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# Factors affecting adoption of sustainable soil management practices among vegetable producers in Dhading, Nepal

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**A research was conducted using primary data for the year 2012 obtained from randomly selected 120 vegetable farmers using pre-tested semi-structured interview schedule. Nalang and Salang VDCs of Dhading district in Nepal were purposively selected for the study. Different variables were fed to probit regression model to identify and quantify the major factors affecting the adoption of sustainable soil management technology. Overall, the model predicted 85.76%of the sample correctly. The findings of the study revealed that number of economically active family members, household head education, livestock holding, membership in farmer's group and credit availability affects positively whereas, age of household head affects negatively in the adoption of sustainable soil management technology. A unit increased in economically active family members, years of education and livestock standard unit would increase the probability of adoption of technology by 21.3, 5.8 and 7.6% respectively. Likewise, if farmers were made member in the groups and credit made available, the probability of adoption of technology would increase by 46.2 and 46.3% respectively. But a unit increased in the age of household head would decrease the level of adoption by 1.4% indicating old aged farmers do not adopt innovative technologies in agriculture.**

**Key words:** Nepal, adoption, probit, sustainable soil management, vegetable.

## INTRODUCTION

Dhading district of Nepal is one of the highly vegetable producing districts of Nepal which produces 74797 metric tons under total area of 6051 ha with the yield of 12361 kg/ha in year 2011/2012 (MoAD, 2012). Among commercial vegetable growers in Dhading district extremely hazardous pesticides are being used in vegetables which were banned for normal agriculture use by Government of Nepal (Shrestha et al., 2010). With the initiation of commercial vegetable cultivation, there is increasing trend of chemicals use. Excessive application of chemical fertilizers and pesticides is causing the partial desertification in many pocket areas of agriculture. Also, huge amount of money is being spent for the import of chemical fertilizers and pesticides every year.

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Total sale of chemical fertilizers in Nepal is 144813.48 mt. in 2011/2012 composed of 97956.51 mt. of urea, 43146.06 mt.of DAP and 3710.91 mt. of Potash (MoAD, 2012). The small farmers cannot afford these chemical fertilizers because the soil needs more and more of these chemical (Subedi et al., 2001).

On the other hand, excessive use of chemicals in agriculture is reducing soil fertility. Almost 98% of the soil in Nepal is deficient in organic matter (Tripathi, 2002). Poor soil fertility status of the farmland in the middle Hills of Nepal is a major constraint faced by the farmers (Pandey, 1995). Thus, the concern of feeding a fertile population from infertile soil in fragile and marginal agricultural land in mid-hills of Nepal is really a dilemma. To cope with the situation of pesticide hazards and environment deterioration, sustainable soil management practices are providing a suitable alternative which was brought in practice in commercial vegetable production under SSMP program. Sustainable soil management (SSM) practices are compatible with the capabilities of rural communities and smallholder farmers who generally lack capital to buy synthetic pesticides and inorganic fertilizers. In some situations SSM based growers may be less vulnerable to natural and economic risks than conventional farmers since their systems are usually more diversified (Olson et al., 1982). Also, addition to this Nowadays, various areas in the world have faced water logging and salinity problems, which are intensified by a myriad of factors including use of wastewaters for irrigation, unsuitable cropping pattern, torrential rains and floods, lack of sufficient drainage, uncontrolled drainage, lack of adequate knowledge, wrong management decisions, very poor construction and rehabilitation rates of drainage systems, increase of irrigation systems without paying any attention to their adverse impacts on soil and quality of water resources, etc. (Valipour, 2014).

Although, there are many agricultural technologies nowadays available for farmers which are eco-friendly and sustainable, their use and sustainable adoption is lacking. Farmers are adopting such practices whose profitability, sustainability, and viability are not known to them. Though here is availability of resource conserving and sustainable technologies for cultivation, poor extension and adoption is one of the problems in Nepalese agriculture development. Thus finding out the level of adoption and the major factors influencing adoption of such eco-friendly SSM practice is an urgent need. The specific objectives of this research work were:

(i) To find the level of adoption of SSM practice among the vegetable farmers.
(ii) To identify the major factors influencing the level of adoption of SSM practice.
(iii) To quantify the factors influencing in adoption of SSM practice.
(iv) To recommend best suggestions for increasing the level of SSM practice.

