DETERMINANTS OF IRRIGATION TECHNOLOGY ADOPTIONS AND PRODUCTION EFFICIENCY IN NEPAL'S AGRICULTURAL SECTOR

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Abstract:

The factors considered in using irrigation as a production strategy in Nepal has been different from many countries mainly because of geographical diversity, water availability and investment constraint. This paper identifies the factors affecting irrigation technology adoption among the farmers in Nepal using household survey data 2011. We use a multinomial logit model to estimate variables affecting multiple irrigation technology (tube-well, canal and pond) adoptions in which sociodemographic information, land holding, access to credit, and geographical factors are major explanatory variables. Preliminary results show that education, land holding size, access to credit, and geographic factors have a higher impact on tube-well irrigation technology adoption. Additionally, productivity of major crops found to increase substantially in irrigated land. The impact of shallow tube-well is much greater in plain compared to other modes of irrigation in plain and hilly regions. Findings from this study should provide insights to producers and policy makers in identifying opportunities for utilizing and investing in more efficient irrigation technology

Key words: Irrigation technology, shallow tube well, water, farming, multinomial logit.

JEL classification: Q12, Q25

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Introduction

Nepal is very rich in surface water, yet crop yield and crop productivity consistently suffer from a lack of irrigation water specifically during the growing season. The factors considered in using irrigation as a production strategy in Nepal has been different from many countries mainly because of geographical diversity, water availability and financial constraint.

Nepal, where only 17% of the total land is appropriate for farming (CARE 2001), is bestowed with plentiful surface and ground water resources. However; due to geographical factor, water demand from non-agricultural sectors, and seasonal water availability, Nepalese agriculture is consistently suffering from water scarcity problem, notably in the growing seasons. Ground and surface water resources are the main source of irrigation water in plain region of the country, whereas surface irrigation is the only source in hilly region where horticultural crops are the primarily cultivated. Most of the areas in hilly region face worst drought in dry winter season due to lack of water reservoirs or storage tanks that would have been used to collect rain water of surface run off water in rainy season.

In developing country like Nepal, irrigation can be considered as a strategy of poverty reduction through intensive agriculture (Hayami and Ruttan 1971; Kulshreshtha 1989; Smith 2004). Nevertheless; for proper management and development of irrigation system, there must be a sound coordination between local institution and government agency (Ostrom 1992). Irrigation policy of Nepal 2003 emphasized on the participation of beneficiaries in irrigation management with a joint responsibility of water users and government agency. Effective and achievable national irrigation policies fortifies the irrigation system, introduces higher supply of irrigation water that ultimately raises the agricultural outputs (Smith 2004). However; the policies that require high investment cost with conventional irrigation technologies may result more supply of water in agriculture sector and higher scarcity of resources. Water scarcity has become a major issue for both policy makers and water users. In fact, agriculture sector is more prone to water scarcity. Adoption of modern irrigation technology can be an appropriate strategy to overcome the effects of water scarcity (Cason and Uhlaner 1991; Koundouri et al. 2006).

Plethora of studies (Fishelson and Rymon 1989; Dinar and Zilberman 1991; Dinaret al. 1992; Dinar and Yaron 1992; Koundouri et al. 2006) address the decision making behavior of farmers that affects the adoption of irrigation technology. Such behaviors are associated with socio-economic, demographic and structural factors. Some of the key variables that have empirical relationship with for farmers' decisions whether to adopt or not to adopt the technology are land quality, land size, and human capital (Caswell 1991; Dinar at al.1992). Moreover, in the case of developing countries, farmers might have been facing some constraints such as lack of credit, lack of information, aversion to risk, inadequate farm size, insufficient labor, absence of equipment to relieve labor shortages, and inadequate inputs supply in the process of technology adoption (Feder et al.1985).

Some conventional methods of irrigation like flood, level border, and furrow requires more water in short amount of time. Since those technologies are based in the gravity that results in non-uniform distribution of water. Whereas, for some modern technologies, such as drip and sprinkler irrigation, comparatively less amount of water is required over long time period and the distribution of water is uniform by maintaining a level of pressure in water delivery system (Caswell and Zilberman 1986). Feder et al. (1985), Caswell and Zilberman (1986), Dinar and Yaron (1990), and Green et al. (1996) observed that the likelihood of adoption of new technology for the productive land with good physical attributes such as good soil quality accompanied by higher water holding capacity gets increased because the expected utility of income gets raised by the enhanced production.

