An Impact of New Technologies on Cropping Pattern in the Eastern Hills of Nepal

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Abstract

This abstract starts with the purpose of the study of the impact of using new technologies on cropping pattern particularly in the case of the Eastern hills. It also examines the role of governmental organizations and non-governmental organizations to improve agricultural systems of this area. Relevant data have been obtained from both primary and secondary sources. It draws on the data collected from interview, focus group discussion, key informant survey, and field observation. For this, 30 percent sample households were selected from three altitude belts such as upper, middle and lower, ranging from 300 to 2,250 masl along the Koshi-highway. It has a wide range of climates, ranging from sub-tropical to alpine with monsoon precipitation in the summer for three and half months, and therefore it has diversity in flora and fauna and people. Similarly, secondary data have been collected from various books, journals and official records.

This paper has showed that the crucial impact of acceptance of innovative methods in agriculture in the study area is a joint effort of local people, government, and non-government agencies too. The government with the development agencies and non-government organizations has contributed to impart knowledge of the agriculture innovative methods to the local farmers. At the same time, the farmers were enthusiastic to learn and adopt those methods. Consequently, one can easily see the remarkable changes in cropping pattern due to the impact of such innovations. The cereal crops based on agricultural system is gradually moving towards high value off-season crops farming.

Keywords: a*doption, commercial production of vegetables high yielding variety of seeds, plant protection measures, seed treatment/ seed germination test.*

Introduction

In common situation, pre-established theories and models form the base for the geographical study and analysis too. Such theories and models are being taught in

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school and universities for this particular reason. The scholars developed the theories and models through the experience and study of various geographical regions which are being used in geography for a long time. Central Place Theory (Christaller 1933) provides a comprehensive frame work for the explanation of spatial pattern of urban places (Pradhan 2004). Similarly, Agricultural Land Use Model (Von Thunen 1826) forms the base to analyze how and why agricultural land use varieties with the distance from market (Husain 1996). Likewise, The Pipeline Model of Innovation Diffusion (Biggs, 2003) provides the literature to describe 'Transfer of Technology' and The Diffusion Model (Hagerstrand 1953) leads most of the geographical interest towards diffusion studies (Wagle 2019). These theories have been widely appreciated to analyze geographic phenomenon for a long time. In this context, the use of new technologies in agricultural sector has completely changed into the cropping pattern of the Eastern hills of Nepal (Wagle 2019). This prototype may be helpful to understand the change of cropping pattern in other geographical regions through the access of these technologies. Hence, this study may provide a base to understand the strength of these technologies in cropping pattern especially for other hilly regions of the world.

Agricultural growth and development depend on various innovative techniques, and ideas adopted by the farmers and influenced by several socio-economic and spatial factors. They are different from one place to another based on personal, agronomic, socio-economic, bio-physical and intuitional factors (Sharma 1979, Mathema (1986). Besides Choe & Pradhan (2010) focus on marketing networks for production activities, but Chand (2016) has found the decisive of geographical factors to understand the acceptance rate of new technologies in agricultural sector. Agarwal et al. (1978) had identified the use of chemical fertilizer is highly interrelated with the distance from the road and availability of extension service centers in the Gandaki Zone of Nepal. In addition, farmers' perceptions, infrastructure and the economic incentives of the agriculture sector are also equally important to decide alternative production techniques (Berner, Harrison, Baxter, 1984).

In the same perspective, Virgo and Subba (1994), Koirala (2006), and Khatiwada (2014) revealed the case of hills, and they found that there are some changes occurred in the agriculture sector along the Koshi Highway. They argued that commercial crops have been replaced by cereal-based subsistence farming. They point out that the establishment of the then Pakharibas Agriculture Research Centre (PAC), increasing access to roads, farmers' self-efforts and market integration, and GO and NGO supports are drivers to change. But these studies did not analyze the role of new technologies minutely i.e. chemical fertilizer, plant protection measures, improved seeds and seed treatment etc. Realizing the existing situation, the question can be raised regarding driving factors and pace of changes in the acceptance of innovations of the eastern hills.

