Analysis of factors and major problems of production of paddy farming in Sunsari district, Nepal

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ABSTRACT

Despite all its potential for paddy farming, productivity in Sunsari is still below the productivity of nearby districts like Jhapa, Morang, and Udayapur having similar climatic conditions as Sunsari. So, this research was carried out in the month of May-June in 2020 to identify the factors affecting paddy production and problems of paddy production in Sunsari district. Sunsari district was purposively selected due to the high potential of paddy production in the region. Total one hundred of farmer's households were selected by simple random sampling and primary data was collected with the help of a pre-tested semi-structured questionnaire by interview schedule and secondary data were collected from relevant journals. A multiple regression model was applied to identify the factors of paddy production. This study identified that paddy cultivated land with irrigation facility, the experience of farmers in the field of paddy farming (years), and use of modern rice varieties had a significant positive impact on paddy production in the study area. About 85% variation in paddy production was explained by the independent variable considered under the study. Indexing was applied to identify major problems of paddy production. This study revealed that lack of fertilizer in peak plantation time, lack of sufficient measure and knowledge for disease and pest management, lack of training about improved paddy farming practices, lack of government support in agricultural inputs, etc. were major constraints of paddy production in the study area. The irrigation facility should be further improved to bolster paddy production.

INTRODUCTION

Paddy cultivated area in Nepal is 1,491,744 ha of land. The production and productivity of the rice being 5,610,011 Mt and 3.76 Mt ha⁻¹ respectively. The area of rice production in eastern terai is 756,336 ha with productivity 3.12 Mt ha⁻¹, and Sunsari district being the major area for rice production with an area of 75,846 ha with productivity 3.81 Mt ha⁻¹ (MoALD 2019). Sunsari district is the major district for the rice production in Nepal. Rice is one of the major staple cereals.

Rice (*Oryza sativa*) belongs to the family Poaceae. The consumption of the rice started since the civilization. The rice was believed to be first

originated and cultivated in the lower Yangtze river delta in Eastern China around Neolithic age (Hu et al., 2013). Rice is an important staple food for many people across the globe, especially people belonging to Asian sub-continent. According to Muthaya et al. (2014) the demand for rice in Asia for next 30 years will be increased by almost 90%.

There are many varieties in rainy season rice or summer season rice which are being cultivated throughout the country. But 15 rice varieties are recommended specially for Sabitri, Radha-4 Radha-12, Hardinath-1, Sworna sub 1, Makawanpur-1, Mansuli and Indian varieties like Sona Mansuli, Sona Masuli are major of them. Many farmers throughout the country also grows varieties like Pokhrela jethobudho, Pokhrela masino, Basmati, and Anadi which are indigenous varieties. (MoAD 2072)

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Sunsari district is one of the major paddies producing district in eastern Terai of Nepal. With the large number of the people engaged in the rice cultivation it is one of the major occupations of the people here. The yield of the rice is 3.76 Mt ha⁻¹ in Nepal, 3.77 Mt ha⁻¹ in province 1 and that of the Sunsari is 3.98 Mt ha⁻¹. Whereas rice productivity in district close to Sunsari with similar environmental condition like Udayapur is 4.05 Mt ha⁻¹, Jhapa 4.26 Mt ha⁻¹ and Morang 4.14 Mt ha⁻¹ (MOALD 2019). The rice production in Sunsari district seems to be more than that of national productivity and average productivity of that province No. 1. But when we look further productivity of rice in Sunsari was found lower than many districts like Udayapur, Jhapa and Morang in province 1 with similar climate, environmental and ecological variables. When paddy productivity increases the total paddy production increases keeping the cultivated land area constant. The paddy production in sunsari district has been hindered by many problems and this study helps to identify such problems as well as various factors associated with paddy production in sunsari district Nepal.

MATERIALS AND METHODS

Study area and sample size

The survey was conducted in Sunsari district of Nepal which is located at latitude 26°38'29.76" N and longitude 87°07'44.76" E having suitable climate for paddy production. In Sunsari district Ramdhuni municipality, Itahari sub metropolitan city, Duhabi municipality and Gadhi rural municipality were purposively selected due to extensive rice farming in the region and this region also comes under PMAMP rice zone Sunsari. Hundred farmers were selected randomly by the use of simple random sampling from the total paddy growers in PMAMP region. The selected farmer's household were interviewed face to face by the use of well prepared and pre-tested semi structured questionnaire. The study took place during the month of May- June 2020.

