PROSIDING SEMINAR NASIONAL

Bogor, 6 November 2014

PENGARUSUTAMAAN LINGKUNGAN DALAM PENGELOLAAN SUMBERDAYA ALAM: TANTANGAN DALAM PEMBANGUNAN NASIONAL

PS Pengelolaan Sumberdaya Alam dan Lingkungan
Sekolah Pascasarjana,
INSTITUT PERTANIAN BOGOR

ISBN : 978-602-17593-6-3

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KATA PENGANTAR

Prosiding Seminar Nasional ini merupakan kumpulan makalah yang telah diseminarkan dalam Seminar Nasional yang diselenggarakan pada tanggal 6 November 2014 di IPB International Convention Center, Bogor. Seminar ini diselenggarakan oleh Program Studi Pengelolaan Sumberdaya Alam dan Lingkungan, Sekolah Pascasarjana, IPB.

Permasalahan pengelolaan sumberdaya alam dan lingkungan merupakan isu yang berskala nasional maupun global.Indonesia sebagai negara berkembang tidak terlepas dari permasalahan tersebut. Eksploitasi sumberdaya alam yang berlebihan yang tidak memperhatikan daya dukung dan daya tampung membawa dampak lingkungan yang besar pada seluruh ekosistem, termasuk lingkungan tanah,air, dan udara.Kerusakan lingkungan terjadi tidak saja pada ekosistem daratan, tetapi juga ekosistem perairan.

Berbagai kebijakan dan penelitian maupun praktek-praktek pengelolaan sumberdaya alam dan lingkungan telah banyak diimplementasikan.Namun, implementasi praktek pengelolaan sumberdaya alam saat ini belum optimal yang memberikan konsekuensi pada pembangunan yang tidak berkelanjutan.Oleh karena itu diperlukan media yang memfasilitasi sharing pengalaman dan pengetahuan dibidang ini sehingga terwujud pembangunan yang berkelanjutan.

Permasalahan pengelolaan sumberdaya alam dan lingkungan merupakan permasalahan yang bersifat multisektordan multidimensi yang memerlukan penanganan yang bersifat *multiapproach* dan terintegrasi.Oleh karena itu, pendekatan dari berbagai aspek termasuk pendidikan, penelitian, kebijakan, dan praktek di lapangan akan memberikan informasi yang berarti bagi perumusan strategi pengelolaan sumberdaya alam dan lingkungan yang berkelanjutan.

Seminar Nasional yang diselenggarakan PS Pengelolaan Sumberdaya Alam dan Lingkungan ini diharapkan untuk dapat mendokumentasikan dan memperluas jaringan informasi terkait praktek, permasalahan, dan alternatif solusi yang optimal (dari dimensi ekologis, ekonomis, dan sosial budaya) dalam pengelolaan sumberdaya alam dan lingkungan. Karena itu, seminar mengambil tema: Pengarusutamaan Lingkungan dalam Pengelolaan Sumberdaya Alam: Tantangan dalam Pembangunan Nasional.

Dengan demikian diharapkan output seminar yang berupa Prosiding ini dapat memberikan sumbangan pemikiran bagi pengelolaan sumberdaya alam dan lingkungan khususnya, dan pembangunan nasional pada umumnya.

