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*RESEARCH ARTICLE*

# DETERMINANTS OF PRODUCTIVITY AND MAJOR PRODUCITON CONSTRAINTS OF MANGO FARMING IN SAPTARI DISTRICT OF NEPAL

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**ABSTRACT**

Mango is one of the major fruit crops of Terai region of Nepal; however, farmers are experiencing poor productivity. Therefore, a study was conducted to determine the factors affecting the productivity and major constraints of the mango production in Saptari district of Nepal. Pre-tested semi-structured questionnaire was administered among randomly selected 106 farmers from the district of Nepal. Face to face interview was scheduled to obtain the data from sampled farmers from March 26 to May 25, 2020. Multiple regressions were used to access the various factors affecting the productivity of the mango. The regression model depicted that the total number of productive trees and training on commercial mango production was found statistically significant at 1% level of significance. A unit change in the total number of productive trees was found to change the productivity by 0.94 units. Additionally, one-unit change in the trainings regarding commercial mango farming caused the change in productivity by 0.53 units. Further, incidence of diseases and pests, poor access to market, lack of irrigation facility, incidences of natural hazards and modicum of fertilizers on orchard were the major production constraints of mango in Spatari district of Nepal. Therefore, the study has suggested indispensable need training on commercial mango cultivation practices in Saptari district of Nepal.

**KEYWORDS**

Loranthus, Mango productivity and multiple regression.

## 1. INTRODUCTION

Nepal is an agricultural country with 65.6 % of population involved in agriculture (MoALD, 2019). In Nepal, agriculture and forestry sector contributes 28.89% share in the national GDP (MoALD, 2017). Nepal is divided into mountainous, hilly and terai region. Nepal is a country with huge diversity that provides the opportunity for cultivation of various agricultural commodity. Terai region of this country is considered as the food basket of the country due to its plain and fertile land. Terai region is highly cultivable for cereals, fruits and vegetables. The soil and climate of the terai region of Nepal is considers good for the cultivation of various fruits and vegetables. Fruit cultivation is one of the major commodities contributing to the AGDP. The total area under fruit cultivation in Nepal is 1, 62,660 ha with production of 9.22 Mt/ha (MoALD, 2017). Out of the total fruit cultivation area grown in Nepal mango occupies an area of 48,204 ha (MoALD, 2017). Mango is one of the major tropical fruit crops grown in the terai region of Nepal. 39,664 ha of land is under mango cultivation in terai region (MoALD, 2017). Further, Saptari district of eastern terai is the major mango producing district with 7,165 ha of area under cultivation (MoALD, 2017).

Mango, king of fruits, belongs to the family Anacardiaceae (Bose and Mitra, 1996). Hot and humid climate of province 2 of Nepal is magnificently suitable for the cultivation of the Mango. The major cultivars of mango grown in Nepal are Amarpali, Mallika, Neelam, Maldah, Calcuttia, Dasheri, Bombay green, Krishnabhog, Chausa, Cipia, Fazil, Alfanso, Pakistani, Gualb khash, Zardalu and Sukul (RARS, 2015). The major fruits grown in Nepal includes citrus, mango, apple and banana. Mango is mainly grown in the frost-free areas which mainly include the terai region of Nepal. Mango is grown in the altitude above 600 m with very few rainfalls during the time of flowering. The favorable temperature for proper growth of the mango is $24^0$ to $27^0$ C. Mango has been found to grown on a wide scale of soils. The soil favorable for the cultivation of mango is deep and well-drained loamy to sandy loam soils. pH range for flourishing of mango cultivation is 5.5 to 7.5. These all conditions for the growth of the mango are suitable for the terai region.

The major diseases incident in mango are powdery mildew, mango malformation, bacterial black spot diseases of mango, tip die-back, anthracnose, black spot diseases, sooty mold and fruit decay (Akhtar and Alam, 2002). Besides diseases the major insects and pests responsible for the low mango productivity are mango hopper, mealy bug, inflorescence midge, fruit fly, scale, shoot borer, leaf weber and stone weevil but the loss in yield is irrespective to the genotype of the mango rather to the organ specific pests (Chowdhury, 2015). Inappropriate orchard management being major reason for the decline in productivity (Saeed et al., 2012). Decline in the productivity is known to occur due to the incidence of diseases and pests as well as conventional technique of the mango farming unable to adapt to the modern technology (Mango, 2020). Climatic change has also played an important role in the yield of the mango.