Farmers categorization

Based on the minimum, maximum and average± standard deviation land holding of the household all the sampled farmers household were divided into three distinct groups i.e. farmers whose land holding lies within minimum to mean-standard deviation was categorized as small household farmers. Likewise, those household whose land holding lied within mean-standard deviation to mean+ standard deviation were categorized as medium farmers household and finally those household whose land holding lied within mean+ standard deviation to maximum range were categorized as large farmer household.

Based on these it was observed that out of 100 farmers included in our study 11 of them belonged to small farmers group, 70 of them in medium farmers group and 19 of them in large farmers group. The average land holding of the small, medium and large farmers group was found as 13.81 kathha, 36.50 kathha and 87.10 kathha respectively.

Data analysis

The data collected from face to face interview schedule was tabulated using MS-excel v2019 and later imported to software python 3.8 for further analysis. Descriptive analysis was performed in regards with farmers category namely small holder, medium holder and large holder.

The continuous variable comparison was done by one-way analysis of variance (ANOVA) and the categorical variable comparison was done by contingency chi-square test in regards with different farmers category.

Factors affecting paddy production

The factors affecting paddy production were accessed by using multiple regression model as given by Mary L Thompson (Thompson, 1978)

$$\ln(Y_{\text{production}}) = \alpha + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7$$

α = intercept made on the regression line

X_1 = Number of economically active members of the respondent household

X_2 = Total paddy cultivated land having irrigation facility

X_3 = Experience of the household head in paddy cultivation (in years of paddy cultivation)

X_4 = Dummy for training in paddy cultivation if yes=1 and if no=0

X_5 = Dummy for use of high yielding (Hybrid and Improved both) varieties if yes=1 and if no=0

X_6 = Dummy for gender male=1 female =0

X_7 = Education level of the respondent household head

β_1 to β_7 are the coefficients of those independent variable respectively.

In this model three continuous and two dummy variables were selected as independent variable and to avoid multicollinearity in the model the intercorrelated independent variable was removed and the one with strong effect on production was selected.

This method was also used to identify the productivity and profitability of vegetable production in Swaziland (Masuku, 2013). Similar

model was applied in an analysis of factors affecting agricultural land use patterns and livelihood strategies of farm households in Kanchanaburi province, Thailand (Santiphop et al. 2012). This method was also used to identify factors affecting the wheat grain yield and protein content in Northern wheat belt of New South Wales (Martin et al.1988).

Problems of paddy production

Problem for the production of the paddy were ranked with the help of forced ranking technique with five-point scale. The formula given below was used to find the index for intensity of production problem faced by paddy growers.

$$I_{\text{imp}} = \sum \frac{S_i F_i}{N}$$

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 formula was applied to rank the problems associated with wheat production (Subedi et al., 2019). Bhattarai et.al (2020) also applied similar five-point scale to rank the production constraints of coffee in Gulmi and Arghakhachi district Nepal.

RESULTS AND DISCUSSION

Description of important socioeconomic and demographic characteristics

The table 1 shows the socioeconomic characteristics of the sampled respondents. In regards to the age of household head; the average age of household head was 37.63 years, 39.62 years and 39.68 years for small, medium and large farmers respectively. The average household size is 5.9 for small farmers and 7.94 for medium farmers and for large farmers is 11.63. The average number of males in household were 3.09, 4.18 and 6.16 for small farmers, medium farmers and large farmers respectively. Likewise, the average number of females in household were 2.81 for small farmers, 3.72 for medium farmers and 5.47 for large farmers category.

The age group of sampled household population was divided into different groups namely; 0-5, 6-17, 18-59 and 60 and above. The population age group of 18-59 is considered as economically active population whereas remaining age group is considered as dependent population.