Therefore, this study has attempted to observe the role of various organizations for the diffusion of innovations and appraisal the impact of innovations on cropping patterns of the study area too.

2. Method and Materials

Sources of Data

The paper is based on primary and secondary data. The major sources of primary data collection are field observation, focus group discussion, questionnaire and key informant survey. Similarly, various books, journals, and official records are the core sources of secondary data collection. Besides, collected data are arranged, and presented in the table as required. Simple statistical tools percentage and percentile change are used. On the basis of analyzing the gathered data, a descriptive paper is prepared. Both quantitative and qualitative techniques are used in order to achieve the goal.

Selection of Sample Sample Study Centers and Households

Based on the **central place theory of Walter** Christellar**,** the study area has delineated along with buffering of 1.50 km of the Koshi Highway of Dhankuta district located in the Southern slope of the Eastern hills where rapid changes in the agricultural sector have been occurred after the decade of 1980. Besides, the study area is divided into 3 Agro-Climatic Belts, namely, lower, middle and upper altitude belts, respectively based on Agro-Climatic classification of the District Agriculture Development Office Dhankuta. From this, the study has been based on a stratified random sampling method. For this purpose, almost 30 percent (166 households) farm households have been selected from each ecological belt having more than 0.50 hectares (0.83 ropani) of each, both *Khet* and *Bari* land (Table 1).

Table: 1 Method of Sampling Households

Altitude Belts	**Total Households**	**Distance from Koshi Highway (In meters)**			**Sample Households**	**Mean Farm Size (In hector)**
		0-500	**501-1000**	**1001-1500**		
Lower	101	10	10	10	30	o.78
Middle	265	28	28	24	80	1.10
Upper	185	19	19	18	56	1.01
Total	**551**	**57**	**57**	**52**	**166**	**1.02**

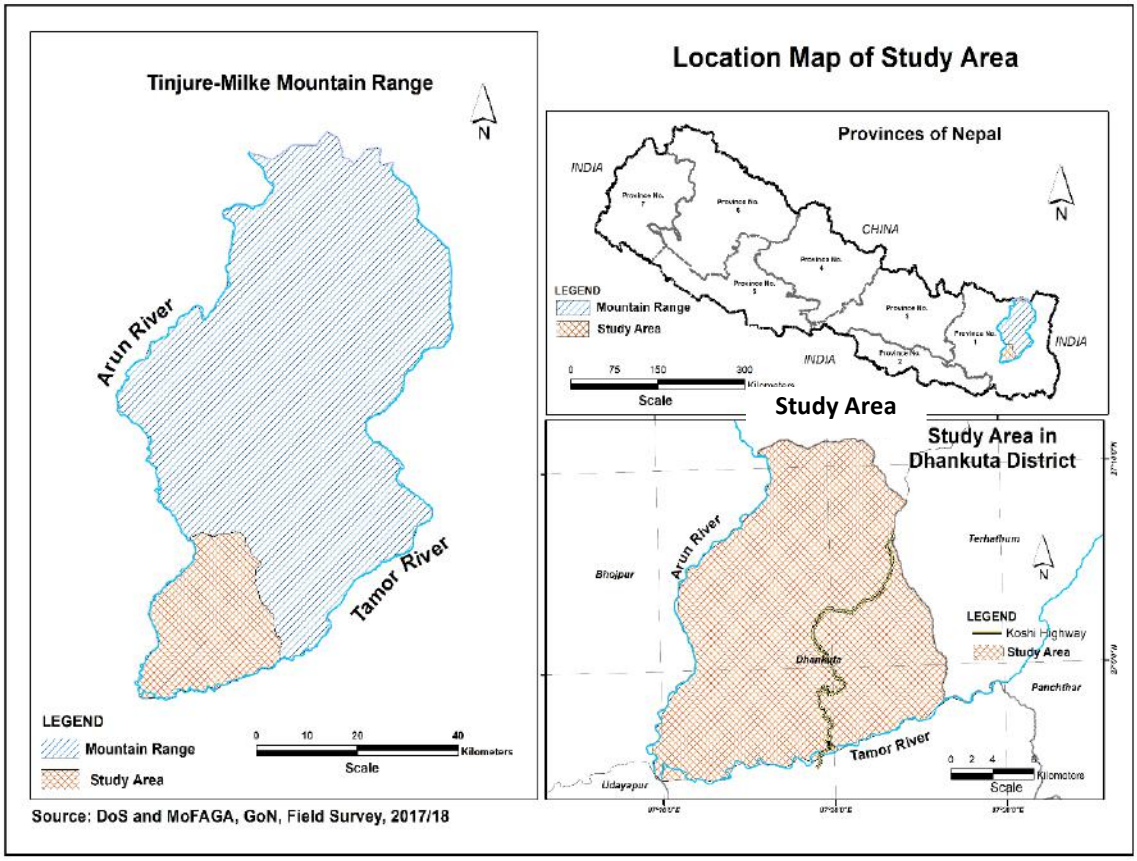
Source: Field Survey, 2016.

