The Use of Chemical Fertilizer Technology in Eastern Hills of Nepal: Knowledge, Attitude and Practice (KAP)

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Abstract

The use of new technologies issue in agricultural sector is the global concern of the current days. This paper attempts to assess about the kanowldge, attititude and practice of farmers related to the use of chemical fertilizers in their agricultural works in the case of eastern hills of Nepal. The study applied househod questionnaire survey, key informant survey, focus group discussion and field observation to collect relevant information. The study conducted in 30 percent (180hss) in total (601hhs) of 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 three and half months. Secondary data were gathered from previous research journals, dissertations and official records.

This paper has showed that chemical fertilizer technology is well known technology for the protection and promotion of fruits, crops and vegetable in the study area. Around 79 percent (142hhs) farmers have used this as an useful and profitable technique. Despite various problems, the practice of this technology is gradually increasing in this area and the maximum practice is concentrated with vegetable farming. Although it was introduced through the inspiration of local research centers at first time, the role of neighbours, friends/ relatives and television programs seems to be significant respectively in its development and expansion in the study area. This technology is the choice of the farmers and also they have positive attitude towards it but the amount of adoption is declined through the negative impact of unscientific practice in the actual field.

Keywords: Chemical fertilizers, nitrogen, phosphorous, potassium (NPK) and adoption.

1. Introduction

Fertilizers are organic or inorganic substances containing chemical elements that improve the growth of plants and the fertility of the soil. The percentage content of nutrients in organic fertilizers (manure's) is relatively low. In inorganic or mineral fertilizers, the nutrients are inorganic salts, obtained by physical and chemical processes. The three primary plant nutrients are nitrogen, phosphorus and potassium (UNO, 1997). A chemical fertilizer is a substance applied to soils or directly onto plants to provide nutrients optimal for their growth and development. The essential nutrients contained in these fertilizers are nitrogen, phosphorous, and potassium (NPK), as well as other nutritional substances in smaller amounts all presented in a form that can easily be absorbed and metabolized by plants (Topper, 2011). Agriculture Perspective Plan (1995-2015) has identified chemical fertilizer as an engine of agricultural growth. Fertilizer is expected to

contribute 64 to 75% of the total envisaged agriculture growth target of APP. APP has targeted an increase in fertilizer use from 31 kg nutrient/ ha of the base year 1995 to 131 kg nutrient/ ha by 2017 (Shrestha, 2010). Supply of essential chemical fertilizer in Nepal is far below the total demand at present. Farmers are not getting chemical fertilizers in time and have to pay higher price to them. Past studied clearly indicated that the fertilizer supplied by the informal sources are of poor quality (Panta, 2018). In this context Shrestha (2018) has remarked:

> According to Ram Ashih Yada, chief of the planning division at the laboratory most of the farmers generally use fertilizers, like diammonium phosphate (DAP) and potash, before planting paddy. They then use urea when rice seedlings start growing. Farmers generally do not hold consultation with experts before making use of fertilizers. They simply purchase fertilizers from stores and use them as per the recommendation of shop attendants. This practice has been affecting soil quality and hitting agricultural productivity. The acidity in soil reduces agricultural productivity, so farmers are not being able to harvest as much produce as they could have. (February, 22, The Kathmandu Post, p. 2)

Chemical fertilizer has been widely practiced to supply additional nutrients which are deficiency in compost manure. Nitrogen, Phosphorus and Potash (NPK) are major components of chemical fertilizer which are used to fulfill the additional needs of nutrients in their crops. It was introduced in the eastern Nepal before 1980 through the inspiration of the then Pakhariwas Agriculture Centre (PAC). Although farmers have basic knowledge in this regard, it is not being practiced properly due to various socio-economic reasons i.e. lack of technical knowledge, excess price, not available on time etc. (Wagle, 2019 pp. 83- 86). Contemplating this situation, this paper attempts to describe the current situation of knowledge, attitude and practice of this technology among the farmers of eastern hills based on previous studies.