TIM EDITOR

DAFTAR ISI

CHALLENGES FOR VEGETABLE SMALLHOLDER FARMERS IN ACHIEVING AGRICULTURAL SUSTAINABILITY

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Abstract

Agricultural sector plays a significant role in the Indonesian economy and local's livelihood. One of the major stakeholders in agriculture is the smallholder farm sector. Large number of these smallholder farmers (SHF) produces vegetables for commercial and subsistence purposes but they have limited access to agriculture resources including labor, technology and other inputs. The purpose of this study is to identify socio-economic characteristics, agricultural farming practices and environmental variables influencing smallholder's sustainable vegetable production in the villages of Situ Daun and Cinangneng located in the sub-district of Tinjolaya, Bogor regency, West Java. The study uses descriptive and ordinal logistic regression analysis. Drawing on a sample of 96 households, this study shows that 71.09% of the smallholders are not satisfied of their production from land because of the lack of financial resources, heavy rainfalls, and other inputs required for their agricultural practices. Based on the output from logistic regression analysis, crop rotation, agricultural training, member of a farmer's group and land size are the significant variables influencing smallholders yield. Crop rotation and agriculture training are significant variables that positively while member of a farmer's group and land size negatively influenced SHF yield. The study also established that the key requirement to increase smallholder's production is to provide them subsidized fertilizers, pesticides, seeds, farmer's friendly loans and other necessary tools for vegetable farming to ensure constant and sustainable production. Given the dominance of smallholder sector in the economy, the effective utilization of these resources will hinge on the implementation of a set of policies that would allow smallholders to seek greater specialization and improve their produce.

Key words: smallholder farmers, sustainable vegetable production, agricultural inputs, logit analysis

INTRODUCTION

Rural households in Indonesia are involved in a variety of economic activities, as part of complex livelihood strategies (IFAD, 2010). While agriculture remains important, it is not the sole or sometimes the principal activity of poor people (Roshetko *et al.*, 2012). Agriculture contributes the Indonesian national economy, accounting for 15% of gross national product (BPS, 2012-2013). Contribution of agriculture sector to exports was 4% in 2012. Out of 102 million farmers 17 million are smallholder farmers. The average landholding size of these poorest of poor SHF is 0.45 ha. Roshetko (2012) reported that smallholder farmers generally practice mixed-cropping systems, cultivating both annual and perennial crops to produce rice, vegetables, fruits and other staples. Although these traditional systems are environmentally sustainable, management and productivity are often suboptimal. Many smallholders face challenges related to crop production. These include lack of access to sufficient and productive land for expansion, sufficient water, modern irrigation system, mechanization, cheaper and good quality inputs, transport logistics and market information (Hazell, 2011). Smallholder farmers choose crops that grow faster and require less investment. In this regard vegetables are one of the best choices to grow but it needs best management and care to store and sell it.

A more sustainable agriculture (which meets the needs of the present without compromising the ability of future generations to satisfy their own) seeks to make the best use of nature's goods and services as functional inputs. It does this by integrating natural and regenerative processes, such as nutrient cycling, nitrogen fixation, soil regeneration and natural enemies of pests into food production processes. It minimizes the use of nonrenewable inputs that damage the environment or harm the health of farmers and consumers. It makes better use of the knowledge and skills of farmers; so improving their self-reliance. It seeks to make productive use of social capital - people's capacities to work together to solve common management problems, such as pest, watershed, irrigation (Altieri *et al.*, 2012; Pretty & Hine, 2001; Thapa & Gaiha, 2011; Rigby & Caceres, 2001).

Sustainable agriculture technologies and practices must be locally-adapted. They emerge from new configurations of social capital (relations of trust embodied in new social organizations, and new horizontal and vertical partnerships between institutions) and human capital (leadership, ingenuity, management skills and knowledge, capacity to experiment and innovate). Agricultural systems with high social and human capital are able to innovate in the face of uncertainty (Pretty & Hine, 2001).

This study primarily focuses on identifying which farming practices of smallholder farmers are agriculturally sustainable and what factors (social, economic, and environmental) influence SHF vegetable production?

RESEARCH METHOD

Study Area

The Study area comprises of Situ Daun and Cinangneng villages located at sub district of Tinjolaya in the Bogor Regency (Figure 1) where agriculture is the main source of income of the local's livelihood. Both the villages are located at an altitude of 450 meter and 380 meter above sea level respectively. According to the Central Bureau of Statistics, Indonesia (2012) total population of Situ Daun was 8 678 with a total land size of 3.29 km^2.

The population density in Situ Daun village was 2 638 persons/km^2 while the total population of Cinangneng village is 8 660 with a population density of 4085 individuals/km^2. The total land size of Cinangneng village is 2.12 km^2. The mean monthly rainfall in both villages was 15 days and 245 mm for the year 2012. The field surveys were conducted between July-August 2013 following by data analysis in the October 2013.