Moreover, the researcher has taken three study centers as sample from each altitude belts. They are Chitre, Sindhuwa and Jorpati from the upper altitude belt; Kuwapani, Kagate, and Dhankuta Bazar from middle altitude belt. Similarly, Guthitar, Rudrabari, and Mulghat from lower altitude belt, respectively. Chemical fertilizer, improved seeds, plant protection measures and seed germination test are included as modern innovations in the study. Apart from this, the farmers who have adopted all innovations are considered as an 'Adopter' whereas other groups fall in the category of 'Non-adopters' in the study.

Study Area

The southern slope of eastern hills is different from the other parts of Nepal in various ways, such as geographical, ecological, historical, socio-cultural, and economic perspectives. The farming population of this area is also living in a subsistence agricultural system. It is a region of outstanding natural and social diversity, resulting from the tremendous geographical and climatic extremes. In this area, altitudes (300-2250 masl) and climates are range from sub-tropical to alpine and long periods of winter dryness altering with torrential downpours during the monsoon which is a challenging for human survival. It is mainly due to insufficient resource base like rocky and sloppy cultivated land, extreme climate, poor communications and infrastructures etc (HMG/ MoE 1974). The greatmajority of the people who live in this region are subsistent farmers. Over the centuries, these people have developed strategies for survival that can be maintained independently of contact with the adjacent areas. Indeed, such condition found in the Hindu-Kush Himalayan Region (Ya & Tulachan, 2003). The majority of farmers living in this area seem to have gradually changed their socio-economic conditions after the adopting new technologies in their agricultural works.

Figure: 1 Location Map of the Study Area



Mr. Uddab Wagle, the former administrative clerk of KHARDEP has reported that Koshi Hill Area Rural Development Project (KHARDEP) is one of the IRDP approach launched project in the eastern hills of Nepal. This project has made Koshi Highway. It has transferred technology through improved seed production, farmer training, exposure visits, and field demonstration. Besides the contribution of the District Agriculture Development Office (DADO, Dhankuta), the then National Orange Research Center (NORC, Dhankuta), and other Non-Government Organizations also appears significant. With all these efforts, the Koshi Highway seems to have brought significant changes in the agricultural development of this area since the mid -1980s. It provides access to the supply of chemical fertilizer, improved seeds, and plant protection measures at a significant rate in the study area. Indeed, it was comparatively low in the past (Pathak, 2010). The use of chemical fertilizer, improved seeds, and pesticides is increasing particularly in high-value cash crops and off-season vegetables. But the amount of use of agricultural inputs is decreasing with the increasing distance from the main road

(Khatiwada, 2014). This situation is relevant not only with farming system of the eastern hills, but also similar with other hillly regions of Nepal (Wagle, 2019). Thus, it is relevant to identify the role of various organizations for the diffusion of new technologies and changing behaviors of the farmers towards the selection of crops in the present situation.