The average number of dependent populations was found to be 2.09 for small farmers, 3.34 for medium farmers and 5.15 for large farmers per household. Likewise, the average number of active populations was found as 3.81 for small farmers, 4.58 for medium farmers and 6.42 for large farmers per household. The dependency ratio is defined as the ratio of dependent population to that of active population (CBS, 2014). The dependency ratio was found to be 0.66 for small farmers, 0.75 for medium farmers and 0.90 for large farmers. Dependency ratio 0.66, 0.75 and 0.90 means that the 100 small, medium and large farmers must be able to feed 66, 75 and 90 number of people respectively who are dependent on them in sampled household.

In rainy season, farmers cultivate rice in most of their land. Average land holding of the farmers was found to be 13.81 kattha, 37.02 kattha and 81.84 kattha for small, medium and large farmers respectively. This data is also same for average paddy production area for small, medium and large farmers group indicating that farmers cultivate rice in all of their land in rainy season. Likewise, average area in which irrigation facility available was found as 13.81 kattha, 35.17 kattha and 69.73 kattha respectively. This shows us that farmers have extensive availability of irrigation water in sampled area of rice zone sunsari.

The sociodemographic data consisting of gender of the household head, education level, religion, family type, major occupations are shown in table 2.

Majority of the respondent were male except for small farmers group where 54% of the respondents were female. the difference was statistically significant on 5% level of significance this means that there is contingency of gender distribution with respect to farmers category. Major religion was found to be Hinduism in all categories of the farmer group and data was not found statistically significant at any level of significance. Brahmin and Chettri were major ethnic group in small farmers group but Madhesi community people were dominant in medium and large farmers group and data was found significant at 1% level of significance. Paddy cultivation was found as major occupation across all farmers group and this data was found significant at 5% level of significance. Majority of the farmers in small farmer group were either SLC pass or +2 completed, large section of farmers from middle farmers category had passed SLC and dominant education status of large farmers group was also found to be SLC Level.

Out of total small farmers household 72.72% of those had training on paddy cultivation at least once and 61.42% household of the medium farmers group had obtained similar kind of training and

Table 1. Socio-demographic characteristics (continuous variable) of sampled household Sunsari district of Nepal

Variables	Small farmers (Mean±Standard deviation)	Medium farmers (Mean±Standard deviation)	Large farmers (Mean±Standard deviation)
Age of HHH	37.63±8.84	39.62±7.92	39.68±6.42
HH Size	5.90±0.70	7.94±3.11	11.63±5.37
Male members of HH	3.09±0.3	4.19±1.72	6.16±2.81
Female members of HH	2.82±0.60	3.73±1.55	5.47±2.65
Economically active members	3.82±0.98	4.59±1.46	6.42±3.77
Dependent members	2.09±0.94	3.34±2.15	5.16±2.33
Dependency ratio	0.66±0.56	0.75±0.44	0.90±0.42
Average land holding	13.81±2.08	36.60±13.38	87.10±29.16
Average rice cultivated land	13.81±2.08	37.17±13.33	69.73±11.08
Land with irrigation facility(rice)	13.81±2.08	35.17±13.26	69.70±10.47

68.42% household of the large farmers group had obtained training on paddy cultivation at least once. This partially may be due to the factor that large

farmers household have owned more farmland and they must have had less time to take part on training. This training difference in farmers group is significant.

Factors of paddy production on study area

From table 3 the R-square value was 0.858 which signified that around 86% variation in paddy production was explained by explanatory variable in the model. Adjusted R-square value was 0.85 which means that when degree of freedom was taken into consideration around 85% variation in dependent variable (production) was explained by independent explanatory variable in the model.

From the table it was clear that paddy cultivated land having irrigation facility, experience in paddy cultivation (measured in terms of years), training in improved and advanced paddy cultivation practices, use of high yielding varieties (both hybrid and improved) and gender of the household head had positively contributed in paddy production in the study area.

The negative coefficient obtained in economically active members of the farmers household signified that not all working class people contribute to paddy farming of the household which was mainly due to those members were actively engaged in other works like government jobs, business etc. and this result was

in contrast with Sehu et.al (2010) as they found that with the increase of adult member in the family Yam production also increased in Benue state, Nigeria.