Increase in the temperature during cold season has resulted in increase in the productivity however, climate related changes have adversely affected

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the fruiting and flowering pattern (Makhmale et al., 2016). Additionally, the productivity is influenced by the application of both the irrigation and fertilizer use in the orchard, without there scientific use the productivity is decreased (Panwar et al., 2005).

The productivity of the mango is sum of the effort of the both socio-demographic character of the farmer and biological character of mango itself. Socio-demographic character is found to significantly affect the productivity as found by the study on productivity of paddy in Sri Lanka (Siriwardana and Jayawardena, 2014). The study of the socio-demographic character and its impact to the productivity is also mandatory as studied by this survey. The study is aimed to determine the various factors affecting the productivity of the mango in Saptari district of Nepal.

## 2. Statement Of Problem

The production of the mango has been decreased for five years before 2018 in Mango capital of Nepal i.e. saptari district. The productivity of the mango in the Saptari district is 7 Mt/ha which below the average yield of the mango of Nepal which is 8 Mt/ha (MoALD, 2017). The production of mango is decreasing. In addition, the productivity of the mango is following retardation due to infestation of pests, disease, and faulty mango orchard management practices (Acema et al., 2016).

Mango sudden decline, has been one of the most important determinants for the low productivity of the mango. The low productivity has resulted in the low income of the farmers, mango cultivation is the major occupation of the people living in the Saptari district. Unavailability of the proper post-harvest storage facility is also the major problem in this reason however the decrease in the productivity directly hampers the living standard and the day-to-day activity of the farmers.

Due to climate change various outbreaks of pests and diseases are seen as well as due to the perennial nature of the mango it is difficult to apply the mitigation approaches. The productivity of the mango for the year 2014, 2015, 2016, 2018 and 2019 are 3.5Mt/ha, 4Mt/ha, 3Mt/ha, 4.86Mt/ha and 2.8Mt/ha respectively.

## 3. Objectives

General objective:

- The general objective of the study was to identify the determinants & major constraints of mango farming in Saptari district.

Specific objectives:

**1.** To determine the factors affecting the production of mango farming.
**2.** To identify the production potential and major constraints of mango production.

## 4. Methodology

### 4.1 Study area and Sample size

The study was conducted in Saptari, a tropical eastern terai of Province-2, Nepal. The district encompasses within coordinates of 26° 34' 59.99" N longitudes to 86° 44' 59.99"E latitude (LATITUDE, 2020). The vast fertile plain of the district is highly suitable for growing variety of crops, particularly suitable for growing mango. Since, the area is highly occupied by commercial mango farming with total area greater than one thousand hectares; the government of Nepal has declared it as Mango Super Zone under Prime Minister Agriculture Modernization Project (PMAMP).

The district is laden with large number of farmers; therefore, the area was selected purposively. Ward number 7, 9 and 12 of Kanchanrup municipality, Saptari was selected for the study. Out of the farmers listed in the Super Zone of the Mango in Saptari district, 106 farmers were randomly selected for the study. Pre-tested semi-structured questionnaire and predetermined interview schedule was used to obtained data. Further, prescheduled Face to face interview technique was adopted to obtain data from March 26 to May 25, 2020.

### 4.2 Data Analysis

The data collected from the respondents were coded and tabulated in the Microsoft excel. Then, the file was imported into the software Python 3.7.4 for further analysis. After the entry of the data, descriptive statistics (mean, standard deviation), inferential statistics (chi-square test and One-Way ANOVA), and analytical statistics (multiple linear regression) were performed. For the comparison of socio-demographic characteristics the sampled farmers were categorized into the three different groups small, medium and large respectively. The categorization was done on the basis of the mean ± standard deviation.

### 4.3 Econometrics

Factor affecting the mango productivity was accessed using the multiple regression model. Additionally, for the determination of the productivity of the Coffee in Gulmi District of Nepal similar multiple regression model was used (Bhattarai et al., 2020). Hence, the model used for the estimation of the productivity of the mango was also used as multiple regression and the model is given as:

$$\ln (Y_{productivity}) = \alpha+\beta_1 \ln X_1+ \beta_2 \ln X_2+ \beta_3 \ln X_3+ \beta_4 \ln X_4+ \beta_5 X_5+ \beta_6 X_6$$

Where ln Y= natural log of the productivity which is the dependent variable

Here,
$X_1$= Total economically active member
$X_2$= Cost of FYM (farm yard manure)
$X_3$= Cost of pesticide
$X_4$= Total number of Productive trees
$X_5$= Dummy for intercropping if respondents says yes=1 and if not=0
$X_6$= Dummy for training on mango farming if respondents says yes=1 and if not= 0
$\alpha$ = intercept made on the regression line
$\beta_1$ to $\beta_6$ are the coefficients of the farmers category.

