed to limited opportunities for women due to differences in time use; access to resources, assets, and credit; differential treatment by formal institutions; absence of women's decisions and policymakers; the existence of socio-cultural norms; and lack of sex-disaggregated data for informed policy making. Climate change would also exacerbate the existing gender disparities.

The Cancun Agreement, 2010, acknowledges the importance of gender equality and women's participation in effective dealing with the myriad aspects of climate change. Hence, it is imperative that policymakers neither overlook the disproportionate costs imposed by climate change on women nor their significant role as agents of positive change; and must formulate policies providing women with the resources to bear the associated costs.

The arguments have special importance even in the Nepalese context, a landlocked Himalayan state in South Asia where gender disparities intersect with risks and vulnerabilities associated with climate change (Devkota et al., 2018). According to the latest estimates by the World Economic Forum's Global Gender Gap Report, Nepal has closed only 32 percent of its gender gap up to 2020. In addition, Demirgüç-Kunt et al. (2018) suggest a gap of about eight percent between male and female account ownership in Nepal, with only 45 percent of adults with account ownership as a whole, suggesting the need for financial inclusion. Financial inclusion is an important policy concern for Nepal, not only for gender gaps but for the country as a whole. In light of these gender inequities, especially regarding financial inclusion, climate change presents a significant challenge for Nepal's agriculture-based economy (NPPR, 2017 MoAD, 2017). Recently, the country has faced challenges in its hydrological cycle. Studies suggest that (Malla, 2008; Karn, 2014; Devkota and Phuyal, 2016; Adhikari et al., 2017; Devkota et al., 2018; Devkota et al., 2021) coming decades shall witness a steeper rise in winter temperatures as compared to summers, along with dwindling winter rainfall and increasing instances of summer rains and heat waves. As such, climate change adaptation has also been posited as the key to effectively dealing with the grim realities of climate change (IPCC, 2022).

The present study examines the gendered impact of financial inclusion on climate change adaptation among rural rice farmers in Nepal through an odds-ratio-based binary logistic regression analysis. The study is based on data collected (January and

February 2017) through structured questionnaires from 773 farmers in 28 primary sampling units; situated in rice pocket areas of diverse agroecological zones spread across seven districts – Ilam, Sindhuli, Syangja, Surkhet, Bara, Dang, and Kailai, of Nepal. As explained by IPCC 2022, climate change adaptation refers to the adjustment process to actual or expected climate and its ensuing effect to moderate the damages or leverage the opportunities. The researchers chose rice farmers because rice is the main agricultural crop of Nepal in terms of area, production and livelihood (Gauchan et al., 2012; Maclean, Hardy & Hettel, 2013 MoAC, 2017; Devkota & Phuyal., 2018; Devkota & Paija, 2020). Further, the research focused on rural areas because factors such as distance from the bank, unavailability of documents, household work responsibilities, mindset and attitude, etc., impede rural women's access to financial institutions in developing economies.

This paper, preceding the introduction, presents a related literature review followed by an elaboration on the methodology adopted for the research and data presentation. The study subsequently presents the descriptive data analysis along with respondents' household demographics, regional distribution, select variables pertaining to financial inclusion, and econometric analysis undertaken to assess the gender-specific impact of financial inclusion on climate change adaptation among rural rice farmers in Nepal. After that, an overall discussion on the issue is followed by a conclusion.

2. Literature Reviews

The literature reviews in this paper present a brief discussion of existing literature to highlight the role played by income and wealth, access to financial services, and gender in climate change adaptation.

2.1 Climate change adaptation, income and wealth

To a great extent, the adaptive capacity of individuals, households and communities is shaped by their access and control over five critical resources, i.e. i) natural, ii) human, iii) social, iv) physical, and v) financial (Dixit, 2011; Thapa, Scott, Wester & Varady, 2016; Devkota et al., 2021). Meanwhile, Agrawala et al. (2003) posit that access to and control over resources varies at country, community, and household levels.

With these two arguments, evidence from the literature suggests that limited access to varied resources and the lack of insurance mechanisms against income loss positively influence climate change adaptation (Heltberg, Siegel & Jorgensen, 2009; Smit & Pilifosova, 2001). Adopting different adaptation options depends on farmer wealth, as the options basket would not be the same for rich and poor farmers (Mendelsohn, 2012; Devkota et al., 2021). The better access of rich farmers to technology and capital

provides them with more substitutes to choose from and quicker adoption (Mendelsohn, 2012; Pender, 2007; Devkota et al., 2017). The limited budgets of poor households would constrain them from making efficient choices (Mendelsohn, 2012). Developing countries particularly concerned with agriculture and agricultural sectors would be characterised by a lower climate change adaptation capacity (Adger et al., 2007; Ottinger, Wang & Motel, 2014; Devkota et al., 2021). Discussing the adaptation challenges confronting the agricultural world, Hertel and Lobell (2014) posited that adaptation challenges would be the greatest in the world's poorest regions, characterised by a meagre adaptive capacity. However, there is a paucity of empirical evidence favouring the argument that richer farmers would more readily undertake climate change adaptation measures than poor farmers (Devkota et al., 2021).