Paddy cultivated land with irrigation facility had positive impact on paddy production, which was significant at 1% level of significance. This finding revealed that with additional one unit increase in paddy cultivated land with irrigation facility there was 0.0108 unit increase in paddy production. This primarily signified that with increase in additional 1 kattha of paddy cultivated land with irrigation facility there was increase of paddy production by 0.0108 ton keeping other factors constant. Similar results were found by Dahal (2015) where results were found as: the irrigation facility provided by Bagmati irrigation project increased total paddy production by 41.49% in Rautahat district. Moreover Urgessa (2016) reported that drought during the cropping season had negative significant effect on rural household land productivity in Ethiopia which again stresses that irrigation water is indispensable factor for paddy production. Similarly, Thanawong et.al (2014) also found that when irrigation water supply was made easily available paddy productivity increased in Northeastern Thailand.

Experience in paddy cultivation (measured in terms of years) was found to be significant at 10% level of significance. The coefficient value of 0.24 showed that keeping other factors constant when experience increase by one-unit paddy cultivation increased by 0.24 unit in the study area. Farmers

Table 2. Relationship between farmers category and important categorical variable in Sunsari district of Nepal

Variables	Small Farmer (n=11)	Medium farmer (n=70)	Large farmer (n=19)	Chi square value	P value
Gender of HHH					
Male	5(45.45)	44(62.85)	17(89.47)	7.024**	0.029
Female	6(54.54)	26(37.15)	2(10.13)		
Religion					
Hindu	10(91)	57(81.43)	19(100)	4.528 ^{ns}	0.103
buddhist	1(9)	13(18.57)	0		
Ethnic group					
Brahmin/Chhetri	6(54.54)	10(14.28)	0	21.579***	0.0002
Janajati	1(9.09)	13(18.57)	0		
Madhesi	4(36.36)	47(67.14)	19(100)		
Education status					
Illiterate	0	3(4.28)	0	21.781**	0.04
Literate	0	0	4(21.05)		
Primary up to class 5	1(9.09)	4(5.71)	2(10.51)		
Lower secondary up to class 8	1(9.09)	17(24.28)	3(15.79)		
SLC	4(36.36)	22(31.43)	6(31.58)		
+2/certificate	4(36.36)	18(25.71)	3(15.79)		
Bachelors and above	1(9.09)	6(8.57)	1(5.26)		
Major occupation					
Paddy cultivation	8(72.72)	53(75.71)	10(52.63)	15.344**	0.017
Service	0	11(15.71)	1(5.26)		
Remittance	3(27.27)	5(7.14)	7(36.84)		
business	0	1(1.42)	1(5.26)		
Training					
Yes	8(72.72)	43(61.42)	13(68.42)	6.679**	0.035
No	3(27.28)	27(38.58)	6(31.58)		

Note: figures in parenthesis indicates percentages, ***=1% and **=5% level of significance

experience had significant positive impact in efficacy of Indian farmers (Coelli and Battesi, 1996). This result is also on par with Gedara et. al (2012) in which the team of

researchers found that farmer's age had significant positive impact on technical efficiency of paddy farmers of Sri Lanka. Furthermore, this is also explained by the Wilson et.al (2001) in which investigators found that farmer's having more of the managerial experience were seeking more new information and subsequently had higher technical efficiency of wheat production in Eastern England.

Training obtained by the farmers on paddy production had positive impact on paddy production however it didn't have significant impact on overall paddy production in the study

area. This was primarily due to the fact that training program had become largely ineffective in the study area. This finding is slightly different than Kijima et.al (2012) in which they found that training had significant positive impact on adoption of improved practices and profit from lowland rice production in Uganda.