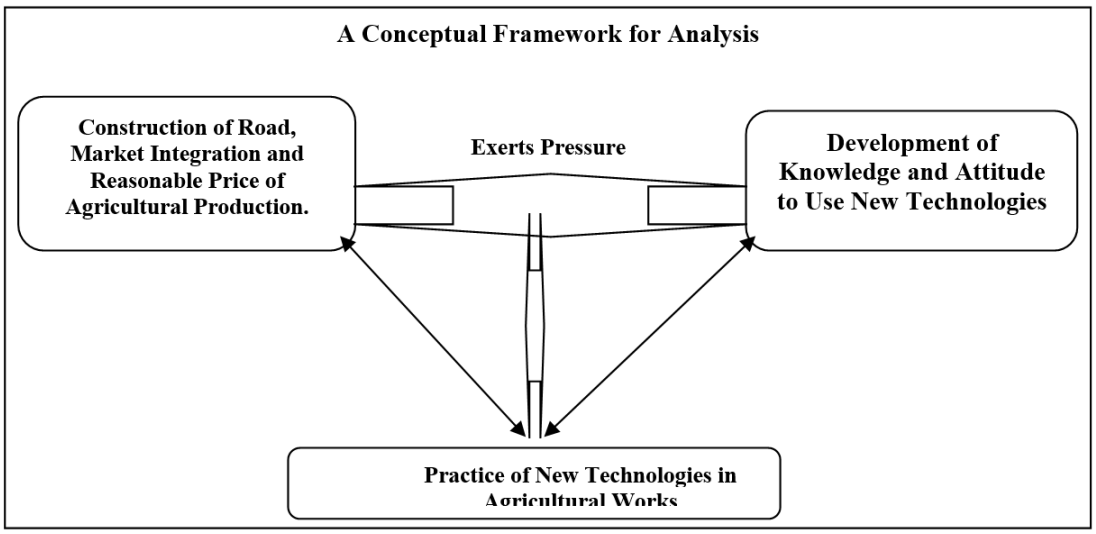
2. Methods and Material

This study is basically based on primary data collected from the field survey from January 1st to last in 2020. Experience field surveyors including myself were involved in this work. Three focus group discussions (FGD) and the same number of key informant interviews (KII) were carried out at least one from each ecological belt out of three belts by representing various sectors of farmers i.e. age sex, ethnicity, education and occupation focused on knowledge, attitude and practice of the farmers related to this techonolgy. There were five to eight farmers in each focus group discussion and long and open interviews were taken for key informant interviews. An interview guideline was prepared for the purpose of key informants' interviews. Moreover, an observation sheet was also used during the field survey observation so all tangible phenomena could be recorded by the researcher.

The study area was determined around the three-kilometer buffer of the Koshi Highway of Dhankuta district based on **centeral place theory of Walter** Christellar where the agriculture sector has undergone extensive change after the decade of 1980. It was divided into three ecological belts on the basis of agro-climatic classification of the then District Agriculture Development Office Dhankuta, 2016 namely upper altitude (<.2000masl), middle altitude

(1001-2000masl) and lower altitude (>1000masl) belts. Household survey was conducted using pre-structured questionnnare sheet. In addition, three study centers were selected as samples form each ecological belt randomly and nearly 30 percent (180hhs) were selected from the total 601 buffer farm households having more than 0.50 hectare both *Khet* and *Bari* land by using stratified random sampling method. More than 78 percent (142hhs) of these farmers are using chemical fertilizers as an additional nutrient for their crops now. Required secondary data were collected through various books, journals, dissertations and official records. Simple stistical tool percentage is used for the analysis of collected data. A descriptive paper is prepared through the help both quantitave and qualitative analysis of the relevant data. The whole study of this paper is based on the *State- impact process* derived from Pradhan &Pradhan (2006).