2.2 Climate change adaptation and access to financial services/credit

The literature discussed above categorically provides credence to the argument that access to financial resources could go a long way in facilitating climate change adaptation among agricultural communities, especially in poor and developing parts of the world. Literature abounds with evidence pertaining to the positive role played by improved access to financial services/availability of credit in climate change adaptation (Hassan & Nhemachena, 2008; Deressa et al., 2009; Sarker, Alam & Gow, 2013; Arimi, 2014; Khanal, Wilson, Hoang & Lee, 2018; Bryan et al., 2009; Mabe, Bruce & Yaw, 2012; Dhakal, Regmi, Dhakal, Khanal & Bhatta, 2013; Devkota et al., 2018). Simultaneously, studies such as Ozor et al. (2010), Antwi-Agyei et al. (2013) Acquah & Onumah (2011) have identified credit constraint as a major barrier to climate change adaptation.

2.3 Climate change adaptation and gender

The repercussions of climate change are not gender neutral (IPCC, 2007; UNDP, 2013; UNDP, 2007; Mainlay and Tan, 2012, World Bank, 2011; Reggers, 2019). Women can play a pivotal role in climate change adaptation considering their extensive expertise in natural resource management and involvement in productive as well as reproductive activities of the household and community (UNDP, 2013; Ylipaa et al., 2019). However, in the global context, there is a paucity of empirical research exploring the linkages between climate change adaptation and gender. However, the focus has been limited to discussions about the problem's scientific and other technical aspects. Moreover, very few National Adaptation Plans of Actions recognise women as agents of change in adaptation (Mainlay and Tan, 2012). Skinner (2011) also asserts that women are generally not perceived as part of solutions addressing climate change. The findings of Djoudi and Brockhaus (2011) suggest a

gender divide in adopting adaptive strategies because of a lack of influence in household decisions, knowledge, and financial resources. In the Nepalese context, Rai et al. (2021) and much other literature already identified that women are affected by climate change differently.

2.4 Policy provision for female farmers in Nepal

Gender equality, women's rights, and women empowerment-related issues have been the top priority of the government of Nepal in the last two decades. The Constitution of Nepal in article 38 is exclusively on women's rights. The sub-article (1) entails "every woman shall have equal lineage right without gender-based discrimination", and Sub-article (6) states that "the spouse shall have the equal right to property and family affairs". Civil Code, 2017 under Chapter 10 provisioned that "the joint property of the spouses shall be used to run the family, based on earning capacity and mutual understanding". The Joint Land Ownership Policy (2011) provides a simple mechanism for spouses (husband and wife) to register their land with their two names, paying only Rs 100 as a registration fee to the land's revenue office. In the case of new joint land registration, the couple gets a minimum of 25-50% tax exemption during land registration based on land locations (Budget Speech 2011/12). These measures, depending on the geographical location, include a 25 per cent to 50 per cent tax exemption on registration when a woman owns the land; a 35 per cent tax exemption for single women (Financial Bill 2072, Ministry of Finance); and joint registration of land in the names of husbands and wives with a fee of Rs. 100 (or less than \$1) (IOM, 2016). Land registration fees for women are discounted by 25 percent in urban areas and 30 percent in rural Nepal. Pun and Shrestha (2019) highlighted that the Government of Nepal has provided immense opportunities through different policies and guiding documents to empower women in agriculture development activities. The MOALD has made mandatory provisions in its policy to involve 50% of women in its extension and capacity-building programs. Women's participation, on average, was about 50% in different fiscal years. The MOALD has implemented special projects and programs for food security and agricultural commercialisation. Under these programs, women's participation and empowerment have been prioritised (Ali et al., 2019).

As Rai et al. (2021) stated, agriculture-related policy documents in Nepal are gender-neutral and gender-specific. National Agriculture Policy (2004) envisions improved access to agricultural resources and benefits to women. It also states that the involvement and participation of women in all possible fields of the operation of agricultural programs shall be raised to 50%. The Agro Biodiversity Policy Amendment (2014) has gender-neutral provisions as it states that women shall be involved in the sustainable use of agro-biodiversity for increasing production, employment, and income-generating

activities. It also envisages the operation of necessary programs for the involvement of women in research, promotion, and utilisation of farmers' indigenous knowledge. The policy recognises the role of women in promoting agro-biodiversity but does not address their differentiated needs. Agriculture Development Strategy 2015-2035 (2015) is also gender-specific as it enlists strategies for accelerating the growth of micro, small, and medium agro-enterprises, including those headed by women.