## MATERIALS AND METHODS

Primary data was collected using semi-structured interview schedule in June, 2012. One hundred and twenty vegetable producers were randomly selected from Nalang and Salang VDCs of Dhading district for the study. Adoption index was used to calculate the level of SSM practice adoption. Different scores were assigned to the responses made by the respondent using checklist. Selected individuals were categorized in to different categories of adopters' level as high adoption, medium adoption, and low adoption. On this basis of adoption level, index was determined as adoption of SSM innovation. The level of technology adoption was calculated by using the following formula (Dongol, 2004).

$$Adoptionindex(AI) = \frac{Total\ score\ obtained\ by\ an\ individual}{Maximum\ possible\ score} \times 100$$

For determining factors affecting level of adoption of SSM practices, probit regression model was applied in this study. In many studies investigating the factor influencing the adoption of agricultural practices use has been made of probit models (Hattam, 2006). The characteristic feature of probit models is that the effect of independent variables on dependent variables is non-linear. It is a statistics model which aims to form a relation between probability values and explanatory variables and to ensure that the probability value remains between 0 and 1.

In the Probit model, suppose $Y_i$ be the binary response of the farmers and take only two possible values; Y = 1, if farmer's adoption level is more than 84% and Y = 0, if less than 84% (Bhusal, 2012). Suppose x be the vector of several explanatory variables affecting to the level of adoption and β, a vector of slope parameters, which measures the changes in x on the probability of the farmers to adopt the practice at higher level. The probability of binary response was defined as follows:

If Yi = 1; $Pr(Y_i = 1) = P_i$
$Y_i = 0$; $Pr(Y_i = 0) = 1-P_i$

Where, $P_i = E(Y = 1/x)$ represents the conditional mean of Y given certain values of X.

According to Nagler (2002) probit model constrains the estimated probabilities to be between 0 and 1 and relaxes the constraint that the effect of the independent variables is constant across different predicted values of the dependent variables. This is normally experienced with the Linear Probability Model (LPM). The advantage of probit model is that it includes believable error term distribution as well as realistic probabilities. There were several factors that affect to the level of adoption of the practices at the farm level. Decision to adopt at higher level might be influenced by several socioeconomic, demographic, institutional and financial conditions. The aim of the model is to predict the influence of variables (X) on the probability of adoption of sustainable soil management practices (Y, dependent variables). According to this, in the probit model the likelihood of farmers adopting SSM practices is a non-linear function of variables.

$Pr(Y=1) = (X\beta)$

### Model specification

The Probit model specified in this study to analyze factors affecting farmer's level of adoption of sustainable soil management practices was expressed as follows (Table 1):

$Pr(>84\%=1) = f(b_0 + b_1 X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + b_{11}X_{11})$

**Table 1.** Description of the variables used in the Probit model.

| Variable | Type | Description | Value | Expected sign |
|---|---|---|---|---|
| Dependent variable Yi | Dummy | Farmers scoring more than 84% in adoption score. | 1 if farmer secured score> 84%; 0 otherwise | |
| Independent variables economically active members | Continuous | Number of economically active (16-59years) family members in the household | Number | + |
| Education | Continuous | Years of education of the household head | years | + |
| Farm size | Continuous | Total size of cultivated land | Ropani* | + |
| Experience | Continuous | Experience of household head in vegetable farming | Year | + |
| Gender | Dummy | Gender of the household head | 1 if male; 0 otherwise | +/- |
| Age | Continuous | Age of the household head | years | + |
| Training | Dummy | Whether farmers received training from different governmental and non-governmental organization. | 1 if farmers received training ; 0 otherwise | + |
| Livestock holding | Continuous | Livestock holding | Livestock Standard Unit, LSU | + |
| Membership | Dummy | Participation of respondent on SSM farmers group | 1 if yes; 0 otherwise | + |
| Credit | Dummy | Whether farmer had access of credit | 1 if farmers had access to credit; 0 otherwise | + |

*1 ha = 19.66 ropani

Where,
Pr (> 84%) = Probability score of adopting SSM practices
$b_1$, $b_2$.... $b_{11}$= Probit coefficient
$b_0$= Regression coefficient