Figure 2.1



Source: Field survey, 2020

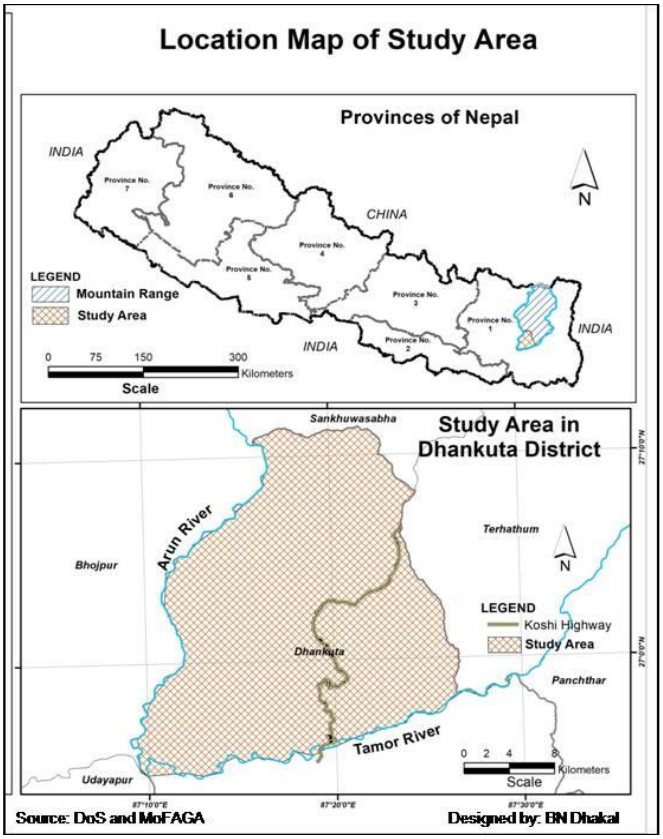
Study Area

Eastern hilly region is expanded in middle part of Mahabharata and northern marginal Himalayan range in Province Number One of Nepal. This region is parted by several rivers and rivulets of Koshi drainage pattern which flow north to south. In this region, there are so many mountain ranges extended towards north to south. Among them, Tinjure-Milke Mountain Range area is situated extending with four districts of the eastern hills namely Dhankuta, Terrhathum, Sankhuwasabha and Taplejung. The area falls under the lesser Himalayas and altitude ranges from 300 to 5000masl. It is one of the longest mountain ridges and lies between the watersheds of Arun and Tamor Rivers. The range has expanded towards Dhankuta, Mulghat from Lumbasumbha and Jaljale Himal. Almost geographical part up to the elevation 2400 masl can be noticed human residential area and more than this elevation almost lands are used as pasture land. It lies within $26^0$53' to $27^0$19' north latitude and 87^0 08' to $27^0$38'east longitude. The farming population of eastern hills of Nepal is still living in subsistence agricultural system. However, this area is full of specific characteristics in various

ways, such as geographical, ecological, historical, socio-cultural and economic perspectives in comparision with other parts of Nepal (HMG/MoE, 1974 pp.1-14; Oli (2002 p. 3).

Figure 2.2

Location Map of the Study Area



It is a region of great natural and social diversity, resulting from the tremendous geographical and climatic extremes. In this area, altitudes (300-2250masl) and climates are ranging from sub-tropical to alpine and long periods of winter dryness altering with torrential downpours during the monsoon that is a challenging issue for human survival. It is mainly due to poor resource base, especially, cultivated land; the extreme terrain and climate mean that communications are often poor and infrastructure minimal. The majority 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 independent of contact with the adjacent regions. Indeed, such conditions are found in the Hindu-Kush Himalayan Region (Ya & Tulachan, 2003). Currently, the agricultural system of this region is gradually changing due to the use of new technologies through the inspiration of different governmental and non-goverental. Among these organizations, Koshi Hill Area Rural Development Project (KHARDEP) is one of the Integrated Rural Development Program (IRDP) approach launched in the eastern hills of Nepal. Koshi Highway was constructed through the initiation of the KHARDEP. It has been able to transfer technology through various hybrid seeds, technical knowledge for the protection and promotion of crops, farmer training, exposure visits and field demonstration etc. Apart from this, the contribution of the then District Agriculture Development Office (DADO, Dhankuta) and other non-novernmental organizations also seem very important to diffuse new technologies in this area.

With all these efforts, the Koshi Highway seems to have brought major changes in the agricultural development of this area since the mid 1980s (Wagle, 2019). The emphasis of new technologies in this area seems especially for off-season vegetables. But, the amount of use of agricultural inputs is decreasing with the increasing distance from the road (Khatiwada, 2014). This situation is relevant to not only in the eastern hills, but also equal to other regions of Nepal and in many other parts of developing countries (Wagle, 2019). Koshi highway provides access to the supply of new technologies i.e. chemical fertilizer, improved seeds and plant protection measures at a significant rate. Indeed, it was comparatively low in the past in Nepal (Pathak 2010).

3. Discussion and Results

3.1 Sources of Knowledge

The sources of knowledge play an important role in the development and expansion of new technologies in any geographical or political area of the country. This process mainly depends on the ability and reliability of these sources. If such resources are viable and reliable, farmers will follow them with out doubt which makes the expansion and development of these technologies easy and fast (Wagle, 2019). Among the various sources knowledge, the following sources have played an important role in the adoption and diffusion of chemical fertilizers in eastern hills of Nepal (Table 3.1).

Table 3.1

Sources of Knowledge to Use Chemical Fertilizers (in hhs)