In this model 4 independent variable with 2 dummy variables was selected, to avoid the multicollinearity in the model the intercorrelated independent variable was removed selecting only one that affected the most.

### 4.4 Ranking of problems

Problem for the production of the mango were ranked with the help of forced ranking technique. The formula given below was used to find the index for intensity of production problem faced by producers.

$$I_{imp} = \sum \frac{Sifi}{N}$$ Where,

$I_{imp}$ = index of importance
$\sum$ = summation
$S_i$ = $I^{th}$ scale value
$F_i$ = frequency of $i^{th}$ importance given by the respondents
N = total number of respondents

Similar technique was also used by Subedi et.al for the ranking of the problems in potato (Subedi et al., 2019).

## 5. Results and Discussion

### 5.1 Socio demographic characteristics of the sampled respondents of saptari district

The important socio-demographic characteristic of the sampled household is mentioned in table No. 1. The average age of the household head was found to be 54.44 years, 54.27 years and 58.89 years respectively for small, medium and large farmers respectively. The dependency ratio was found to be higher in medium farmers (0.88) as compared to the large farmers (0.78) and small farmers (0.75).

Table 2 represents the socio-demographic characteristics of important categorical variable of the respondents. The tyrant education status was found to be illiterate for small farmer (70%) whereas SLC for the medium farmers (35.30%) and bachelors and above (46.43%) for the large farmers. The data was found to be significant at 1% level of significance for the education status of the different farmer category.

Regarding the religion of the farmers category was found very dominating with 100% in both small farmer and large farmer whilst 98.53% in medium farmer and the remaining small amount being the Muslim truly representing Hinduism in Nepal.

Major ethnic status was found to be Janjati in small farmers (70%) whereas Brahmin/Chettri being impervious in medium farmer (58.82%) and large farmer (67.86%). The society seems more or less patriarchal as major percentage of the household decision was taken by male in all the different farmers category respectively 60%, 72.06% and 89.29% for small farmers, medium farmers and large farmers.

**Table 1**: Socio-demographic characteristics (continuous variable) of sampled respondents

| Variables | Small Farmers (Mean±Standard deviation) | Medium farmers (Mean±Standard deviation) | Large farmers (Mean±Standard deviation) |
|---|---|---|---|
| Age of the HHH[1] | 54.44±15.66 | 54.17±14.05 | 58.89±14.10 |
| HH[2] size | 5.33±2.12 | 6.26±2.78 | 6.79±2.91 |
| Male members of HH | 2.78±1.30 | 3.41±1.47 | 3.43±1.50 |
| Female members of HH | 2.56±1.24 | 2.82±1.72 | 3.50±1.62 |
| Economically active members | 3.56±1.81 | 3.69±1.76 | 4.21±1.62 |
| Dependent population | 1.78±1.30 | 2.66±2.11 | 3.00±2.09 |
| Total mango cultivated land(ha) | 0.19±0.06 | 0.64±0.24 | 2.97±2.52 |
| Dependency ratio[3] | 0.75±0.90 | 0.88±0.84 | 0.78±0.55 |
| Total number of productive trees | 8.80±4.49 | 36.12±24.54 | 172.93±164.64. |

Table 2: Socio demographic characteristics of the sampled respondents of saptari district of Nepal (2020)