Use of high yielding varieties was found statistically significant at 1% level of significance and this study revealed that farmers household who had used high yielding varieties had almost 0.08 units more production than those farmers household who hadn't used high yielding rice varieties when all others factors were kept constant. Mishra et. al. (2016) also found that significant positive impact of High yielding varieties on production, revenues and profits in paddy farming

Table 3. Factors affecting paddy production in the study area

	Coefficient	Standard Error	t-stat	P-value
Intercept	3.1204***	0.179	17.405	0.000
Economically active family members	-0.0584	0.065	-0.900	0.370
Paddy cultivated land with irrigation facility	0.0108***	0.001	13.567	0.000
Experience	0.2487*	0.144	1.724	0.088
Training	0.0227	0.025	0.897	0.372
Use of high yielding varieties	0.0897***	0.020	4.414	0.000
Gender	0.0087	0.022	0.396	0.693
Education level	-0.0068	0.007	-0.924	0.358
R-square=0.859	Adjusted R square=0.849			

Note: *** indicates 1 % level of significance and * indicates 10% level of significance

in Nepal. Furthermore, Hossain et.al (2006) found that with the increase in popularity of high yielding modern rice varieties among farmers of area with irrigation facility, resulted to growth of paddy production 2.3% annually in last three decade in

Bangladesh which resulted in increase in profitability from paddy production. In Vietnam according to Thi and Kajisa (2006) growing popularity of modern high yielding varieties post-Vietnam war was the one of the major causes for green revolution, which greatly increased paddy production in the country. These findings signify importance of irrigation water for successful paddy farming.

Gender of the household had positively contributed to the paddy production. However, the contribution was not significant at any level of significance. This finding was somewhat similar with Siriwardana et.al (2014) where researchers found that gender played positive as well as significant impact on paddy production in Sri Lanka.

The education level of the respondent household head had negative impact on the paddy production. This finding signified that more educated people are less involved in rice farming as they had been involved in different kind of profession like government job, business and lucrative private jobs. Arshad et.al (2015) also found that negative impact of education for flood insurance in rural household of Pakistan which somewhat similar to this result. However, Paltasingh and Goyari (2018) found that education level of the farmers positively drives the farm productivity in case of Indian farmers.

Problems associated with rice farming

Based on the field visit, focus group discussion, KII knowledge sharing with AKC and

rice zone major problem prevalent in my study area was short listed and included in interview schedule. From that discussion, unavailability of fertilizers in the time of paddy plantation, incidence of disease and insect pest and lack of efficient measure to control it, lack of training on efficient management practices for paddy production, lack of government support on agricultural inputs and natural hazard like flooding and destruction of rice field by wild animals were found to be the major problem for successful rice farming and adoption of new technologies. For the ranking of these problem forced ranking of five-point scale was used and farmers were asked to rank the problem scaling maximum 1 and then then decreasing as the severity of the problem decreases.

The majority of the farmers responded the lack of fertilizers at the peak time of plantation as severe most problem in the area as it limits the total production capability of soil and plant can't yield to their maximum potential thereby giving low yield due to lack of essential nutrient for growth, development, grain formation and grain filling. The index value for fertilizer shortage was found to be 0.718.

Similarly, problems like incidence of disease and pest, lack of training on efficient and improved management practice on rice farming, lack of government support on agricultural input lack and natural disasters like flooding and destruction of rice field from wild animals were ranked as 2nd, 3rd, 4th and 5th problems with index value 0.658, 0.582, 0.544 and 0.498 respectively.

High incidence of disease and pest infestation was also one of the major problems associated with rice farming which was again accentuated by lack of proper mechanism to control this problem. Disease and insect pest hinder the crops growth subsequently these crops can't give maximum

potential yield. So, incidence of disease pest and lack of efficient measure to manage them was second most severe problem in my study area with

The major objective of the study was to analyze the factors affecting the paddy production in Sunsari district, Nepal. This study revealed that increase in paddy cultivated land having irrigation facility

Table 4. Problems in paddy cultivation and adoption of improved farming practices

Problems	Index value	Rank
Lack of fertilizer in peak plantation time	0.718	I
Disease and pest infestation and lack of measure to manage it	0.658	II
Lack of training on improved farming practices	0.582	III
Lack of government support on agricultural inputs	0.544	IV
natural hazards like flooding and problem from wild animals	0.498	V

index value of 0.658.

Lack of training on efficient and improved management practices on rice farming was third most severe problem in paddy cultivation with index value of 0.582. Training on efficient nursery management like modified dapog method, seed treatment before sowing, efficient management of nutrient and other agricultural input, lack of knowledge and demonstration of DSR technology were major factors of hindering technology adoption which would have further bolstered paddy production. These were almost nonexistent making lack of training one of the prominent factors hindering technology adoption and resulting low efficiency of production from rice farming.