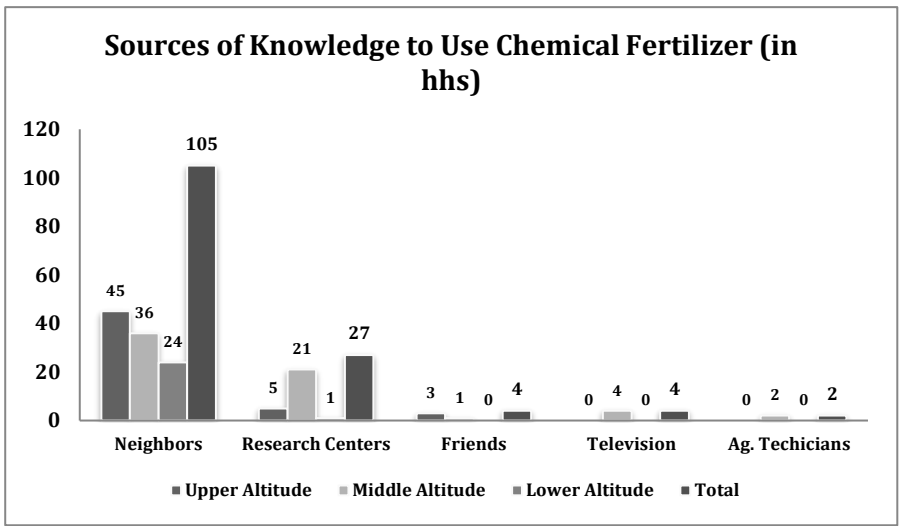
Eco. Belts	Sources of Knowledge						
	Number	**Neighbors**	**Reasearch Centers**	**Friends**	**Television**	**Ag. Tec.**	**Total**
Upper	Number	45	5	3	0	0	**53**
	Percent	31.69	3.52	2.11	0	0	**37.32**
Middle	Number	36	21	1	4	2	**64**
	Percent	25.35	14.79	0.70	2.82	1.41	**45.07**
Lower	Number	24	1	0	0	0	**25**
	Percent	16.90	0.70	0	0	0	17.60
Total	**Number**	**105**	**27**	**4**	**4**	**2**	**142**
	Percent	**73.94**	**19.01**	**2.82**	**2.82**	**1.41**	**100**

Source: Field Survey, 2020**.**

The analysis of Table 3.1 shows the significant role of the neighbors, research center, friends/relatives, television programs and agricultural technicians in increasing the use of chemical fertilizers in the study area. The figures of the table indicate that around 74 percent (105hhs) adopter farmers are using this technology through the communication of their neighbors. Similarly, more than 19 percent (27hhs) such farmers are inspired to the use of this

technology through the inspiration of local research centers. Likewise, the role of peer groups and television programs also seems to be remarkable to expand it in this area. According to data obtained from the table, almost, 3 percent (4hhs) farmers are motivated through the contact with their friends and equal percent of the farmers are using it through the inspiration of television programs broadcast on Krishi Television. Moreover, only a little over 1 percent (2hhs) of adopter farmers are oriented to use this technology with the helip of local agricultural technicians. Pathak (2010) have also found the same role of neighbors in a smilar study of Dhading district.

Figure 3.1



Source: Field Survey, 2020.

The local elite farmer Meghendra Gurung remarks that the research centers reached with key farmers at first to communicate about this technolgy. Only then, it was diffused in the study area with the help of other means of communication. Another noteworthy fact is that although all farmers are familiar with this technology, they do not have adequate knowledge regarding their balanced use. The number of farmers using urea, phosphorus and potash in balanced proportion is very low. Due to this, the fertility of soil is decreasing day by day and the outbreak of various dieseas is also increasing. Figure of the field survey shows that only a little over 28 percent (40hhs) of the adoper farmers use this technology in a proper way.

3.2 The Practice of Chemical Fertilizer

Farmers have been using chemical fertilizers as an additional source of nutrients in eastern hills of Nepal since 1978 to till now. It has been widely practiced to supply additional nutrients which are deficient in organic manure. Nitrogen, Phosphorus and Potash (NPK) are major varieties of this technology (Wagle, 2019). Moreover, one of the agricultural scientists of Agriculture Research Station Pakharibas has reported that the quantity of using such nutrients depends on the nature and variety of crops. NPK are commonly used in the ratio of 120:60:40 per hectare in food crops production. However, its practice in cash crops production is found to be comparatively more than cereal crops production. In this study, an attempt has been made to analyse the practice of this technology in the context of the eastern hilly areas of Nepal (Table 3.2).