3. Discussion and Results

The historical development of the adoption and diffusion of agricultural innovations in the eastern hilly area can be divided in three major phases: Before Panchayat Regime Period (Before 1960), Panchayat Regime Period (1960-1990), and After Restoration of Democracy Period (After 1990 to till now). After the unification of Nepal, newcomers from other parts of the country and abroad brought new seeds, farm techniques and tools based on their experiences Wagle 2019 p. 81).

According to local elite intellectuals and farmers, the foundation of modern agriculture had created from 1960 to 1990 in the eastern hills of Nepal. Some important innovation diffusion friendly policies and programs implemented by the then government of Nepal seem to be the milestone to develop this sector. The extension of Agricultural Service Centers, construction of the Koshi Highway, subsidy in agricultural inputs, and implementation of integrated Rural Development Programs (IRDP) were considerable achievements at that period in the study area. Besides the contribution of the then Pakharibas Agriculture Centre (PAC, 1978) and Koshi Hill Area Development Program (KHARDEP, 1977) as non-governmental organizations also seems remarkable to promote the agricultural sector of this area at that duration. After that, joint efforts of both governmental agencies and non-governmental agencies have been playing a vital role in developing the agriculture sector of the study area after the restoration of democracy in 1990 (Table 2).

Table 2: Adoption and Diffusion of Agricultural Innovations in the Study Area (In Households)

	Ecological Belts				
Years		**Upper**	**Middle**	**Lower**	**Total**
Before 1980	Number	0	7	0	**7**
	Percent	0	4.21	0	**4.21**
1981-1990	Number	4	24	1	**29**
	Percent	2.41	14.46	0.60	**17.47**
1911- 2000	Number	35	34	15	**84**
	Percent	21.08	20.48	9.04	**50.60**
2001- 2010	Number	14	12	12	**38**
	Percent	8.43	7.23	7.23	**22.90**

2010+	Number	3	3	2	**8**
	Percent	1.81	1.81	1.20	**4.80**
Total	Number	**56**	**80**	**30**	**166**
Percent	Percent	**33.73**	**48.20**	**18.07**	**100**

Source: Field Survey, 2016.

The table reveals that only 4.21 percent (7 Households) farmers have used agricultural innovations before 1980. The farmers of the Kagate and Dhankuta centers in the middle altitude belt had used such technologies at first which is known as the first beginning point towards the use of new technology in the eastern hills (Wagle 2019). The table indicates that the adoption reaches the top level during the years 1991 to 2000. Almost, 51 percent (84 Households) farmers have used such innovations at that period. The diffusion seems rapid in the beginning, and reaches the climax by 2000. After that, diffusion seems a rapidly decreased. The existing trend shows that the acceptance of innovations appears satisfactory, but the sustainability of such new technologies is questionable (Wagle 2019). Besides, the table also shows that all farmers of the study area had the users of any type innovations for their agricultural works in the past, but some farmers had stopped to use such measures after some time.

Role of Organization to Promote New Technology

Several GOs and NGOs have been working for a long time to develop the farming system of the eastern hills focusing on cash crops. The local intellectuals and key informants have remarked that District Agricultural Development (DADO, Dhankuta), Agricultural Research Station Pakharibas (ARSP) and National Citrus Research Programs (NCRP, Dhankuta) have a leading role in developing the agricultural sector of this area (Table 3).

Table: 3 Role and Involvement of the Agencies to promote Agriculture

Ecological Belts	Number	ARSP	DADO	ARSP + DADO	Ag. Centre	ARSP + Ag. Centre	Others	NCRCP	NCRCP + ARSP	None	Total
	Number	12	16	11	7	6	4	0	0	0	56
Upper	Percent	7.22	9.64	6.63	4.21	3.61	2.41	0	0	0	
	Number	0	14	41	0	1	0	2	22	0	80
Middle	Percent	0	8.43	24.70	0	0.60	0	1.20	13.25	0	
	Number	1	14	14	0	0	0	0	0	1	30
Lower	Percent	0.60	8.43	8.43	0	0	0	0	0	0.60	
	Number	13	44	66	7	7	4	2	22	1	166
Total	Percent	7.82	26.50	39.76	4.21	4.21	2.41	1.20	13.25	0.60	100

Source: Field Survey, 2016.