Selection of Sample Data Collection

There were 20 and 23 neighborhoods (Rukun Tetangga "RT") in the villages of Situ Daun and Cinangneng respectively. For primary data collection the neighborhoods were selected randomly (Simple Random Sampling) while the households were selected purposively on certain basis i.e. a household has to be involved in any kind of agriculture or horticulture activities, a household should own/rent land less than or equal to 2 hectares (definition of smallholder on the basis of land occupation) (Joshi, 2006) a household should be largely dependent on family labor and a household can decide independently on what to grow and where to sell agricultural products.

The sites were chosen for this research because most of the farmers grow vegetables there, they are economically marginalized, lacking the necessary requirements for doing good agriculture practices (GAP). The study covers only the producer's perceptions regarding participation in supermarkets. It also covers the level of awareness of those farmers regarding the standards for the quality and quantity of agricultural commodities and products.

Table 1 Population and sample size of the study area

Characteristics	Villages	
	Situ Daun	Cinangneng
Total population of the village (persons)	8 678	8 660
Total population involved in agriculture (persons)	660	680
Land holders (persons)	330	245
Sampled Population (households)	49 (15% of the total landholders)	47 (15.62% of the total landholders)

Source: Central Bureau of Statistics (BPS) 2012

Primary data was gathered on household level through household surveys with the farmers by using both closed and open ended questions. The questionnaire was divided into different sections starting from the very general characteristics of the respondents, assets of the household and awareness of a respondent regarding participation in supermarkets, agricultural production and supermarket accessibility, institutional support for participating in supermarkets, good agricultural practices and environmental sustainability. A sample of 104 farmers was selected purposively for the study from the villages of Situ Daun and Cinangneng in Bogor Regency. After cleaning process the data of 8 respondents was eliminated since they were not owning, renting or contracting the land. They were only working on daily wages on someone else land which was not the criteria to choose respondent for this study. Hence out of 104 respondents 96 were included in the analysis accounting for about 15% of the total land owing farmers in the villages. Detailed information was collected on their socio-economic conditions, institutional support from government and non-government bodies, landholding, type of fertilizer and pesticide use, irrigation facilities, shifts in cultivation, crop rotation, livestock holdings, and access to market information. It needs to note that prior to the survey, a village level study was carried out applying Rapid Rural Appraisal (RRA) technique to gather data and information about sub-district Tajolaya as basis for village selection.

Direct field observations were made to cross check the data obtained from interviews. The additional information from direct field observations was used in the analysis to complement the information gathered from the questionnaire. Secondary data was collected from existing and available literature in hard form such as thesis, dissertation, Journals, internet, and other Government related bodies/organizations.

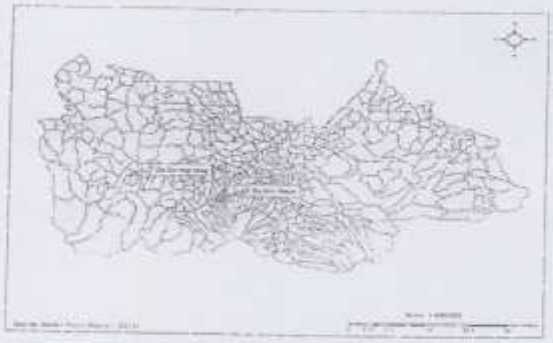

Figure 1 Map of the study area

Data Analysis

From the survey, descriptive statistics on environmental, agricultural, social, economic and the aspects of awareness level of smallholder farmers is generated

to determine their farming activities, tillage practices, household's assets, cropping patterns, selling sources, constraints to smallholder farmers in accessing their production to supermarkets and their perceptions regarding participating in supermarkets.

Using farmers and farm characteristics including socio-economic, agricultural and environmental, an ordinal logistic regression model was estimated to determine the dependency of yield on crop rotation, pesticide use, fertilizer use, agricultural training, member of a farmer's group, access to market information, age of the household, gender, education, size of the household, time spent in agriculture and land holding size.