| Variables | Farmers Category | | | Chi-square value | P-value |
|---|---|---|---|---|---|
| | Small farmers | Medium farmers | Large farmers | | |
| Gender of HHH (male) | 6(60) | 51(75) | 2(85.71) | 2.9141$^{ns}$ | 0.233 |
| Education status | | | | | |
| Illiterate | 7(70) | 20(29.42) | 6(21.43) | 23.908$^{***}$ | 0.008 |
| Literate | 0(0) | 2(2.94) | 1(3.57) | | |
| Primary up to 5 | 0(0) | 6(8.82) | 1(3.57) | | |
| Lower secondary up to 8 | 0(0) | 8(11.76) | 1(3.57) | | |
| SLC | 2(20) | 24(35.30) | 6(21.43) | | |
| +2/Certificate | 0(0) | 0(0) | 0(0) | | |
| Bachelors and above | 1(10) | 8(11.76) | 12(46.43) | | |
| Religion | | | | | |
| Hindu | 10(100) | 67(98.53) | 28(100) | 0.56$^{ns}$ | 0.754 |
| Muslim | 0(0) | 1(1.47) | 0(0) | | |
| Ethnic group | | | | | |
| Brahmin/Chettri | 3(30) | 40(58.82) | 19(67.86) | 5.68$^{ns}$ | 0.22 |
| Janjati | 7(70) | 26(38.25) | 9(32.14) | | |
| Others | 0(0) | 2(2.94) | 0(0) | | |
| Family type | | | | | |
| Nuclear | 7(70) | 52(76.47) | 19(67.86) | 0.830$^{ns}$ | 0.66 |
| Main occupation (mango farming) | 5(50) | 42(61.77) | 21(75) | 9.144$^{ns}$ | 0.521 |
| Household decision (Male) | 6(60) | 49(72.06) | 25(89.29) | 4.922$^{ns}$ | 0.29 |
| Training received (Yes) | 1(10) | 13(19.12) | 9(32.14) | 2.869$^{ns}$ | 0.238 |
| Intercropping (Yes) | 3(30) | 13(19.12) | 2(7.12) | 3.344$^{ns}$ | 0.188 |

explains the approach of the different category of farmer's to the training regarding commercial farming of the mango. Very less farmer's had received the training on mango farming. In small farmers 10% followed by 19.12% in medium farmer's and 32.14% in large farmers were found to receive the training on mango farming. The difference among the different category however was not found significant at any level of significance. Adoption of the intercropping is found to be adopted by skimpy farmers of different category. Mainly intercropping in the orchard was done by the farmers whose orchard is young with wheat. 70%, 80.88% and 92.86% of the farmers were found not to adopt intercropping respectively in small, medium and large farmers category.

### 5.2 Factors affecting mango productivity

**Table 3:** Factors affecting the mango productivity

| | Coefficient | Standard error | t-stat | P-value | Lower 95% | Upper 95% |
|---|---|---|---|---|---|---|
| **Intercept** | 1.953 | 0.374 | 5.216 | 0.000 | 1.209 | 0.975 |
| **Active member of family** | -0.5828$^{*}$ | 0.339 | -1.721 | 0.089 | -1.256 | 0.091 |
| **Cost of FYM** | 0.0324 | 0.035 | 0.924 | 0.358 | -0.037 | 0.102 |
| **Cost of Pesticide** | -1.106e-05$^{**}$ | 5.04e-06 | -2.195 | 0.031 | -2.11e-05 | -1.04e-06 |
| **Total number of productive trees** | 0.9410$^{***}$ | 0.18 | 5.229 | 0.000 | 0.583 | 1.299 |
| **Intercropping** | -0.085 | 0.11 | -0.772 | 0.442 | -0.305 | 0.134 |
| **Training on commercial mango farming** | 0.5270*** | 0.171 | 3.083 | 0.003 | 0.187 | 0.867 |

Adjusted R- squared=0.381 F-static= 10.86$^{***}$

$^{*}$, $^{**}$ and $^{***}$ represents significance at 10%, 5% and 1% level of significance.

The model was found to be significant at 1% level of significance with F-static value of 10. 86. The adjusted R-squared was found to be 0.381 which implies that 38.1% of the productivity is explained by the independent variable incorporated in the model. Economically active population of the family was found to be significant but negatively at 10% level of significance. It is found to affect negatively because the active population are not involved in the agricultural occupation rather involved in other jobs except agriculture. So only old aged farmers were found to be involved in the farm activities and according to the study in Pakistan it was found that the old farmers were not able to adopt to the modern practices as compared to the young farmers (Hassan et al., 2002). Similarly, the cost of the FYM was found to affect the productivity positively but not significantly.

The FYM plays a very important role in the productivity of mango. As mango is perennial plant its nutrient requirement can be fulfilled by FYM finally impacting in the increase of the yield (Iyer, 2004). Additionally, use of the pesticide was also found to be significant and negative at 5% level of the significance. However, the impact of the change in the productivity due to pesticide is very low. As the study on time series analysis of the orchard fruit in Great Britain from 1992-2008 the use of the pesticide was found to have both negative and positive impact on the production, the study revealed that during the time series analysis the productivity of the six of the seven crops increased whereas for custard apple and plum it was found to have decreased (Cross, 2013). Unscientific use of the pesticide in the orchard results in the productivity rather than increase. Another independent variable total number of the productive tress was found to significantly and positively influence the productivity and was found significant at 1% level of significance.