## RESULTS AND DISCUSSION

### Socio-demographic characteristics of respondent in the study area

Total population of sampled households in the study area was 726 of which male population was 53.45% with average family size 6.15. Average age of household head was 56.6 years. Among total population 51% were economically active of which 82.5% of household were male headed and 65% of the household were found with nuclear family. About 63% were found literate total area owned in an average was 13.42 ropani of which 11.95 ropani was cultivated and only 3.18 ropani was under irrigation. Among the total respondent about 62% had received trainings related to sustainable soil management based vegetable farming and 65.8% were participated in farmers group. The average livestock holding was 10.12 LSU in the study area.

### Level of technology adoption

Majority of the respondent that is, 46.67% had medium level of adoption (77-91% level) of sustainable soil management practices. From the study 25.83% respondent was at high level whereas, 27.50% were at low level. The mean level of adoption of the practice was 84.05 with mean standard deviation of 7.42 (Table 2).

### Factors affecting the level of SSM technology adoption

The adoption level of the farmers in the study area was categorized into binary response by the adoption level of more than 84%= 1 and 0 otherwise. The extent to which the probit regression analysis model's independent variables used in prediction correctly predicted the dependent variable. Overall, the model predicted 85.76 per cent of the sample correctly. Thus the models developed may be said to be consistent and meaningful. The wald test (LR $chi^2$) for the model indicated that, the model had good explanatory power at the 1% level. The Pseudo $R^2$ was 0.777. For the interpretation of the model, marginal effects were driven from the regression coefficients, calculated from partial derivatives as a marginal probability. The interpretation is shown in Table 3. Probit regression analysis showed six variables were statistically significant for the level of adoption and they were; economically active family members, education, age, livestock standard unit, membership and credit. Five other variables namely experience, occupation, training and gender were statistically non-significant and associated positively with adoption while farm size was negatively associated (Table 3).

The study revealed that, number of economically active family members was positively significant ($P<0.05$) and keeping other factors constant, a unit increase in the number of economically active family members, probability of level of adoption would increase by 21.3%. This might be due to the availability of the more labor force in the agricultural activities. Similar to this, Teklewold et al. (2006) reported that the higher size of the household reduces the labor constraints and influence

**Table 2.** Level of adoption of sustainable soil management practices by the farmers in the study area.

| Level of adoption | VDCs | | Total |
|---|---|---|---|
| | Nalang | Salang | |
| <77% (low) | 16(26.67) | 17(28.33) | 33(27.50) |
| 77%-91% (medium) | 29(48.33) | 27(45.00) | 56(46.67) |
| >91%(high) | 15(25.00) | 16 (26.67) | 31(25.83) |
| Total | 60 (100) | 60 (100) | 120 (100) |

Figures in parentheses indicate percentage, mean level of adoption=84.05%
Source: Field survey, 2012.

**Table 3.** Factors affecting the level of adoption of sustainable soil management practices in the study area.

| Variable | Coefficients | P>\|z\| | Standard error | dy/dx[b] | S.E[b] |
|---|---|---|---|---|---|
| Economically active members(No.) | 0.950** | 0.014 | 0.385 | 0.213 | 0.094 |
| Education (Years) | 0.257*** | 0.008 | 0.097 | 0.058 | 0.029 |
| Farm size (Ropani) | -0.003 | 0.935 | 0.042 | -0.001 | 0.009 |
| Experience (Years) | 0.121 | 0.577 | 0.217 | 0.027 | 0.051 |
| Gender (Dummy) | 0.147 | 0.692 | 0.692 | 0.033 | 0.158 |
| Age of HH (Years) | -0.653** | 0.027 | 0.029 | -0.014 | 0.006 |
| Training (Dummy) | 1.013 | 0.088 | 0.594 | 0.272 | 0.196 |
| Livestock holding (LSU) | 0.340** | 0.034 | 0.164 | 0.076 | 0.024 |
| Membership (Dummy) | 1.918*** | 0.002 | 0.624 | 0.462 | 0.164 |
| Credit availability (Dummy) | 1.637** | 0.011 | 0.644 | 0.463 | 0.207 |
| Occupation (Dummy) | 0.078 | 0.914 | 0.724 | 0.018 | 0.172 |
| Constant | -6.121 | 0.008 | 2.318 | - | - |
| Summary statistics | | | | | |
| Number of observation(N) | | | 120 | | |
| Log likelihood | | | -18.248 | | |
| LR $chi^2(10)$ | | $127.15^{***}$ | ($Prob>chi^2$ = 0.000) | | |
| $Prob>chi^2$ | | | 0.000 | | |
| Pseudo $R^2$ | | | 0.777 | | |
| Cases predicted correctly (%) | | | 85.76 | | |
| Goodness of fit test | | Pearson $chi^2$ (107) = 76.85. Prob> $chi^2$ = 0.9877 | | | |