Similarly, the strategy promotes the growth of agro-enterprises led by traditionally excluded groups such as women. Despite policies having explicit provisions for promoting women's participation, they lack visualisation of the improvement of rural women due to the failure to address the social barriers that inhibit their participation (Rai and Mainaly 2018). Tamang et al. (2014) pointed out that the existing agricultural policies fail to recognise the changing socioeconomic paradigm where women are taking the entire burden. Even today, limited representation of women in broader socio-political stakes is reflected in mostly low proportion (12.5-14.3%) of females in decision-making levels, including the Council of Ministers, National Planning Commission, and Public Service Commission, except for 29.4-33.3% in the parliament and National Election Commission (Rai et al., 2021).

Around 75 per cent of Nepalese women are engaged in agriculture as their primary occupation. The number of female-headed households is constantly increasing. Despite these efforts, only 19.7 per cent of women own around 5 per cent of land throughout Nepal, and only around 11 per cent have effective control over their property (IOM, 2016). The distribution of such female property ownership is also not similar, which is high on the eastern side at 5.7% of HH and very low on the western side at 0.7%. It means that the Agriculture Policy of Nepal and Agriculture Development Strategy (2015-2035) have strong provisions for women's inclusion in agricultural structures and services. However, women in rural and remote areas and marginalised communities are not the same as they struggle to fully enjoy constitutional rights and provisions (Upreti et al., 2018). There were several projects for youth and women in agriculture-based enterprise development. These projects lead by the government in collaboration with NGOs, private sectors, cooperatives and farmers' groups. Thus, women should be included in the agenda-setting or policy formulation stage. The focus should be on improving women's qualitative participation to influence decisions and practices while promoting their numerical representation (Nawaz, 2014; Bhattarai, 2020; Rai et al., 2021).

Given the backdrop of this existing literature, the present study would contribute by way of combining these three different facets pertaining to climate change adaptation and present empirical evidence related to the impact of financial inclusion (availability

of credit/financial services) on climate change adaptation by male and female rural rice farmers of Nepal separately. In addition, it would enrich the existing climate change adaptation literature, specifically with respect to Nepal, wherein a minimal number of studies are present in this area with special reference to rice farmers (Manandhar, Vogt, Perret & Kazama, 2011; Dhital, Sharma & Bhandari, 2016; Karn, 2014 and Adhikari et al., 2017; Pant, 2011; Jones & Boyd, 2011; Regmi & Bhandari, 2013; Chhetri et al., 2012; Devkota et al., 2018; Devkota et al., 2021).

3. Methodology

3.1 Study Area and Data

The study is based on primary data collected from rice pocket areas of diverse agroecological zones spread across seven districts of Nepal¹. These include the four hill districts of Ilam, Sindhuli, Syangja, and Surkhet; and three Terai districts of Bara, Dang, and Kailai. Selection of the regions was made keeping in mind the agricultural characteristics and their vulnerability to climate change. The rationale for exclusion of other districts is attributed to hilly regions with no meteorological stations or less than 30 years of data available; complete coverage by irrigation canals; and presence of systematic canal or scientific irrigation canals; and mountainous location with rice cultivation being a rarity.

Respondents for the study were chosen from a population of rice farmers. Seven districts were selected from the seven provinces of Nepal through random sampling. Based on expert opinions and suggestions from district agriculture offices and local representatives, each selected district was divided into two clusters based on rice cultivated area/rice pocket area² with the rationale to capture variability in adaptation practices within a district. The selection of rice pocket areas was also made based on information received from the District Agriculture Office and verified by VDC secretaries. Further, based on literature (Gilbert, 2008 and Blaikie, 2010), simple random and multi-stage sampling was employed to select villages and households for primary data collection through a questionnaire-based survey. Based on the results of the National Population and Housing Census (CBS, 2011), the rural population of the households was used for data collection. The study chose 56 households³ from

1 Total number of districts in Nepal is 75

2 These areas refer to those regions where almost the whole population is engaged in rice cultivation during the rice growing season and the most collection of rice for the districts comes from these areas.

3 Every VDC in Nepal is divided into nine wards. In the present study, two wards each were selected from one VDC and 28 rice farming households were selected from each ward.

one VDC to implement the survey questionnaire. As such, information from 112 households from one district was obtained, and information pertaining to 773 households was captured through the entire survey.

A pre-tested⁴ structural questionnaire with a mix of closed and open-ended questions was designed to collect qualitative and quantitative information from rice farmers. Final data collection was held from the end of December 2016 to the end of January 2017.

3.2 Econometric Analysis

The present section undertakes an econometric analysis to assess the gendered impact of financial inclusion on climate change adaptation among rice farmers in rural Nepal.

3.3 Methodology and Variable Description

Econometrically, we use odds-ratio-based binary logistic regression to estimate and ascertain whether financial inclusion results in adopting climate change adaptation methods. The following regression equation is estimated:

$$Y = \beta_0 + \beta_1 X + \beta_i Z + \mu_0$$

Where:

Y represents a binary variable, which takes on the value 1 if the climate change adaptation method has been adopted, else it takes on the value 0.