Fourth most severe problem in rice farming was found to be lack of government support on agricultural input like seed of high yielding hybrid varieties, fertilizer and lime and other necessary inputs like chemicals and bioagent to control disease and pest with index value of 0.544. Some subsidy on fertilizer, seed and lime was present however those support was hijacked by people with political power, moreover subsidized varieties were found to be less productive than non-subsidized varieties of rice.

Natural disasters like flooding of rice cultivated area and grazing and destruction of rice field by wild animals like elephant and wild buffaloes was also problematic in rice farming in my study area with index value of 0.498 making it least problematic in my study area. However, in certain part of my study area like Ramdhuni ward number six and seven flooding was one of the major problems in rice farming and particularly in Ramdhuni ward number 7 wild animals' destruction of rice field was more common.

CONCLUSIONS

positively drives paddy production in the study area. Furthermore, experience and use of high yielding varieties such as improved and hybrid varieties significantly improves production of paddy in the study area. Findings of this study revealed that farmers having more experience in paddy cultivation and who have used either hybrid or improved varieties have harvested more amount of raw paddy than those with lower experience and those who planted local rice varieties in their field. The major constraints of paddy production in the study area were identified as lack of fertilizer in peak plantation time that is in monsoon season, disease and pest infestation, lack of training on improved management practices and so on. The identified factors which positively contributed to paddy production in the study area need to be further improved and along with this the major problems identified need to be resolved in order to further boost production in Sunsari district. The government and policy makers should acknowledge the farmers perception regarding rice farming and try to address the problems and issues revealed by this study.

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CONFLICT OF INTEREST

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

REFERENCES

- Ashrad M. Amjath-Babu T. S. Kachele H. & Muller K. (2015) What drives the willingness to pay for crop insurance against extreme weather events (flood and drought) in Pakistan? A hypothetical market approach. *Climate and Development*, *https://doi.org/10.1080/17565529.2015.1034232*
- Bhattarai C. Bhandari D. Bhandari S. Bhusal K. Khatri B. Srivastava A. & Sapkota B. (2020) Factors affecting the productivity of coffee in Gulmi and Arghakhanchi districts of Nepal. *Journal of Agriculture and Natural Resources*, *3*(1), 51-60. <https://doi.org/10.3126/janr.v3i1.27017>
- CBS. (2014) Population monograph of Nepal. Government of Nepal, National Planning Commission Secretariat, Central Bureau of Statistics, Ramshah Path, Kathmandu; 2014.
- Crop Development Directorate, MoAD. (2072). Rice varietal mapping in nepal: implication for development and adoption. Lalitpur: Government of nepal.
- Coelli T. J. and Battese G.E. (1996) Identification of factors which influence the technical inefficiency of Indian farmers. *Australian Journal of Agricultural Economics*, *40*: 103-128. doi:10.1111/j.1467-8489.1996.tb00558.x
- Dahal A. (2015) Impact of irrigation in the command area of Bagmati Irrigation Project. *Economic Journal of Development Issues*, *15*(1-2), 1-14. <https://doi.org/10.3126/ejdi.v15i1-2.11854>
- Gedara K. M. Wilson C. Pascoe S. and Robinson T. (2012) Factors Affecting Technical Efficiency of Rice Farmers in Village Reservoir Irrigation Systems of Sri Lanka. *Journal of Agricultural Economics*, *63*: 627-638. doi:10.1111/j.1477-9552.2012.00343.x
- Hossain M. Bose M. L. & Mustafi B. A. A. (2006) Adoption and Productivity Impact of modern rice varieties in Bangladesh. *The Developing Economies*, *44*(2), 149-166. <https://doi.org/10.1111/j.1746-1049.2006.00011.x>
- Hu L. Chao Z. Gu M. Li F. Chen L. Liu B. Li X. Huang J. Li Y. Xing B. & Dai J. (2013) Evidence for a Neolithic Age fire-irrigation paddy cultivation system in the lower Yangtze River Delta, China. *Journal of Archaeological Science*, *40*(1), 72-78. <https://doi.org/10.1016/j.jas.2012.04.021>
- Kijima Y. Ito Y. & Otsuka K. (2012) Assessing the Impact of Training on Lowland Rice Productivity in an African Setting: Evidence from Uganda. *World Development*, *40*(8): 1610-1618. <https://doi.org/10.1016/j.worlddev.2012.04.008>
- Martin R. J. McMillan M.G. & Cook J.B. (1988) Survey of farm management practices of the northern wheat belt of New South Wales. *Australian Journal of Experimental Agriculture* *28*, 499-509. <https://doi.org/10.1071/EA9880499>
- Masuku M. & Xaba B. (2013) Factors Affecting the Productivity and Profitability of Vegetables Production in Swaziland. *Journal of Agricultural Studies*, *1*(2), 37-52. <http://dx.doi.org/10.5296/jas.v1i2.3748>
- Ministry of Agricultural and livestock Development. (2019) Statistical Information on Nepalese Agriculture. kathmandu: Government of Nepal.
- Mishra A. K. Kumar A. Joshi P. K. & D'souza A. (2016) Impact of contracts in high yielding varieties seed production on profits and yield: The case of Nepal. *Food Policy*, *62*, 110-121. <https://doi.org/10.1016/j.foodpol.2016.05.005>
- Muthayya S. Sugimoto J. D. Montgomery S. & Maberly G. F. (2014) An overview of global rice production, supply, trade, and consumption. *Annals of the New York Academy of Sciences*, *1324*, 7-14. <https://doi.org/10.1111/nyas.12540>
- Paltasingh K. R. & Goyari P. (2018) Impact of farmer education on farm productivity under varying technologies: case of paddy growers in India. *Agricultural and Food Economics*, *6*(1), 7. <https://doi.org/10.1186/s40100-018-0101-9>
- Santiphop T. Shrestha R. P. & Hazarika M. K. (2012) An analysis of factors affecting agricultural land use patterns and livelihood strategies of farm households in Kanchanaburi Province, Thailand. *Journal of Land Use Science*, *7*(3), 331-348. <http://dx.doi.org/10.1080/1747423X.2011.587208>
- Shehu J. F. Iyortyer J. T. Mshelia S. I. & Jongur A. A. U. (2010) Determinants of Yam Production and Technical Efficiency among Yam Farmers in Benue State, Nigeria. *Journal of Social Sciences*, *24*(2), 143-