In a study conducted on the production of guava the number of productive guava trees were also found to positively affect the production and was found significant as well (Khushk et al., 2009). One-unit change in the total number of the productive trees resulted in 0.94 units change in the

productivity. Training on commercial mango farming was also found to be significant positively at 1% level of significance. Unit change in the training and support resulted in the 0.53 units change in the productivity. Study on the productivity of the mango in Pakistan also found that the farmers in touch with the extension agents were found to have positive effect on the productivity (Shahbaz et al., 2017). More the farmers are in touch with the extension agents more will be the number of trainings received by them. Farmers taking trainings are well versed with the modern techniques and are plausible to create better orchard management practices. Intercropping in the orchard of the mango was found to negatively affect the productivity of the mango. Lachungpa when intercropped maize with the citrus, the yield of the citrus was found to decrease (Lachungpa, 2004). The effect of the intercrops to the productivity of the crop depend upon the rooting behavior and the strata of the soil from which absorption of the nutrient takes place (Awasthi and Saroj, 2004). Due to the lack of the use of the fertilizer on the field and any other management practice resulting in the nutrition depletion and competition for the nutrient absorption intercropping mango with wheat was found to affect negatively.

### 5.3 Constraints of the mango production in Saptari district of Nepal

The forced ranking method with five-point scale was used for the ranking of the prevalent constraints in mango farming. Incidence of diseases and pest was found to be the major problem constraining mango farming with the index value of 0.945. Every orchard was found to be infected by pests and diseases mainly pest Mango stem borer (*Batocera rufomaculata Dejan*). A study conducted in the eastern terai region of the Nepal recorded mango stem borer to be the major insect pest of this region (Upadhyay et al., 2013). None of the orchards under survey were free from pests. Lack of proper access to the market and market price was ranked second with index value of 0.692. Due to higher amount of the mangoes being imported from the Indian border at a cheaper rate the Nepalese mango were unable to get the proper price and market. As well from the survey very large amount of farmers of every farmers category were found to adopt contract farming as a result the contract persons acted as the arbitrator resulting in decrease in farmers' profit.

Unavailability of the irrigation facility ranked third with index value of 0.602. Although being the district of the largest river of Nepal Saptakoshi the irrigation facility was found to be the problem it is because no irrigation channel is made in the area of mango orchards as well due to the poor economic condition of the farmers, they were not able to pay for the boring of underground water. Natural hazards mainly hailstorm and heavy rainfall during the initial fruit development stage has resulted in heavy decrease in the total production of mango. Natural hazard is ranked 4$^{th}$ with index value of 0.464. The unavailability of the fertilizer is ranked last with index value of 0.296. It is ranked last, because of the more illiterate farmers in the area they were still unaware about the impact of the fertilizers on the yield of the mango. They believed only in the FYM but not chemical fertilizers. In a study conducted for assessment of the constraints of the mango in Ethiopia scarcity of the irrigation, pest and diseases and limited technology were found to be the major constraints (Hussen and Yimer, 2013).

**Table 4:** Ranking of major problem of mango production

| Problems | Index value | Rank |
|---|---|---|
| High incidence of pest and diseases | 0.945 | I |
| Lack of proper access of market and market price | 0.692 | II |
| Unavailability of irrigation | 0.602 | III |
| Natural Hazards | 0.464 | IV |
| Unavailability of fertilizers | 0.296 | V |

## 6. Conclusions

The study was made to overview the determinants of mango productivity and problems of mango production. The average age of different farmers category small, medium and large was found to be 54.44 years, 54.17 years and 58.89 years respectively. The average land holding used for the mango cultivation were found to be 0.19 ha, 0.64 ha and 2.97 ha respectively. To determine the factors affecting productivity multiple regression was used. Active population and cost of pesticide was found negatively significant and significant at 10% and 5% level of the significance respectively. Training on commercial mango farming and total number of the productive trees were found to positively alter productivity and was found significant at 1% level of significance. The major constraints in mango farming were found to be incidence of diseases and pests, unavailability of market and market price and unavailability of the irrigation was determined as most hindering factors of production. Although use of pesticide is used the incidence of diseases and pests is not reduced hence it is recommended for better and scientific use of pesticide rather in lumpsum. It is recommended to take care of the orchard and practice orchard management practice rather leave it is as it is as seen on the survey. As well intercropping shall be discouraged as it is resulting in the decrease of the productivity.

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## Conflict of Intrest

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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