X represents loan availability, an indicator of financial inclusion and our primary variable of interest. Loan availability represents a binary variable, which takes on a value 1 if the loan is available to rural rice farmers in different districts and is 0 otherwise. The availability of loans is expected to positively impact the adoption of climate change adaptation methods. Technology adaption is contingent on the large initial investment, which may hamper the paucity of borrowing capacity. Therefore, in our estimation, loan availability should positively enhance climate change adaptation.

Z is a vector of five other control variables, which could indirectly impact financial inclusion and influence the decision to adopt climate change adaptation practices. These include:

⁴ The pre-testing for the questionnaire was done on 17 households in the three districts of Kathmandu, Lalitpur and Bhaktapur during the first and second week of December, 2016

- a. **The distance of the bank** represents a categorical variable. It takes on a value of 1 if a bank is situated within a distance of less than five kilometres and 0 otherwise. Reduced bank distance from the household would bring about increased usage of banking services and could work towards replacing informal borrowing with formal credit. It is expected that this could play a positive role in bringing about climate change adaptation among rural Nepalese rice farmers.
- b. **Access to extension services** represents a binary variable, which takes a value of 1 if extension services are available and is 0 otherwise. The availability of agricultural extension services is instrumental in increasing the efficiency of making adaptation decisions. Extension services could expose farmers to information pertaining to different options of financing new adaptation-related technologies and hence are positively related to the adoption of climate change adaptation methods.
- c. **Non-farm income** is a continuous variable representing non-farm income from myriad sources like government jobs, business, remittance, and other non-farm engagements. It is indicative of the presence off-farm employment opportunities. The availability of off-farm employment could restrict the adoption of climate change adaptation methods because it directly competes for time spent undertaking on-farm activities. Thus, it is expected that non-farm income could influence climate change adaptation in both ways, i.e. positively or negatively.
- d. **Plain Region** represents a binary variable, which takes on the value of 1 if the region is Terai and 0 otherwise. We assert that banking facilities might be less intensive in hilly regions than in plain areas due to geographical impediments to creating physical banking infrastructure. Hence, location in plain regions shall increase the chances of climate change adaptation.
- e. **Phone access** represents a categorical variable, which assumes the value 1 if there is the availability of phone access and is 0 otherwise. Access to a mobile phone has a significant positive relationship with the level of climate change awareness. Serving as a proxy indicator of financial inclusion, ownership of a mobile phone could provide information about the various financial schemes in place to foster climate change adaptation by farmers.

Based on the dependent and independent variables as elaborated above, we estimate three main binary logistic regression models in STATA to assess the gendered impact of financial inclusion on climate change adaptation:

Model 1: Impact of financial inclusion on climate change adaptation by female rice farmers in rural Nepal

Model 2: Impact of financial inclusion on climate change adaptation by male rice farmers in rural Nepal

Model 3: Impact of financial inclusion on climate change adaptation in rural areas of Nepal for the overall sample

In addition, two other supplementary models to assess the impact of financial inclusion on climate change adaptation based on the gender of the household head are also estimated (refer to Table 4).

4. Results

4.1 Descriptive Analysis

This section presents respondents' household demographics and a descriptive discussion of certain key variables, which act as a building block for the econometric model in the subsequent section.

4.2 Household Demographics

Data was collected from 773 respondents, i.e. rural Nepalese rice farmers (refer Table 1), across seven districts of Ilam, Sindhuli, Bara, Syangja, Dang, Surkhet and Kailali (112 respondents each). Of this, around 71 per cent were males, and 29 per cent were females. Moreover, in 79 per cent of the cases, the respondent was also the household head; for 94 per cent of household heads, farming was reported as the main occupation.

Further, regarding the gender of the household head, respondents primarily belonged to male-headed households (72 per cent). The incidence of male-headed households was higher in the Terai region than in the hills. In addition, male-headed households were highest in Bara (93 per cent). Regarding age, the average age of household heads in each district ranged between 45 to 55 years (mean of 48), with the youngest in Kailali (44 years) and the oldest in Syangja (52.5 years). Meanwhile, the minimum and maximum age of household heads in sample areas were 86 years and 18 years, respectively.

Table 1: District-wise Household Demographics

		Ilam	Bara	Sindhuli	Syangja	Dang	Surkhet	Kailali	Total
Gender-wise respondents' participation (in number)	Male	64	93	79	60	93	63	96	548
	Female	48	18	27	49	19	48	16	225

Gender of HH head (in %)	Male	57	93	74.5	55	83	57	86	72
	Female	43	7	25.5	45	17	43	14	28
Age of household head (in years)		46.5	52	51	52.5	46	44.5	44	48
Household size (in number)		5.5	10.3	7.8	6.1	6.1	5.9	7.8	7.0
Respondent as a HH head (in %)		67	86	87	76	85	71	83	79
Farming as the main occupation of HH head (in %)		98	97	84	95	91	97	98	94

In addition, minimum and maximum household sizes were 1 and 26, respectively, with an average household size of approximately 7. 94 per cent have farming as the main occupation of the household head.