- 148.<https://doi.org/10.1080/09718923.2010.11892846>
- Siriwardana A. N. & Jayawardena L. N. A. C. (2014) Socio-demographic factors contributing to the productivity in paddy farming: A case study. *Tropical Agricultural Research*, 25(3), 437-444.
- Subedi S. Ghimire Y. N. Adhikari S. P. Devkota D. Shrestha J. Poudel H. K. & Sapkota B. K. (2019) Adoption of certain improved varieties of wheat (*Triticum aestivum* L.) in seven different provinces of Nepal. *Archives of Agriculture and Environmental Science*, 4(4), 404-409.
<https://doi.org/10.26832/24566632.2019.040406>
- Thanawong K. Perret S. R. Basset-Mens C. (2014) Eco-efficiency of paddy rice production in Northeastern Thailand: a comparison of rain-fed and irrigated cropping systems. *Journal of Cleaner Production*, 73: 204-217.
<https://doi.org/10.1016/j.jclepro.2013.12.067>
- Thi Ut. T. and Kajisa K. (2006) The impact of green revolution on rice production in Vietnam. *The Developing Economies*, 44: 167-189. doi:10.1111/j.1746-1049.2006.00012.x
- Thompson M. (1978) Selection of Variables in Multiple Regression: Part I. A Review and Evaluation. *International Statistical Review / Revue Internationale De Statistique*, 46(1), 1-19. doi:10.2307/1402505
- Urgessa T. (2016). The determinants of agricultural productivity and rural household income in Ethiopia. *Ethiopian Journal of Economics*, Vol. XXIV No 2
- Wilson P. Hadley D. and Asby C. (2001) The influence of management characteristics on the technical efficiency of wheat farmers in eastern England. *Agricultural Economics*, 24: 329-338. doi:10.1111/j.1574-0862.2001.tb00034.x