Table 3.2

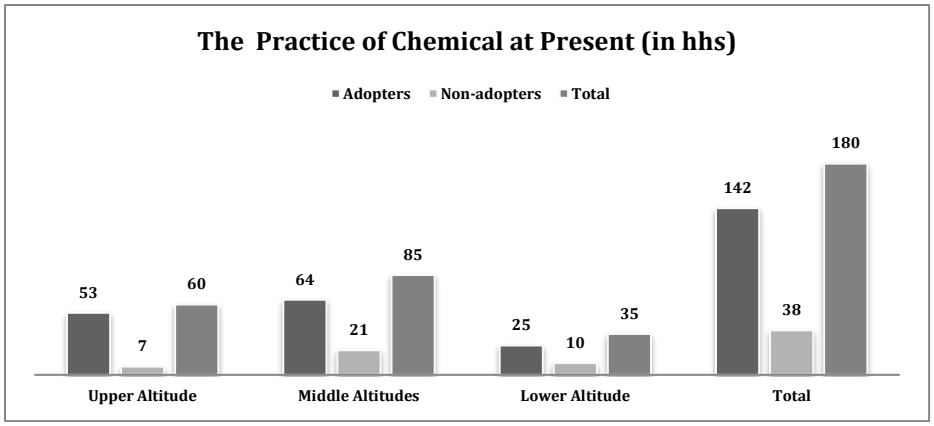
The Practice of Chemical Fertilizers (In hhs)

	Ecological Belts							
	Upper Altitude		Middle Altitude		Lower Altitude		Total	
Years	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**
<= 1980	1	0.70	7	4.93	0	0	**8**	**5.63**
1981 - 1990	0	0	16	11.27	1	0.70	**17**	**11.97**
1991 - 2000	38	26.76	27	19.01	10	7.04	**75**	**52.81**
2001 - 2010	14	9.86	10	7.04	10	7.04	**34**	**23.94**
2011 -2020	0	0	4	2.82	4	2.82	**8**	**5.64**
Total	**53**	**37.32**	**64**	**45.07**	**25**	**17.61**	**142**	**100**

Source: Field Survey, 2020.

According to the data from Table 3.2, only about 6 percent (8hhs) of the adopter farmers used this technology before 1980. Since then, its practice has been steadily increasing until 2000 and seems to have reached in maximum point from 1991 to 2000. More than 52 percent (75hhs) users were added during this period. Moreover, the data also shows that the user growth rate is steadily declining after 2000. From the geographical point of view, most of the farmers are living in the middle altitude belts among the adopters. More than 45 percent (64hhs) users are currently living in this belt. Then, about 37 percent (53hhs) user farmers live in the middle altitude area and only around 18 percent (25hhs) adjust in the lower altitude belt. In this way, nearly 79 percent (142hhs) of the total farmers (180hhs) are using this technology in their agricultural works of this area in current situation (Figure 3.2).

Figure 3.2



Source: Field Survey, 2020.

In addition, this study also examines the use of chemical fertilizers based on the distance from the headway links (Table 3.3).

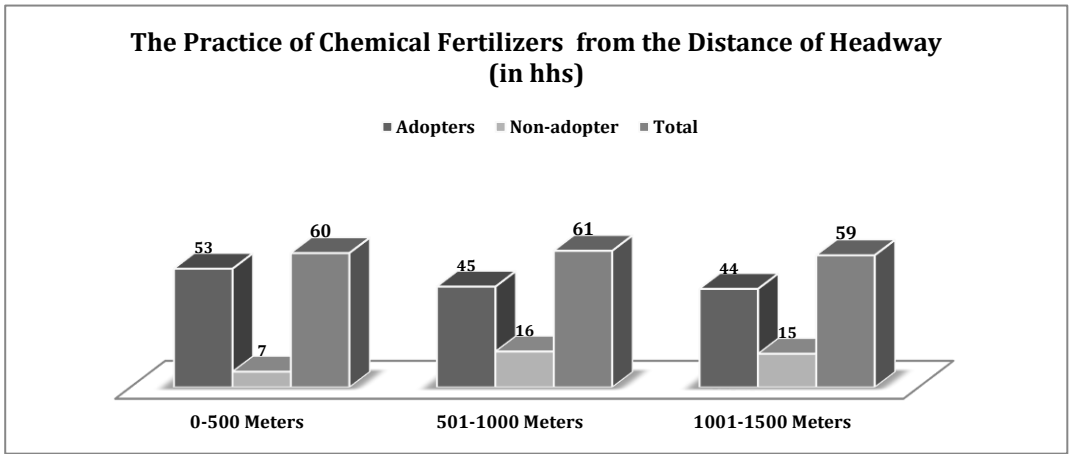
Table 3.3
The Practice of Chemical Fertilizer from the Distance of Headway (In hhs)

Distance (in Meters)	Adopters		Non-adopters		Total
0 -500	53	88.33	7	11.67	**60**
501 - 1000	45	73.77	16	26.23	**61**
1001 - 1500	44	74.58	15	25.42	**59**
Total	**142**	**78.89**	**38**	**21.11**	**180**

Source: Field Survey, 2020.