Determinaw of Dependent Variable

Sustainability was analyzed through the q antity of yield and was divided into three categories with codes assigned to it (an increase in yield was coded as 3, if constant then 2 and if yield is decreasing then was coded as 1).

Selection and Coding of Independent Variables

A total of twelve independent variables were included in the logistic regression model to analyze dependency of yield. Specific codes were assigned to all variables.

An independent variable 'Crop Rotation' was created by scoring method. If a farmer is rotating his crop(s) then it was coded as 1, otherwise 0. It was hypothesized that a farmer doing crop rotation will be having a higher yield which means that this is sustainable agriculture, otherwise not. Pesticide utilization was another independent variable to analyze how much yield was dependent on it. A farmer using pesticide was coded as 1, otherwise 0. The assumption made was that if a farmer is using pesticide then his/her yield will be less and that means that the agricultural he is practicing is un-sustainable and vice versa. Fertilizer utilization was a dummy variable created by scoring method. It was assumed that by using organic fertilizers, yield will be higher and agriculture will be sustainable otherwise not. Organic fertilizer use was coded as 1 and in-organic as 0.

Agricultural Training (years) was coded as (received=1, 0 otherwise). Farmers who have received any kind of agricultural training were expected to have higher yield. A farmer who shares resources within 'farmer's group' was desired to have higher yield and was coded as 1 otherwise 0. A farmer who has 'access to market information' was coded as 1, if not than 0. It was expected that a farmer keeping himself aware of the current updates about market will try to adjust his/her agriculture according to the demands of the market and will have higher yield. Age of the household (years) was a continuous variable. Original ages of the respondents were used for logistic regression analysis. It was assumed that older farmer will be more mature will cares about his agricultural production to support his family. The assumption was that he/she will be having higher yield.

Gender was another dummy variable used to separate the sex (male or female) of the respondents and was created by scoring method. A score of 1 was given to male and 0 to female farmers. Historically male are more engaged in agriculture compare to females, however the scenario has been changing since last decade. Households headed by male farmers were expected to have higher yield than those headed by female. Female famers are also starting to adopt vegetable farming due to the direct benefits it offers (Tiwari *et al.*, 2008a). Education (years) was used as a continuous variable. It was hypothesized that education of the respondent will be positively related to yield. Educated farmers are more likely to be practicing sustainable agriculture will be having higher yield (Nkamleu *et al.*, 2000) Size of Household (persons) was a continuous variable and it was hypothesized that large households will be having higher yield because the total number of laborers involved in farming activities from their families will be more. Farming time (years) was a continuous variable. It was expected that farming time will be positively related to yield i.e. more experience-more yield. He will also be having knowledge of good agricultural practices. Landholding Size (m^2 or hectare) was the last continuous variable included in the model and was expected to have positive relationship with yield.

RESULTS AND DISCUSSION

In this study information about socio-economic profile and current assets of the smallholder farmers was collected. Indicators used for Socio-economic profile includes age, gender, education level, marital status and size of the household while assets of smallholder farmers included in the study were hand phones, car, motor bikes, water pumps and mist blower, poultry, goats, television, home, radio, and storage house for vegetables.

From the survey, it was discovered that there were total 96 smallholder farmers that were interviewed. Out of this total 13.54 % were in the age category of between 20-29 years old, 22.91% smallholders were from 30-39 years old category, 26.04% respondents were in the age category of 40-49, while 37.5% smallholder in the 50 and above age category. Out of the total sample; 22.91% respondents were female and 77.09% were male.