District Agricultural Development Office (DADO, Dhankuta) has been facilitating the farmers from the beginning to adopt such technologies as well as supporting technically and economically among the organizations. The local farmers have reported that they are getting support from DADO Dhankuta, especially on receiving improved seeds, irrigation, and advice during the time of epidemics of plant diseases. Besides, they have been keeping contact for help and advice during the time of need. The farmers also remarked that it has been organizing different programs related to the agricultural development like seminars, meetings, trainings and observation tours for them. In addition, this agency is actively involving in implementing the current policies of government related to the agricultural sector in the study area.

Agriculture Research Station Pakharibas (ARSP) has been working devotedly in this area since 1972. It was established by the then British Government to provide technical knowledge for Ex-Gurkhas soldiers to make them self-dependent. In the beginning, the organization supported the Ex-Gurkhas in their agricultural works, especially for cereal and vegetable crops farming and animal husbandry also. After that, gradually, other farmers of the study area have also been benefitting through the programs of this organization. Recently, this research station is using 88.64 hectares of land for the research purpose of developing new technologies in the agricultural sector. Now, it has known as popular service provider station among the farmers. The local intellectuals have said that there is a leading role of this research station to bring the agricultural sector of this area up to the present condition. Now the main focus of this station is concentrating on research works. Along with this, it has also been conducting seminars and training related to this sector.

National Citrus Research Programs (NCRP, Dhankuta) is next leading organization that has been involving for agricultural development. It was established in 1961 in the mid- hilly region of Nepal to develop and extend horticulture in this region. In the beginning, it focused on the development and extension of both vegetable and fruit farming, but now it focuses only on the development and extension of horticulture. The different species of fruits that are developed and produced by NCRP are spreading all over the world (Wagle 2019). Besides, the role of Uttarpani Technical School seems remarkable to diffuse technical knowledge among the poor farmers by producing JT and JTAs (Table 7.2). Apart from the major governmental organizations, some other non-governmental organizations like Society of Local Volunteers (SOLVE) and Poverty Alleviation and Rural Development Project (PARDEP) have also contributed to promote the market of agricultural products.

Table 4 indicates that around 8 percent of the total farmers (13 households) have benefitted only through the technological support of Agriculture Research Station Pakharibas (ARSP) to continue their occupation. Likewise, almost 27 percent (44

households) of farmers are involving in their agricultural works with the technical and economic support of District Agricultural Development (DADO, Dhankuta) only. In this way, around 4 percent (7 households) of farmers have got support from agriculture extension centers only and almost 1 percent (2 households) farmers have got available support of National Citrus Research Programs (NCRCP, Dhankuta).

Besides, farmers of the study area are getting regular support from more than one organization.Table 3 shows that around 40 percent (66 households) farmers of the study area have been benefiting from regular technical and economic support of both Agriculture Research Station Pakharibas (ARSP) and District Agricultural Development Office (DADO, Dhankuta).Similarly, nearly 13 percent (22 households) farmers are receiving continuous support from National Citrus Research Programs (NCRCP, Dhankuta) and Agriculture Research Station Pakharibas (ARSP). Likewise, Agriculture Research Station Pakharibas (ARSP) and Agriculture extension centers provide their joint services to almost 4 percent (7 households) farmers. In this way, more than 2 percent (4 households) farmers are getting support from non-governmental organizations except mentioned organizations. In this way, there is an indispensable role of both governmental and non-governmental organizations to develop and promote the agricultural works of the study area.

Impact on Cropping Pattern

The land use and cropping pattern are known as dynamic concepts and processes. Cropping pattern varies from place to place depending on the terrain, topography, slope, temperature, amount and reliability of rainfall, soils, and availability of water for irrigation (Chouhan 1987). In this context, Oli (2002) has remarked:

> The general view of farmers seems to be that if high yielding varieties are available, why to keep and continue producing low yielding local varieties. Using hybrid crops is important for increasing yield per unit area. Farmers are happy as they need not keep the seed but still get a bumper crop in the immediate future. This was evidenced by the fact that now a greater number of farmers are using improved crops and have stopped saving their own crops for seed, (P. 20).