4.3 Climate Change Adaptation: Regional Distribution

Of the 773 respondents (refer Table 2), about 73 per cent (562) were found to have adopted methods for climate change adaptation across seven districts with Dang (19.3 per cent), Bara (18.8 per cent) and Kailali (18.1 per cent) leading in terms of climate change adaptation by rice farmers. It is important to note that all these three districts are located in the Terai region.

Table 2: Climate change adaptation among rice farmers: Regional distribution

	Total	Ilam	Sindhuli	Bara	Syangja	Dang	Surkhet	Kailali
N (Total Respondents)	773	112	106	111	109	112	111	112
CC Adaptation	562	34	88	106	79	109	44	102
Non-Adaptation	211	78	18	5	30	3	67	10
Male (CC Adaptation)	421	22	63	89	44	91	24	88

Female (CC Adaptation)	141	12	25	17	35	18	20	14
Total HH Head (CC Adaptation)	463	23	74	92	61	94	34	85
Non-HH Head (CC Adaptation)	99	11	14	14	18	15	10	17

Considering a gendered classification of climate change adaptation by rice farmers in Nepal regionally, we find that data (refer Table 2) is heavily skewed in favour of male farmers, with almost 75 per cent of adopters of climate change adaptation being men.

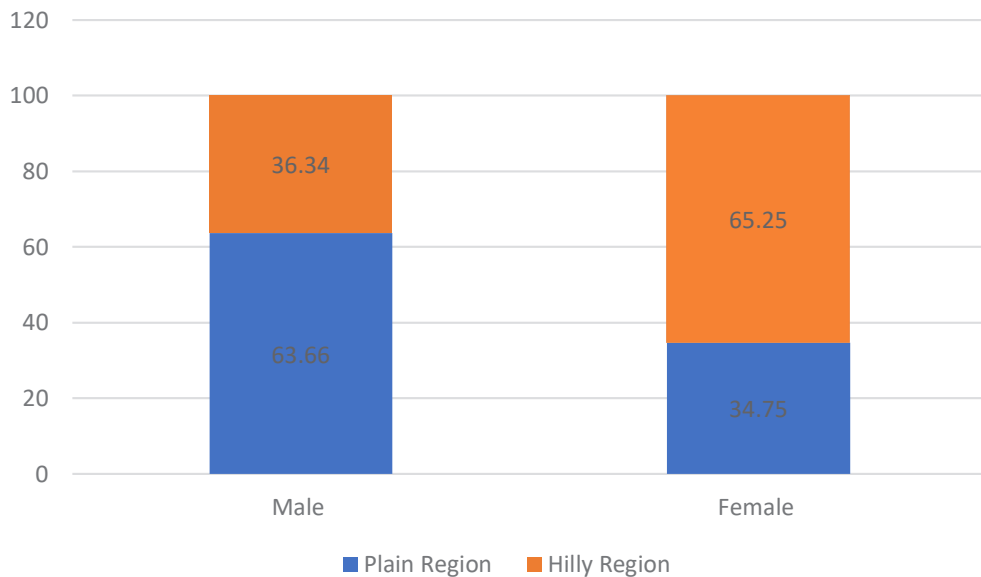


Fig 2: Gender-disaggregated regional distribution of rice farmers in Nepal

Another fascinating observation from data (refer Fig 2) is that male rice farmers engaging in climate change adaptation are concentrated (64 per cent) in plain regions, i.e. terai districts of Bara, Dang, and Kailali. Meanwhile, female rice farmers adopting climate change adaptation are intensively located (65 per cent) in the four hilly districts of Ilam, Sindhuli, Syangja, and Surkhet.

4.4 Climate Change Adaptation and Financial Inclusion

The easy availability of finance to farmers can significantly influence the adoption of climate change adaptation. Thus, policymakers' steps regarding financial inclusion

should be critical. In the present analysis, loan availability is taken as the primary variable to capture the extent of financial inclusion. In addition, variables such as farmers' non-farm income, access to extension services, and mobile phone access are included in the analysis as these could impact financial inclusion, as discussed in Section 5.1.

Concerning loan availability (refer Fig 3), data collected from field surveys show that non-availability of loans is rampant among climate change adaptation adopters. Of 562 respondents who agreed to have undertaken climate change adaptation, a meagre 17 per cent (98) had access to any form of loans.