The traditional gender imbalance dominated by males associated with farming was present in smallholders growing vegetables. In terms of education, the findings showed that of the stallholders, 10.41% had 0-2 years of education, followed by 75.0% with 3-5 years of education and 14.59% had 6 or above years of education. The survey also investigated that 96.87% smallholders were married and 3.13% unmarried. For household size 45.83% smallholders said they are in 1-3 people's category, 48.95% were in 4-7 people's category while 5.22% were in 8 or more than that people living in one household category. The survey discovered that 34.37% smallholder were involved in farming (both agriculture and horticulture) for less than 10 years, 26.04% of the sampled respondents were involved in farming between 11-20 years, followed by 16.67% of them between 21-30 years and 22.92 in the age category of 31 or above.

The study conducted in Bogor Regency explored the assets of the sampled smallholders. The study included hand phones, cars, motorbike, water pumps for irrigating their lands, livestock, television, house/home, radio, storage house to the survey.

The assets we included into the survey are mainly those that can help respondents in carrying their production to the market, or mediums used for listening news about agriculture like TV, radio, and hand phones. In total 96 smallholders were asked about their assets. Out of this total, 36.45% respondents had hand phones following by 63.54% who answering no. 7.29% owns car and 92.71% do not have any car. 37.5% sampled smallholders have motor bike following by 62.5% that do not have motor bikes. Water pumps are a source to irrigate their fields and that is why it is very important for farmers to have their own. In our survey, 42.70% smallholders own water pumps while 57.30% do not have water pumps. 47.91% have chicken and ducks in their homes while 52.09% do not have poultry. Out of the total 96 smallholders, 22.91% reported that they have goats while 77.09% do not have. The findings also showed that 88.54% form the total sampled respondents have television following by 11.46% that do not have television. All the sampled respondents live in their own home. The results showed that 20.83% smallholders have radio to listen news at. This includes news about agriculture as well (i.e. fertilizer aid, pesticide, market prices etc.). 79.17% respondents did not have this feeility. Storage house is an important element to keep vegetables fresh. Unfortunately, in the study area only 5.20% smallholder have storage house while 94.80% did not had it.

Landholding Size of the Smallholders

This section presents results on land holding size of the smallholder farmers. The landholding size in the study area is less than average farm size in Indonesia as reported in the agricultural censuses of 2003 and 2013. According to the census, Farm considered small farms are about 0.79 ha (Sahara *et al.*, 2012).

The findings reveal that of the total smallholders interviewed, 14.58% have the land size of less than 1 000 m.square, 68.75% have land size between 1 000-5 000 m.square, 15.62% have more than 5 000 m.square while 1.04% respondents did not know his agricultural land size. The average holding size of the farmers in the survey area was 4 466.15m^2 or (± 0.45ha).

Production Portfolio and Smallholders Satisfaction form Land

This section includes production portfolio and smallholder farmer's satisfaction regarding production from land. The sampled smallholder farmers in the study area primarily depend on agriculture. Their production portfolio in the study area was a mix of vegetables, food grain crops. The principal occupation of a majority of the farmers was cultivation of vegetables. Food grain crops were cultivated to meet the household food security needs.

The sample households allocated large share of their cultivated land area to vegetables. Mustard green, cucumber, eggplant, long beans, sweet potatoes and

spinach, onions, tomatoes were the main vegetables. Mustard green was the principle vegetable preferred by all. Smallholder farmers preferred vegetables, which were labor intensive, short duration and generated regular income. For example mustard green, sweet potato, eggplant, long beans, cucumber, tomatoes, onions were short duration crops, required almost uniform labor throughout the production cycle unlike paddy, cereal and pulses and generated regular income as well. The survey investigated the production of a principal vegetable for the previous year (2012). The principal crop was mustard green. Out of 93 smallholder farmers 56.98% were from less than 15 ton/year category, while 37.63% were in the production category of 15-30 ton/year. 3.12% of the smallholders were in the category of 31-50 ton/year and 2.15% mentioned their production is above 50 ton/year. Four respondents were not able to mention any value of their production because they were involving subsistence farming.

In terms of farming time, 35.41% farmers were involved in farming for less than or equal to 10 years. 42.72% were involved for 11-30 years. 22.87% were involved for more than 30 years. The low income, inefficient and insufficient availability of inputs always restricts smallholder's productivity (Hazell, 2011). The study also experienced such condition in the study area. 28.13% farmers were not satisfied with the production of their land while 71.87% were satisfied.