Similarly, government agencies can also encourage the farmers to adopt proper crops exclusively rather than traditional crops by providing subsidies. As a result, there is a contraction in an area under the traditional crops and a corresponding change in the cropping pattern. The farmers of the study area have been using newly, improved seeds of vegetables and food grains since 1980 through the inspiration of governmental and non-governmental agencies. So, the cropping pattern of the study area has drastically changed due to the impact of using such new technologies in the study area.

- **Vegetable Farming**

Vegetable farming is known as the crops farming of all year round. In the current day, mainly the farmers of the upper altitude and the lower altitude seem as more professional in the vegetable farming rather than the middle altitude due to the other opportunities like a government job, foreign employment, and other secondary occupations. It is most popular in the upper and lower altitudes although it is spreading everywhere in this area. Generally, cauliflower, cabbage, radish pea, and tomato are known as the major vegetable crops in this area. In the beginning, vegetable farming introduced only as kitchen garden farming. Most of agricultural land was occupied by cereal crops before 1980 and a human settlement was in dispersed forms. The farmers gradually motivated towards the vegetable crops from the beginning of 1981 through the technical support of the then Pakharibas Agriculture Centre and District Agricultural Development Office (DADO, Dhankuta). Besides, the Koshi highway also helped to extend the vegetable crops in the eastern hills of Nepal (Wagle 2019).

Also, local farmers have remarked that Guthitar and Rudrabari of the lower altitude belt are famous as a *Tomato Belts.* However, the cultivation of cauliflower and cabbage has also cultivated professionally in these centers, but the main focus of the farmers seems in tomato production. According to the local farmers, Tomato cultivation has started from the period of 1991 to 2000 through the effort of pioneer farmers Rabin Yogi from the technical support of Agriculture Research Station Pakharibas (ARSP) in this belt. Table 4 shows the detailed information about cropping pattern of the study area

Table: 4 Change in Area of Vegetable Farming before 1980 -2015, (Area in Hectares)

Altitude Belts	**Before 1980**		**2015**		**Total (‘*Bari*’)**	**Percentile Change (In hectares)**	
	A	NA	A	NA		A	NA
Upper Altitude Belt	0	46.43	42.84	3.59	46.43	+347	-275
Middle Altitude Belt	2.86	60.10	33.08	29.70	62.78	+1057	-49
Lower Altitude Belt	0	22.18	16.97	5.21	22.18	+318	-77
Total	**2.86**	**128.89**	**92.89**	**38.50**	**131.39**	**+1297**	**-401**

Source: Field survey, 2016.

Note: - A - Adopted Area NA- non-adopted Area.

The table indicates the change in the cropping pattern from the beginning to 2015 in the study area. The available statistics point out the area under vegetable farming has increased significantly during this period. The percent coverage of the vegetable crops areas has increased from 2.86 hectares (Before 1980) to 92.89 hectares (2015). The percentile change is seen the highest (+1297) in the vegetable cropping area during the

35 years. However, the changing rate varies according to the altitude, and the study centers both.

The situation reflects that the central focus of the farmers has concentrated on the vegetables rather than the traditional cereal crops. The interest seems more in the upper and lower altitude belts in comparison with the middle altitude belt.

- **Maize Farming**

Now, maize is second principle staple crop in the study area. However, it was as the first major staple crop in the past. The area of maize cultivation has gradually been declining with the increasing interest towards the vegetable farming (Wagle 2019).

Table: 5 Change in Area of Maize Farming before 1980 -2015 (Area in Hectare)

Altitude Belts	**Before 1980**		**2015**		**Total (Bari)**	**Percentile Change (In hectares)**	
	A	NA	A	NA		A	NA
Upper Altitude Belt	46.30	0	3.39	43.04	46.43	-7	+7
Middle Altitude Belt	62.78	0	33.01	29.77	62.78	-53	+130
Lower Altitude Belt	22.18	0	10.33	12.05	22.18	-46	+112
Total	**131.39**	**0**	**46.73**	**84.66**	**131.39**	**-36**	**8566**

Source: Field survey, 2016.