According to the data obtained from the table 3.2, the use of chemical fertilizers seems to be gradually decreasing as the distance increases from the main road. The figure dipcits that more than 88 percent (53hhs) farmers living within 500 meters distance of the main road are using this technology in current days. Similarly, nearly 74 percent (50hhs) farmers living within the distance of 501 to1000 meters around the main road have been cultivating through the use of chemical fertilizers in present situation. Moreover, almost 75 percent (44hhs) farmers living more than 100 meters away from the main road are using this technology as a source of additional food supply to their crops now. But there is not much difference in the number of the user farmers.

Figure 3.3



Source: Field Survey, 2020.

According to local intellectual Mrs. Anupa Bhandari, the main reason for this is the problem of transportation during the rainy season. The similar studies of Khatiwada (2014) in the case of eastern hills and Pathak (2010) in the study of Dhading district also support this result. Pathak has found that the farmers residing along the metalled roads are quicker adopters of new technologies in comparison with the farmers living away from the main roads. However, the result of a study conducted by Wagle (2019) under the same heading in the case of eastern

hills does not match with this conclusion. He has found the fact that the adoption of chemical fertilizers is increasing as the distance increasing from the main road.

The Practice of Chemical Fertilizers in Various Crops

Mixed farming is prevalent in in the hilly areas of eastern Nepal. Mailnly, cereals and cash crops are cultivated in a mixed manner. Considering the profit and the nature of crops, farmers have been cultivating more than one crop in the same season. The use of chemical fertilizers depends on the nature of crops and the variation is significant. The usage rate is usually higher in cash crops than in cereal crops (Wagle 2019). The data related to this topic obtained from the field survey is shown in the Table (Table 3.4).

Table 3.4

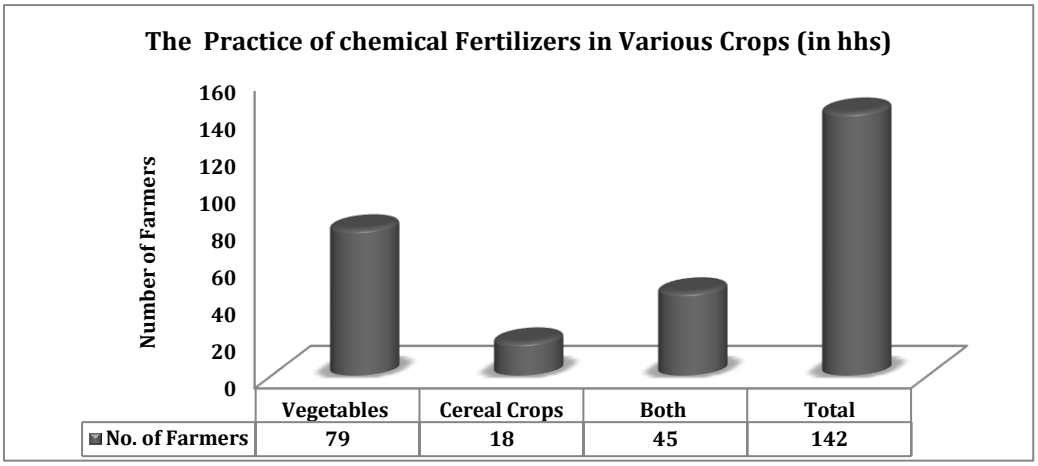
The Practice of Chemical Fertilizers in Various Crops (in hhs)

		Use of Chemical Fertilizers			
Ecological Belts		**Cash Crops**	**Cereal Crops**	**Both**	**Total**
	Number	40	0	13	**53**
Upper	Percent	75.47	0	24.53	**100**
	Number	24	15	25	**64**
Middle	Percent	37.50	23.44	39.06	**100**
	Number	15	3	7	**25**
Lower	Percent	60	12	28	**100**
Total	**Number**	**79**	**18**	**45**	**142**
	Percent	**55.63**	**12.68**	**31.69**	**100**

Source: Field Survey, 2020.

According to the data from Table 3.4, more than 55 percent (79hhs) of the adopter farmers of the study area have use chemical fertilizers only in vegetable production. Among them, more than 75 percent (40hhs) of the upper altitude, around 38 percent (24hhs) of the middle altitude and exactly 60 percent (15hhs) lower altitude farmers seem to have used this technology only in vegetable farming. Similarly, about 32 percent (45hhs) adopter farmers have used this technology in both vegetable and cereal crop framing. Around 25 percent (13hhs) of the upper altitude, more than 39 percent (25hhs) of the middle altitude and exactly 28 percent (7hhs) farmers of the lower altitude have used this technology to produce both crops. Moreover, around 13 percent (18hhs) farmers have been using it only the purpose of cereal crops production. More than 23 percent (15hhs) of the middle altitude and accurate 12 percent (3hhs) farmers of the lower altitude have used this technology only in cereal crops but non of the farmers of the upper altitude have used this only in cereal crops production.