Out of 27 farmers that were not satisfied from their production was because of several reasons like high prices of good quality seeds, heavy rainfalls destroys vegetables quickly and easily, lack of family involvement (agriculture is becoming less important because of the continuous decrease in total production). Lack of inputs was the main concern of sampled households in increasing their production. 48.14% of the total farmers that were not satisfied of their production consider financial resources, technology, seeds, pesticides and fertilizers as the dominant resources that they lack. Natural setting or position of land also disturbs desired production. Smallholder farmers (71.87%) that were satisfied of their land's total production were of the opinion that if provided better quality agricultural inputs they can further improve their production.

Agricultural Sustainability related Farming Practices of Smallholder Farmers

The goals and values of long-term sustainability must be reflected in combinations of practices and methods consistent with an individual farmer's resources, including farmer's knowledge base, technical know-how, and farming opportunities. Millions of small farmers in Indonesia do not have a good resource and knowledge base, and this limits their capacity to pursue sustainability goals. Majority of sampled smallholders (87.5%) were satisfied with the quality of their vegetables while 12.5% were not because of its bad taste, reduced size proolems. The smallholders believed those problems could be controlled by controlling the disease and its vector. Out of total sampled smallholder, 28.13% farmers were not satisfied with the quantity of yield while 71.87% were satisfied. The reasons

of un-satisfaction were lack excessive rainfalls, lack of good agricultural inputs, financial resources that diminishes their total yield.

Agricultural inputs unavailability and small landholdings were the most important hurdles for smallholders to improve productivity sustainably. It is a priority task to develop technologies, crop protection, fertilizer efficiency and soil management that are relevant to small farmers. Out of the total respondents, 95.83% were using pesticides to control diseases following by 4.17% that were not using any kind of pesticides. Crop rotation was considered as one of the important technique of modern sustainable agriculture because it gives soil time to use its nutrients in a sustainable manner. In sampled farmers, 84.37 respondents were rotating crops which keep crops safe from diseases and also a source of keeping soil healthy while 15.63% were growing the same kind of vegetables without rotating it to another crop type. In terms of soil analysis it was very interesting to know that none of the sampled smallholders have ever analyzed their soil in order to know its suitability for the desired vegetable. Shift in agriculture for the last five years was examined. Majority of the farmers (70.83%) were growing vegetables since last five years following by 29.17% who shifted to horticulture form maize and rice crops.

Table 2 Smallholder farmers agricultural sustainability related practices

Question	Response	Percent
Satisfaction with the quality vegetables	Yes	87.50
	No	12.50
Satisfied with quantity of vegetables	Yes	28.13
	No	71.87
Do not use chemical pesticide	Yes	4.17
	No	95.83
Crop rotation	Yes	84.37
	No	15.63
Soil analysis	No	100.0
Shift in agriculture practices	Yes	29.17
	No	70.83
Trend in yield	Increase	35.41
	Constant	36.45
	Decrease	28.12
Utilization of organic fertilizers	Yes	1.04
	No	99.06
Storage House	No	94.80
	Yes	5.20

During last five years trend in yield was explored. Out of total sampled farmers 35.41% have experienced increased in their yield, 36.45% have realized that their yield was constant and 28.12% experienced decrease in yield. It is also believed that smallholders are usually more vulnerable and exposed to seasonal shocks like droughts, floods and heavy rainfalls which destroy their produce. In this study results showed that 44.79% smallholders have never experienced any drought, flood or heavy rainfalls. Out of the total sampled respondents 37.5%

have experienced disturbance from excessive rainfalls and 11.45% from floods. According to 99.06% respondents' organic agriculture needs more labor to take care of vegetables and soil. It also needs more energy, labor, technology and always diminishes production. Respondents reported that they are aware of the supermarkets requirement in order to sell produce in supermarket. Respondents prefer to practice inorganic agriculture because it need less energy, money and labor compare to organic agriculture. Unfortunately, in the study area only 5.20% smallholder have storage house while 94.80 do not have storage house.