*** Significant at P = 0.01; ** significant at P = 0.05.
Source: Field survey, 2012
[b]Marginal change in probability (marginal effects after Probit) evaluated at the sample means.

the adoption of new technology positively.

Higher education level of household head gives the ability to interpret and respond to new information much faster than their counterparts with lower education (Feder et al., 1985). The coefficient of level of education entered the model with a positive sign and highly significant (P<0.01). One year increase in education of household head would increase the level of adoption by 5.8%. This finding is in harmony with the report of Kattel (2009).

The age factor was negatively significant (P<0.05) and a unit increase in the age would decrease the adoption level by 1.4 percent. Ghimire and Kafle, 2014 resulted that age factor negatively affected the adoption of integrated pest management practices in Nepal. Also, finding is in line with (Mussei et al., 2001) but is in contrast with (Chebil et al., 2007). Hussain et al. (2011) also reported that elder farmers do not adopt the innovative technologies like IPM. Livestock holding was positively significant (P<0.05) and a unit increase in the livestock standard unit would increase the adoption level of SSM practices by 7.6%. Similar finding was also reported by Kudi et al. (2011) but the result contrast with (Dhital, 2010). Coefficient of membership was positive and highly significant (P<0.01 and if farmers were participated in a group related with sustainable soil management practices would increases the probability of

adoption level by 46.2%. This might be due to the facts that, farmers gain high skills and knowledge while involving in groups and are in the direct influence of such practices. Similar result was reported by Nchinda et al. (2010). Study revealed that if farmers were provided credit facility, probability of adoption of SSM practice would increase by 46.3% which was positively significant ($P<0.05$). Tizale (2007) also indicated that there is a positive relationship between the intensity of use of various technologies and the availability of credit.

## CONCLUSION AND RECOMMENDATIONS

The study concluded that for the adoption of any agricultural technologies there lies number of factors which affect the adoption process significantly. Though the introduction of SSM practices has a direct role in improving the income and nutrition of many mid-hill households in terms of both quantity and quality, many factors hinders the adoption of such useful practices. Result suggested that SSM practices could be well extended only after addressing the different socio-economic problems of the farmers. Economically active family members, education of household head, age of household head, livestock standard unit, membership and availability of credit to farmers were found as most significant factors affecting adoption of SSM practice in the study area. The conclusions that were drawn from above results in this study can be used to suggest some recommendation for the successful adoption of SSM technology at farm level. Some recommendations have been suggested below to heighten the adoption of SSM technology.

(i) Result of this study concluded that economically active members and availability of credit affects adoption of SSM technology. Hence, technologies along with incentives, trainings and credit should be provided to youth populace avoiding muscle and brain drain.
(ii) Adoption of SSM technology is significantly increased with increase in years of education of household head. Thus, Government should take action to upgrade education and also should provide knowledge through trainings, visit, demonstrations, seminars and workshop etc. for farmers as SSM practices are complex to understand, prepare and use from the farmer's level.
(iii) Study of this result showed the scope for higher income by adding livestock enterprise which also in the other hand increases the adoption of SSM technology.
(iv) The study exposed that older farmers do not adopt innovative technologies like SSM. Hence it is suggested that government should implement youth based program in SSM based vegetable production.
(v) The adoption of SSM technology speeds up if farmers were involved in groups. Membership in farmer groups exposes farmers to a wide range of ideas which may positively change their attitude towards an innovation such that for effective adoption, agricultural technologies should be handed through group approach.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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