Figure 3.4



Source: Field survey, 2020.

Moreover, according to the field survey data (2020), the use of chemical fertilizers for vegetable cultivation was 170 kg per hectare in 2010/11. However, this amount has come down to 141 kg per hectare in 2019/20. Apart from this, the amount used in cereal crops has not changed much. For this purpose, 40 kg per hectare chemical fertilizer was used in 2010/11 whereas only 30 kg is used in 2019/20.

The Major Causes for the Practice of Chemical Fertilizers

It is important to understand farmers' perceptions to identify the causes behind the use of new technologies in their agricultural works (Wagle, 2019). Some of themajor causes are identified and shown in the table (Table, Most of the farmers have reported that they have used chemical for the purpose of increase in production through upgrading nutritional efficiency of soil (Table 3.5).

Table 3.5

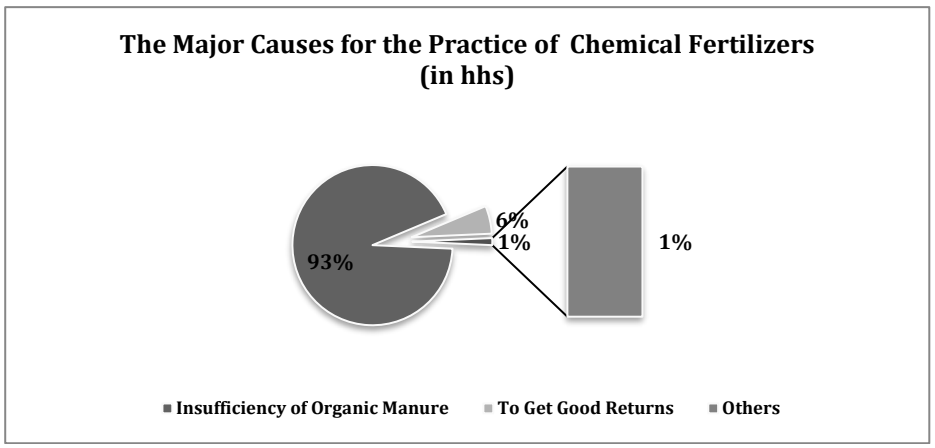
The Major Causes for the Practice of Chemical Fertilizers (in hhs)

Major Causes		**Ecological Belts**			
		Upper	**Middle**	**Lower**	**Total**
In sufficiency of organic manure	Number	4	4	0	**8**
	Percent	2.82	2.82	0	**5.64**
To get good returns	Number	49	59	24	**132**
	Percent	34.51	41.55	16.90	**92.96**
Others	Number	0	1	1	**2**
	Percent	0	0.70	0.70	**1.41**
Total	**Number**	**53**	**64**	**25**	**142**
	Percent	**37.32**	**45.07**	**17.61**	**100**

Source: Field Survey, 2020.

The majority of farmers seem to have used chemical fertilizers for maximum profit in a short period of time. According to the data obtained from the field survey, this is the main opinion of more than 92 percent (132hhs) farmers of the study area. Similarly, the inadequate supply of organic manure at appropriate times seems to be the second major factor to increae the use of chemical fertilizers in this area. More than 5 percent (8hhs) farmers have highlighted this problem as a major problem of the eastern hills. Similar studies made by Pathak (2010) and Wagle (2019) also support this result. They have found same results in the case of Dhading district and eastern hills of Nepal.

Figure 3.4



The Major Problems in the Practice of Chemical Fertilizers

It is common for various peoblems to arise when new technologies are used in agricultural sector. The hilly region of eastern Nepal is also not immune from these problems (Wagle, 2019). The current study is also focused on finding such problems. The major problems identified during the field survey are listed in the table (Table 3.6).

Table 3.6

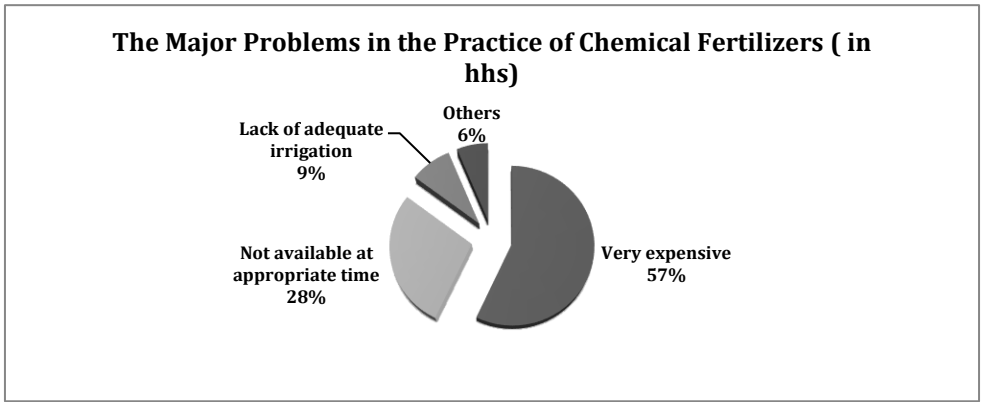
The Major Problems in the Practice of Chemical Fertilizers (in hhs)