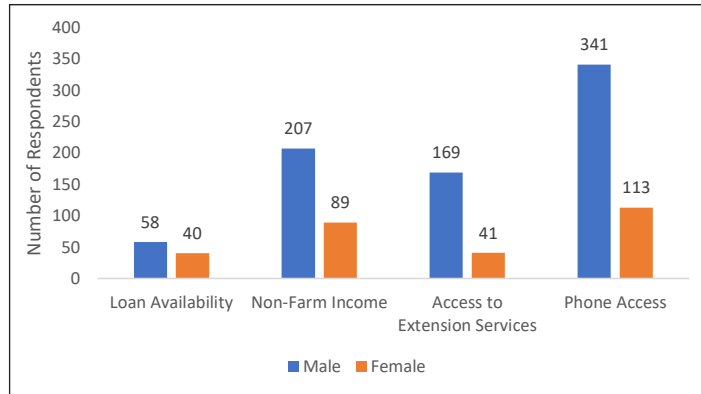


Fig 3: Climate change adaptation and financial inclusion

From a gender perspective, amongst the total respondents undertaking climate change adaptation and having access to loans, distribution between male and female farmers stood at about 60 and 40 per cent, respectively. The finding provides scope for policymakers in Nepal to bring more farmers under the ambit of financial inclusion and reap positive benefits for the environment. The government strategies should be focused and increased in hilly regions because the loan availability access to extension services is found less compared to the terai region, which might be because of the geographical condition of the nation. However, compared to terai regions, non-farm income and phone access are higher in hilly regions.

Similarly, about 52, 37, and 81 per cent of farmers adopting climate change adaptation had sources of non-farm income, access to extension services, and phone access, respectively. However, in all the cases, availability was much more pervasive in the case of male farmers than female farmers (refer Fig 3).

4.5 Econometric Estimations

This section presents the results of our econometric analysis. We estimated three binary logistic regression models to analyse the impact of adopting climate change adaptation methods from a gender perspective. Before reaching our final estimation, we perform pre- and post-estimation tests to ensure the data undertaken for this study fulfils all the criteria. In pre-estimation, we calculate the fittest and classification table

to estimate the data's goodness of fit. Devkota et al. (2018) and Paudel and Devkota (2018), the higher the percentage of model correctness (minimum threshold 60%), the better fit of the model. Looking at the pre-and post-estimation results, all the models undertaken for this study are a better fit (Table 3).

Similarly, for post-estimation, we perform heteroscedasticity and multicollinearity test. Green (2003) mentioned that cross-sectional data analysis often encounters two problems: heteroscedasticity in the error term and multicollinearity among explanatory variables. As all the VIF values are less than ten, there is no issue of multicollinearity in this study. However, the models have heteroscedasticity problems. According to Paudel and Devkota (2018), robust standard error estimations are the proper solution to overcome heteroscedasticity problems. Therefore, each model is treated and taken care of by robust estimation. Hence, all the issues are dealt with before the final regression result.

Table 3: Hypothesis testing for model significance and predictive power

Model	Chi-square (X ²)	Degree of Freedom (df)	P-level ^a	-2 log-likelihood	AIC ^b	Model Correctness (%) ^c	Pseudo-R ²	VIF
Model 1	206.80	6	0.000	-349.71	0.923	74.5	.228	1.13
Model 2	136.73	6	0.000	-228.31	0.859	77.6	.230	1.14
Model 3	59.53	6	0.000	-118.89	1.119	67.6	.200	1.13
Model 4	126.70	6	0.000	-212.92	0.868	77.7	.229	1.14
Model 5	29.28	6	0.000	-51.84	1.090	68.5	.220	1.15

a. AIC (Akaike Information Criterion) measures the relative quality of the statistical model

b. P level shows the statistical significance of rejecting the null hypothesis (H₀)

c. based on the classification table

d. Variance Inflator Factor for Multicollinearity (for model fit, VIF should be ≤ 10)

The overall estimation found that more than 67% model correctness confirms a better fit of the taken model. Similarly, the probability of the X² value indicates model undertaken is significant. The value of the Pseudo-R² ranged from .20 to .23, meaning the model explains 20 to 23 per cent of the overall variables, which is good in the case of logistic regression. The pre-and post-test result indicates that all models

selected for this study are apt and can accurately estimate the rice farmers' perspectives on financial inclusion and climate change adaptation in Nepal.

Since this study aims to measure financial inclusion and climate change adaptation among Nepalese rice farmers from a gendered perspective, we have five dependent variables for the same explanatory variables. The results are presented in table 4.

Table 4: Binary Logistic Regression on financial inclusion in climate change adaptation