To assess the sustainability of vegetable growing smallholder farmers, this research used a criteria; i) less than 40% of respondents responded as "yes" then that agricultural practice would be considered as un-sustainable, ii) if the responces "yes" were between 40-60% then it was considered as moderate and if more than 60% responses were "yes" then it was considered as sustainable. Based the criteria used for assessing sustainability related agricultural practices of smallholder farmers; crop rotation was the only variable that led to sustainability and the reponses were 87%. Seven practices of smallholder farmers were un-sustainable including; quality and quantity of vegetables, pesticide and chemical fertilizer utilization, soil analysis, shift in agriculture and storage house while agricultural trend was found as moderately sustainable.

Determinants of Sustainable Agriculture of Smallholder Farmers

The logistic regression analysis was used to estimate the extent to which socio-economic or demographic characteristics and attitudes influenced smallholders yield. The dependent variable "yield" which had three categories i.e. yield increased coded as 2, constant coded as 1 and decreased coded as 0. The estimated factor scores were then used in an ordinary logistic regression analysis along with selected socio-economic agricultural factors, such as crop rotation, pesticide usage, fertilizer usage, agricultural training, member of a farmer's group, access to market information, age, gender, education level, size of household, time spent in agriculture, land size.

The estimated logit model was statistically significant with a likelihood ratio test probability of P-Value = 0.236, overall percentage of right prediction was 69.6%, Chi-Square was -97.307, degrees of freedom were 12 which indicates joint significance of all coefficient estimates. The estimated coefficients are tested by using standard errors, t-ratios and P-values. A positive sign on the statistically significant parameter estimates of one variable indicates the likelihood of the response increasing, holding other variables constant, and vice versa. The model output revealed that out of twelve variables three positively (crop rotation, agricultural training and farming time) and three negatively (member of farmers group, access to market information and land size) influenced the dependent variable. However two out of six variables (member of farmer group and land size) were statistically significant at 10% following by four (crop rotation, agricultural training and farming time and access to market information) were significant at 25% confidence interval and influencing the

production of smallholders. Thus, the smallholder characteristics in the ordered model for equation are relevant in
explaining the importance of yield sustainability. The results indicated that, the farmers' characteristics play an important role when explaining the importance of sustainable agriculture.

Many studies in the literature reveal that crop rotation led to increase in productivity and soil fertility, resulting in high crop production in the long term (Bajracharya, 2002; Karki, 2006). Crop diversity, on which agriculture is heavily dependent, is being lost at a rapid rate (van Dooren, 2009). Today's farmers rely on a narrow range of crop varieties, which can result in disasters due to plants' vulnerability to pests and disease. Homogeneous modern agriculture threatens genetic diversity, and thus threatens both local and global food security (Vernooy, 2003). The genetic diversity of crops has enabled plant breeders to produce varieties with traits such as improved yield, shorter stem length, and pest and disease resistance. Losing this diversity will jeopardize our future ability to adapt to changes in climate and farming conditions. It was assumed that those smallholders who do crop rotation will enjoy the maximum yield. The results expectedly show a positive response. Smallholders rotating their crops each time they grow vegetables are more likely to increase yield. This value is significant on 77% confidence interval. Trained smallholders with knowledge of agriculture were assumed to be having higher yield from their lands. The logistic regression model showed significant and an expected result. Farmers working in groups have easy access to inputs because of the resource sharing among the groups. On the basis of this we assumed that smallholder working in groups will be having increased yield. The result was significant. Famers working in groups or unions had fewer yields compare to those working individually. Access to market information or any other social media was another variable used in the model. It was expected that those smallholders who have access to social media will be aware of the market prices, good quality fertilizers, pesticides and other agriculture related news. Unexpectedly results showed that access to market information did not have significant impact on yield. It was expected that smallholders having large land will have increased yield but the results showed negative response. The smaller the land they had the higher was the yield. It was because of their economical marginalized condition i.e. if they have large land but do not have access to inputs then they cannot cultivate all the land. It also needs labor, money, time and energy. Labor and money were the two constraints that smallholders of the study area were lacking.