Note: - A- Adopters of Innovations NA- non-adopters of Innovations.

Now, maize farming is practiced in the limited area by the limited farmers as a subsistence crop for food and fodder. Apart from this, it is grown as a kitchen garden farming in the upper and lower altitudes and as subsistence farming in the middle altitude. The table 5 indicates that the maize farming area was 131.39 hectares before 1980. Now it is compacted only in 46.73 hectares during the period of 1980 to 2015. The significant change is occurred in the maize cultivating area. In addition, the changing rate significantly differs from one altitude belts to another. Agricultural technicians of local agricultural extension center have reported that mainly, this area contains only summer maize in *'Bari'* during the period of the rainy season

- **Paddy Farming**

The history of paddy farming seems so long in the study area because of its cultural value. It is compulsory for every cultural ceremony, so the farmers put it in top priority wherever it is possible (Wagle 2019). However, the farmers are still following the traditional method for paddy cultivation. Moreover, farmers have been using only

chemical fertilizer for this crop from the beginning as an innovation. Now, it has existed only in the small patches of the middle and lower altitudes (Table 6).

Table: 6 Change in Area of Paddy Farming before 1980 -2015 (Area in Hectares)

Altitude Belts	1980		2015		Total (Khet)	Percentile Change (In hectares)	
	A	NA	A	NA		A	NA
Upper Altitude Belt	0	0	0	0	0	0	0
Middle Altitude Belt	7.99	0	7.99	0	7.99	0	0
Lower Altitude Belt	0.70	0	0.70	0	0.70	0	0
Total	**8.69**	**0**	**8.69**	**0**	**8.69**	**0**	**0**

Source: Field survey, 2016.

Note: - A- Adopters of Innovations NA- non-adopters of Innovations.

Table 6 indicates that the area of paddy cultivation has remained same from the beginning to now. The local people remark that due to the lack of irrigation, irregular rainfall, and sloppy area paddy cultivation is limited only in a certain area. Besides, it needs more inputs and gives lower output in comparison with other crops. So farmers have been cultivating only in an 8.69 hectares' area from the beginning.

The entire analysis indicates that the study area's cropping pattern is gradually changed and moving towards vegetable and high valued improved crops. A remarkable change has occurred in both land use and cropping pattern from the last 35 years.

Based on the comprehensive analysis of the study, the significant findings related to the core objectives are:

- The trend of new technologies diffusion is found slow in the beginning, rapid in the middle, and declining. Only 4.21 percent (7 households) farmers were adopters of innovations at the beginning period of before 1980. 50 percent (65 households) were added from 1991 to 2000 and reached 92 households as total adopters. Now 78.30 percent (130 households) farmers have used new technologies for their agricultural works.
- The farmers have forwarded their steps towards high value commercial farming.

Similarly, the role of governmental and non-governmental organizatios seems most useful for new technologies diffusion process. The contribution of Agriculture Research Station Pakharibas (ARSP) and the District Agriculture Development Office (DADO, Dhankuta) seems a pioneer among the involving organizations.

- The cropping pattern of the study area is gradually changed and moving towards off-season vegetable farming. The remarkable change occurs in both land use and cropping pattern of the study area from 1980 to 2016. Similarly, the acceptance of new technologies depends on nature of crops rather than altitude and distance factor.

Conclusion

The use and diffuse of new technologies is complex and dynamic process. The focus of study seems to observe the role of various institutions for increasing popularty of new agricultural technologies in the eastern hills of Nepal. Also, it has helped to understand the diffusion trend of such technologies and their impact on the cropping pattern in the case of the southern slope of eastern hills. The south slope of eastern hilly socio-economic environment is changing rapidly through the dynamics of adaptive techniques. Change also occurred in attitudes and activities of people after overcoming traditional thinking due to the increasing awareness. Therefore, one of the striking conclusions of the study regarding with the innovations diffusion is the fact that Koshi highway networks link to major urban centers of Eastern Tarai as well as Indian markets have accelerated to the growth of offseason vegetables. In this change, the farmers have pressured to adopt new technologies in the study area.