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Female Farmers		Male Farmers		Overall		Female-Headed Household		Male-Headed Household	
	Odds Ratio	Marginal effects	Odds Ratio	Marginal effects	Odds Ratio	Marginal effects	Odds Ratio	Marginal effects	Odds Ratio	Marginal effects
Loan Availability (1=Yes; 0=No)	7.600*** (3.75)	.308*** (5.43)	2.883* (1.67)	.099** (2.29)	4.633*** (3.74)	.159*** (5.44)	10.50*** (2.89)	.288*** (3.77)	2.315 (1.30)	.085* (1.67)
Distance of the bank (1=Less than 5kms; 0 = Otherwise)	1.269 (0.64)	.048 (0.66)	0.902 (-0.36)	-.013 (-0.36)	1.021 (0.09)	.003 (0.09)	0.735 (-0.55)	-.051 (-0.54)	0.863 (-0.50)	-.019 (-0.49)
Access to Extension Services (1=Yes;0=No)	2.034* (1.73)	.136** (1.91)	2.332*** (2.88)	.098*** (3.44)	2.258*** (3.45)	.110*** (4.05)	1.098 (0.17)	.015 (0.17)	2.646*** (3.16)	.114*** (3.87)
Non-farm Income	1.000 (0.93)	0.000 (0.92)	1.000 (0.57)	0.000 (0.57)	1.000 (0.86)	.000 (0.86)	1.000 (0.43)	0.000 (0.43)	1.000 (0.45)	.000 (0.46)
Plain Region (1=Terai; 0=Otherwise)	11.46*** (4.72)	.366*** (7.19)	13.89*** (8.13)	.035*** (10.05)	13.91*** (9.74)	.362*** (13.14)	17.45*** (2.70)	.304*** (4.56)	13.93*** (7.76)	.358*** (9.84)
Phone Access (1=Yes; 0=Otherwise)	1.943* (1.63)	.147 (1.53)	1.211 (0.63)	.025 (0.60)	1.488* (1.66)	.063 (1.53)	0.938 (-0.10)	-.010 (-.11)	1.016 (0.05)	.002 (0.05)

Overall Marginal Effect (y)		.704		.853		.816		.797		.849
N	225	548	773	108	507					

Exponentiated coefficients; z statistics in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Results (refer Table 4) suggest that loan availability, the primary variable of interest pertaining to financial inclusion, has a markedly different impact on the adoption of climate change adaptation methods if the distinction is made between the gender of the rice farmer or the gender of the household undertaking rice cultivation. With reference to the gender of rice farmers, it is estimated that loan availability makes female rice farmers (refer Table 4, Model 1) 7.6 times more likely (significant) to undertake climate change adaptation. However, in the case of male farmers, the availability of loans is not estimated to have any significant impact. Similarly, estimations of climate change adaptation based on the gender of the household head suggest that among female-headed households, those with loan availability are almost 11 times (significant) more likely to take initiatives for climate change adaptation. The corresponding odds for male-headed households are only 2.3 times (non-significant). The positively significant impact of loan availability on climate change adaptation methods is also estimated if we consider the overall sample (refer Table 4, Model 3). However, in this case, it is only 4.6 times more likely to bring about climate change adaptation than female rice farmers or female-headed households undertaking rice cultivation.

In addition, our findings regarding the control variables suggest that proximity to a bank also makes female farmers 1.3 times more likely to adopt climate change adaptation. However, the result is not significant. Second, phone access plays a significant role (odd ratio of 1.9) in encouraging female farmers to undertake climate change adaptation. The result in the case of male rice farmers is not significant. Third, access to extension services is estimated to increase the likelihood of climate change adaptation among female and male farmers almost twice. In contrast, a distinction made based on the gender of the household head shows that extension services are more impactful in the case of male-headed households in bringing about climate change adaptation. Meanwhile, female (male) farmers and female (male) headed households in the Terai region are 11.46 (13.89) and 17.45 (13.93) times more likely to pursue adaptation.

Thus, considering the descriptive and econometric analysis of primary data, we find that climate change adaptation among female rice farmers in Nepal based on the

regions studied for the present analysis remains significantly low at 25 per cent of the total adopters. However, as substantiated by our econometric analysis, this statistic could be significantly increased by undertaking steps pertaining to financial inclusion, as the availability of loans among female farmers makes them 7.6 times more likely to undertake climate change adaptation. Further, there is a need to develop banking infrastructure in Nepal. Though the variable distance from the bank is not estimated to be significant in the present models, based on descriptive data and discussion with respondents, we find that farmers in Nepal have to walk long distances to avail banking facilities, a major hindrance to credit access. Across seven districts, about 55 per cent of the respondents reported that banking facilities were situated at a distance of more than 10kms, and only 4.7% had easy access to banks (i.e. less than 1 km). It could exacerbate problems for female farmers who also face the burden of unpaid care work besides working in the fields.

Moreover, in focus group discussions, rice farmers categorically argued that there is an absolute paucity of proper bank loans to rural and marginal farmers. Even rich farmers face numerous difficulties in obtaining bank loans. The presence of information asymmetries further complicates the situation wherein, despite the availability of both formal and informal modes of loan, there is no knowledge among farmers about the availability of these credit facilities. Of the 773 respondents located across the seven study areas, 185 respondents claimed they did not know of the existence of credit facilities.

In this context, extension services and mobile phones could play a vital role in bridging these information asymmetries. Econometric estimations find that extension services significantly impact climate change adaptation by male and female farmers. Meanwhile, access to the mobile phone increases the likelihood of female farmers undertaking climate change adaptation by almost two times. The impact of mobile phone access on climate change adaptation by female farmers could be rationalised considering the ease with which financial information and products could be disseminated to women without any mobility requirement in their context, characterised by a double incidence of work.