Pesticide and fertilizers use, gender, age, education level, time spent in agriculture and size of the household unexpectedly showed insignificant results. Odd-ratios were calculated for the logistic regression model. Odds are determined from probabilities and range between 0 and infinity. Odds are defined as the ratio of the probability of success and the probability of failure. The probability of smallholder farmers rotating their crops had 1.23 times more for recieving higher yield than those that are not doing crop rotation. This is because

of the fact that rotating crops uses soil nutrients eqaully and according to the nature and need of the crop, and crops also have less chance of attack from pests. Agricultural training was significant at 0.211 willingness level and trained farmers had 1.58 times more chance of getting higher yield than untrained smallholder's farmers. Results of logistic regression model indicated a negative response for farmers working in farmer's groups. Estimated coefficient for member of a farmer's group was negative and 0.76 times less likely to have higher yield compared to those working individually on their lands. Smallholder farmers make opportunistic groups to recieve goverment aid and then work induvidually on their land after distributing the aid. Respondents who have indicated no access to market information had 0.40 times higher yield than those who have access. The response land size also negativeiy influenced the probability of smallholders having higher yields i.e. 0.32 times less likely.The marginalized condition and lack of access to good quality agricultural inpets limits smallholder farmers to manage large lands. Hence, It was experienced that farmers with small lands were more efficient in producing higher yield and better manage their lands.

Table 3 Determinants of sustainable vegetable farming

Variable	Coefficient	Standard Error	P-Value	Odd Ratio
Crop Rotation	0.809614	0.627473	0.202*	2.23
Pesticide Use	-0.353261	1.010620	0.727	0.70
Fertilizer Use	0.530911	0.557006	0.341	1.70
Agriculture Training	0.946504	0.756556	0.211*	2.53
Member of a farmer's Group	-1.415070	0.726948	0.052**	0.24
Access to supermarket Information	-0.507454	0.425841	0.233*	0.60
Gender	-0.486869	0.484018	0.315	0.61
Education Level	0.389074	0.460290	0.398	1.48
Age	0.824615	1.005029	0.412	2.28
Farming time	0.398428	0.340999	0.243*	1.49
Size of Household	0.165907	0.514311	0.747	1.18
Land Size	-0.383646	0.202191	0.058**	0.68

** Significant at α = 10% and * significant at α = 25%. Log-Likelihood = -97.307, Df = 12, P-Value = 0.236.

In order to assess how well the model fits the data, Goodness of fitness test statistic was developed and a chi-square test from observed and expected frequencies were compared. As shown in the model for has P value of 0.236, which confirms that the fit of model is good.

CONCLUSION AND RECOMMENDATIONS

This Study has provided information about socio-economic, agricultural and environmental constraints to smallholder farmer's in producing vegetables

sustainably. Information is also provided on the requirements of smallholders to produce vegetables sustainably. The results suggest that most farmers view increase in production favorably. Smallholders strongly identify the small sizes of their lands and lack of purchasing power to buy good quality of inputs for their agriculture practices as the main area of interest. They demanded inputs from government including trainings, soft loans, good quality fertilizers, pesticides, and seeds. Smallholders emphasized on lack of support from both public and private sector. The results also indicates that small farms need to raise their productivity through access to better technologies, good quality agricultural inputs, improvement in infrastructure facilities, external shocks emerging from weather and improved management practices, while at the same time achieving more environmentally sustainable patterns of production. There is urgent need for the kinds of sustainable intensification that significantly raise farming produce. This will require the best of modern science, the best of indigenous knowledge and ecological literacy. This kind of knowledge intensive farming requires new approaches to research and extension, as well as an enabling policy environment. The both public and private sector has little incentive to invest in this kind of for small farms, and the public sector has to play a bigger role to keep the farmers in the equation.

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