The effects of farm size on the decision making behavior of farmers depend on the nature and cost of technology. It could be either positive (Smit and Smithers, 1992; Fuglie, 1999), or negative (Shortle and Miranowski, 1986; Clay et al.1998) or neutral (Nowak, 1987; Agbamu, 1995). Feder et al. (1985), and Genius et al. (2013) found that farmers holding smaller farms may not be interested to invest high amount of fixed cost for the installation of irrigation infrastructures required for irrigation technology such as pipes, hydrometers, and drips for drip irrigation.

Several studies have claimed that the human capital variables such as age, education level, extension services, and information accumulation are positively correlated to the adoption of the irrigation technologies (e.g., Koundouri et al. 2006; Genius et al. 2013; Olen et al. 2015). Adoption of efficient irrigation technology might be a wise approach for farmers to deal with water scarcity. The likelihood of adoption of modern irrigation technology also depends upon the type of crops. Green et al. (1996) showed that the farmers cultivating perennial crops switched to furrow irrigation from sprinkler irrigation. However; Moriana et al. (2003) argued that farmers cultivating fruit trees are more willing to adopt new irrigation technologies. With an increment in irrigation water cost, studies of Caswell and Zilberman (1985) and Carey, J. M., and D. Zilberman (2002) showed that farmers shifted their preferences to sprinkler and drip irrigation from furrow irrigation system. They also found that ground water users are more likely to adopt new irrigation technology than the surface water users.

This paper evaluates the factors affecting irrigation technology adoption in the context of Nepalese agricultural sector which is unique in the sense that the country has heterogeneous geographical regions and farming practice is traditional due to financial, technological and resource constraints.

Theoretical framework and empirical model

For our parameters estimation, we used multinomial logit framework which is based on the utility maximization. In this process, the utility conditional on the choice of producers' alternative j for technology choice is specified by the linear form:

$$V_{ij} = \beta_j X_i + \varepsilon_{ij}$$

Here, V_{ij} is the indirect utility function of individual i for selecting technology j which is a linear function of independents variables represented by vector X. The explanatory variables included are sociodemographic information of household, land holding, access to credit, caste, and geographical factors.

The individual producer is assumed to choose the irrigation technology k (k=1, 2, 3) for which V_{ij} is the highest. Now, the probability of choosing technology j by an individual i, is given by

$$P_{ij} = \Pr (V_j > V_k) \text{ for all } j \neq k$$

$$= \text{pr} (\beta_j X_i + u_{ij} > \beta_k X_i + u_{ik})$$

$$= \Pr (\beta_j X_i - \beta_k X_i > u_{ik} - u_{ij})$$

Assuming u_{ij}'s are distributed independently and identically, their difference have a logistic distribution and the probabilities take the multinomial logit form. Now, we can estimate it by using multinomial logit method. The estimated coefficients β_j are interpreted as the effect of explanatory variable on the utility of being in one irrigation technology alternative j compared to the utility from the base category of technology used.

Data source and description

This study uses Nepal agriculture census data 2011-12 conducted and compiled by Nepal Central Bureau of Statistics. The sample census was conducted across all 75 districts and all three geographical regions: Tarai, Hill and Mountain. It consists of household level information about agricultural land holding, sociodemographic information of household, crop information, irrigation technology, water sources, access to credit, and livestock.

For this study we used the variables mentioned in table 1

Table 1: Description of variables used

VARIABLE	DESCRIPTION
IRRI_TECH	Irrigation technology in use such as furrow, tube well, canal
HHSIZE	Household size i.e. number of people living in a household
GENDER	Sex of household head
CASTE	Castes of household head
EDU	Years of schooling of household head
AGE	Age of household age
CREDIT	Access to credit of household
GEO_REGION	Geographical region (Tarai, Hill, Mountain)
OCCUP	Type of occupation of household head
LAND_ HOLD	Area of owned and rented land
CROP TYPE	Types of crops grown

Empirical results

Empirical results in progress

Discussion and concluding remarks

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