5. Discussion

This study applies a binary logistic regression model to examine the gendered impact of financial inclusion on climate change adaptation among rural rice farmers in Nepal. The result of this study revealed that 71% of males are engaged as rice farmers in Nepal and the terai region, with the majority of male household heads compared to females. Also, 64% of male farmers of the terai region are engaged in climate

change adaptation. The major factor affecting climate change adaptation among farmers is loan availability, where the facility of loan availability influences females. In a nutshell, if female farmers are provided with better financial, infrastructural, and technological facilities, they are more likely to adapt to climate change as fewer female farmers adapt to climate change.

The results of this study are consistent with the study of Khanal et al. (2018), Dhakal et al. (2013), Acquah & Onumah (2011), which states that loan availability and accessibility of proper financial services can encourage farmers to adapt to climate change. In contrast, non-availability or difficulty in receiving credit facilities can cause hindrances for farmers in climate change adaptation. From a gender perspective, the findings show that females are still behind male farmers regarding household power and financial resources, which affect climate change adaptation parallel to the findings drawn by Djoudi and Brockhaus (2011). Climate change would significantly impact farmers' livelihoods (Harvey et al., 2014), and various climate change patterns are disturbing the regular cultivation of Nepal. Therefore, an alternate crop cycle should be planned to prevent fallow farmlands during such times (Gurung & Bhandari, 2009).

Some key implications related to financial inclusion and climate change adaptation among rice farmers in Nepal can be generated from this study. Saito (2013) urges that least-developed countries might face severe problems due to climate change. As Nepal, a member of the least developed country can also face climate change impacts; concerned authorities should take necessary actions to mitigate the risk of climate change. Though farmers have initiated some measures of adaptation themselves and with the support of government or other bodies/institutions, other strategies should be formulated to upgrade the female farmer's status in farming activities and awareness programs on climate change. Further, financial facilities like farmer's loans and subsidies should be restructured to attract and encourage female farmers toward farm activities.

Further study can be conducted in this field by addressing the limitations of this study. Also, broader scope and study area can be covered to get broader output to achieve the objective. Additional variables can be used in further study, which would strengthen the scope of the study.

6. Conclusion and Policy Implications

Although most of the world's poor women rely heavily on natural resources for livelihood, the climate change repercussions are not gender neutral because the

repercussions are afflicted by legacy disadvantages pertaining to limited resource access and rights. Meanwhile, on the other side, women have also been identified as positive agents of change in response to climate change adaptation. Thus, from a policy-making perspective, the research shows the need to formulate and implement policies that empower women to bear climate change costs.

In Nepali Context, the main findings of the gendered impact of financial inclusion on climate change adaptation among rice farmers indicate: First, loan availability makes female rice farmers 7.6 times more likely (significant) to undertake climate change adaptation as compared to male farmers where the variable is estimated to have any significant impact. Second, phone access plays a significant role (odd ratio of 1.9) in encouraging female farmers to undertake climate change adaptation. Third, access to extension services is estimated to increase the likelihood of climate change adaptation among female and male farmers almost twice. Fourth, proximity to a bank, though not significantly but also makes female farmers 1.3 times more likely to adopt climate change adaptation.

From a broad policy perspective, the findings point towards the following: First, efforts need to be made toward increased loan availability to rural Nepalese farmers, specifically females, to facilitate climate change adaptation. Specific schemes targeting this particular section need to be formulated and implemented by Nepalese banking authorities. In this context, the option of microfinance could be explored by policymakers. It could serve as an effective means for the financial inclusion of rural rice farmers at the community level. Second, banks could use the dissemination of loan availability and other financing information through mobile phone-based innovative applications and customised fintech solutions as a potent tool to bring more farmers under the gamut of the banking system along with significant associated positive externalities for the environment. The strategies are especially relevant in the context of female farmers having the double burden of unpaid work who may not find the time to travel to workshops or seminars organised for the same. Third, increased access to extension services could play an instrumental role in bridging the information asymmetries with respect to credit options among rural rice farmers. Fourth, developing robust physical and digital banking infrastructure in Nepal is the need of the hour. Descriptive data and discussion with respondents reveal that farmers in Nepal have to walk long distances to avail of banking facilities, a major hindrance to credit access, which could exacerbate the problem for female farmers who face the burden of unpaid care work besides working in the fields. The development of digital finance solutions can also effectively help to overcome these problems.

Thus, it becomes imperative for Nepalese banking authorities to accept that there is a gender gap pertaining to financial inclusion and a gender angle to the impact of financial inclusion on climate change adaptation. Recognition of the same requires policy making, which is sensitive to the specific needs of female rice farmers as shaped by both their present vulnerabilities and historical disadvantages.

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