Major Problems	**Ecological Belts**				**Total**
		Upper	**Middle**	**Lower**	
Very expensive	Number	38	23	20	**81**
	Percent	26.76	16.20	14.08	**57.04**
Not available at appropriate time	Number	2	33	5	**40**
	Percent	1.41	23.24	3.52	**28.17**
Lack of adequate irrigation	Number	6	6	0	**12**
	Percent	4.23	4.23	0	**8.45**
Others	Number	4	3	2	**9**
	Percent	2.82	2.11	1.41	6.34
Total	**Number**	**53**	**64**	**25**	**142**
	Percent	**37.32**	**45.07**	**17.61**	**100**

Source: Field Survey, 2020.

The figure of the table indicates that the high price of chemical fertilizers is an unbearable problem among the identified problems. More than 57 percent (81hhs) farmers have put this problem in a high priority. Similarly, not being available on time seems to be the second major problem of this area. In the eyes of more than 28 percent (40hhs) farmers, this problem is the main one. In this way, the lack of irrigation facility is identified as the third major problem of the study area. Nearly 9 percent (12hhs) farmers have given top priority to this problem.in addition to these major problems, some other minor problems also exist in this area but farmers do not seem to pay much attention to such problems. This result is supported by a recent study of Wagle (2019) in the case of eastern hills but tne similar study of Pathak (2010) in Dhading district does not support this conclusion. He has found the untimely availability of chemical fertilizers is the major problem of this district.

Figure 3.5



The Perception of Farmers towards the Practice of Chemical Fertilizers

Farmers in this area have a long experience of using chemical fertilizers. They are familiar with both the positive and negative effects of its use. In the view of local elite farmers, there should be a balanced use of both chemical and organic fertilizers to achieve long term returns. But due to the immature use of this technology by the farmers, various problems have come into exixtence at present (Wagle, 2019). The major views expressed by the farmers towards this technology in the household survey of 2020 are presented in the table (Table 3.7).

The perceptions of the farmers about this technology are based on their experiences and practices. According to the available data in the table, more than 49 percent (70hhs) farmers are in favor of gradually reducing its use and increasing the use of organic manure in its place. Similarly, the perception of about 35 percent (50hhs) farmers is to give regularity of current usage rate. But, more than 15 percent (22hhs) farmers are of the opinion that its use should be completely replaced by organic manure. In this way, the attitude of the majority farmers towards this technology is positive but they argue that it should be used in a balanced way through the technical and financial support of the government. Thus, around 35 percent (50hhs) farmers think that this technology is very good and appropriate for their agricultural works. In this way, more than 49 percent (70hhs) farmers are positive and about 15 percent (22hhs) are negative toward the use this innovative technique.

Table 3.7
The Attitude of Farmers on Chemical Fertilizers (in hhs)

		The Attitude of Farmers			Total
Ecological Belts		**Constant**	**Decreasing**	**Making Use Zero**	
Upper	Number	27	20	6	**53**
	Percent	19.01	14.09	4.22	**37.32**
Middle	Number	19	32	13	**64**
	Percent	13.38	22.54	9.15	**45.07**
Lower	Number	4	18	3	**25**
	Percent	2.82	12.68	2.11	**17.61**
Total	**Number**	**50**	**70**	**22**	**142**
	Percent	**35.21**	**49.30**	**15.49**	**100**

Source: Field Survey, 2020.

Conclusion

Chemical fertilizer is a new technology that is preferred and used by the majority of the farmers in eastern hills of Nepal. It is an important technology for the protection and promotion of both cash and cereal crops. More than 78 percent (142hhs) farmers of the eastern hills have used this as a new technology. Although most of the farmers are in favor of balanced use of this technology, it does not seem to be possible due to lack of technical knowledge. Moreover, unavailability at appropriate time in the market, weak irrigation system and the high market price are existed as the major problems of the farmers to use this technology at present. Some farmers are gradually displacing this technology by increasing the use of organic manure but the demand of organic manure by the farmers has not been fulfilled and the organic manure is being used as an alternative so, the use of inorganic manure cannot be reduced to zero immediately.

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