Besides, the role of research centers and non-governmental organizations seem significant in diffusing new technologies, respectively. However, the contribution of the above agencies in this sector is in a limited area, but it is true that their contribution is indeed remarkable and respected. The use of modern agricultural innovations can give good results at the beginnings, but its effect cannot be useful and well soon. The leading causes of the not successful outcome of modern agricultural innovations are the unscientific use of technology due to the lack of knowledge and poverty. Due to these reasons, decreasing soil fertility and the diseases in the crops are increasing day by day. As a result, the durability and acceptance of the new technology can be questionable. If we use the technology properly, it is contextual and familiar. An effective monitoring system should be developed from both government and public sectors to adopt innovations environmental and crop production - friendly.

References

Agrawal, R.C; Ammann, H.; Kaikobad, S.M; Nau, E & Nolle, U (1978). *A study of fertilizer use in the Gandaki Zone of Nepal.* Berlin: German Agency for Technical Cooperation. (GTZ).

Choe, K, & Pradhan, P. (1988). Political organization and changing role of leadership: a case study of the Athapaharia Rai community. *In contributions to Nepalese studies.* Volume8 Kathmandu: CENAS, Tribhuvan University (pp. 95-106).

Cliff, A. D; Haggett, P; Ord, J. K; &Versey, G.R. (1981). *A spatial diffusion, historical geography of epidemics in an island community.* United Kingdom: Combridge University Press.

DDC, Dhankuta (2016). *District profile,* 2016 *Dhankuta:* District Development Committee.

Hagerstrand, T. (1953). *Innovation diffusion as a spatial process. Chicago:* University of Chicago Press.

HMG, Nepal/MOE (1974*). Mechi dekhi* M*ahakali.Part-1.* Kathmandu: His Majesty's Government Press.

KHARDEP (1982). *Koshi-hill area rural development project (KHARDEP), Planning Document, KHARDEP.*

Khatiwada, S.P. (2014*). Spatial patterns of agro-based livelihoods of the communities in the Tankhuwa Kohla watershed, Eastern hills of Nepal.* (Unpublished Ph.D. dissertation). Kathmandu: Tribhuvan University, Nepal.

Mathema, S. (1986). *Adoption and effects of technologies generated by the cropping system program in Nepal.* (Unpublished Ph.D. dissertation). Manila: University of Philippines.

NPC (2016). *Fourteenth plan (FY 2073/74-2075/76).* Kathmandu: National Planning Commission, Nepal.

Oli, K. (2002). *An assessment of Tinjure, Milkey, and Jaljale (TMJ) area of eastern Nepal.* Kathmandu: International Union for Conservation of Nature (IUCN), Nepal.

Pathak, R. S. (2010). *Diffusion and adoption of modern agricultural innovations: A case study of some selected villages of Dhading district of Nepal.* (Unpublished Ph.D. dissertation). Kathmandu: Tribhuvan University, Nepal.

Pradhan, P. (2004). *Rural-urban relation with particular references of Nepal.* Kathmandu: Rural-Urban Partnership Programs MLD/ UND, Nepal.

Upadhya, M.P.(1984). *An evolution of the Koshi-hill area rural development project (KHARDEP).* CEDA, Tribhuvan University.

Virgo, K. J., and Subba, K. J. (1994). Land use change between 1978 and 1990 in Dhankuta district, Koshi hills, eastern Nepal. *Mountain research and development.* Volume 14 (pp. 159-170).

Wagle, S. P. (2019) *Adoption and diffusion of agricultural innovations in Tinjure-Milke mountain range area in the eastern hills of Nepal.* (Unpublished Ph.D. dissertation). Kathmandu: Tribhuvan University, Nepal.

Ya. T. and Tulachan, P.M. (2003). *Mountain agriculture in the Hindu Kush Himalayan region.* Kathmandu: International Centre for Integrated Mountain Development (ICIMOD).