Evaluating Sustainable Agribusiness Farming Practice in Markham Valley of Huon Gulf District, Papua New Guinea (PNG)

Riwasino John[1] and William Kerua[2]

1: 1P O Box 4150, Allotment 16 Section 155, Aquari Ave, East Taraka Lae 441, Morobe Province
Email: jkriwasino@gmail.com

2: Fiji National University, Department of Agribusiness and Extension.
Email: wkerua69@gmail.com

Abstract

Sustainable farming is based on social, economic, environment and psychological viability that enhance economic growth and reduce poverty improve farmers livelihood and wellbeing in the project impact communities. Study intended to investigate the opinions of farmers on tree farming agribusiness on its impact on their livelihood and wellbeing. Study involves cross-sectional research design and the primary field data was collected from local communities of PNG Biomass project impact area in Markham Valley of Huon Gulf District, Papua New Guinea (PNG). Both qualitative and quantitative method are being used to collect primary field data. The main data collection instrument were survey questionnaires, interview, and field observation and assessment. The study selected 10% of total sampling population of 500 tree farmers in order to collect data, analysis data and provide solution to the research problem. The primary data from the field were analysised, processed and interpreted using Ms excel and Statistical Package for Social Sciences (SPSS) software.

Findings about farmers' view on farm sustainability founds that farming for income was ranked highest, and farming for improving ecosystem and bio-physical environment were ranked lowest. Further study into farmers' household unit living standard and wellbeing using Multidimensional Poverty Index (MPI) shows that farmers in Markham Valley were found to be multidimensionally poor.

Study recommends for wider community awareness about importance of PNG Biomass tree farming project. Study also recommends for financial literacy training that may improve farmers' knowledge in farm income management, usage and control.

Key words: agricultural business, farm sustainability, farmers wellbeing, financial literacy training

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Introduction

Research background

The farm business promotes economic growth, livelihood improvement and wellbeing of the people in the rural communities. According to Kahan (2013) and Singh (2014), agribusiness and farming is a technology based enterprise in agriculture that provides new ways of improving productivity and further promote sustainable production to meet the market demand.

Tree farming is the PNG Biomass project in Markham Valley of Huon Gulf district, Papua New Guinea. PNG Biomass tree farming is undertaking the development of high-value, nature-based conservation forests within the Markham Valley, Papua New Guinea, through the reforestation of underutilized grasslands and used land. The significance of PNG Biomass project is to reduce greenhouse effect, global warming and climate change through carbon sequestration process from planted trees and their biomass. The PNG Biomass tree farming project also contribute towards rural economy and cash income through land lease payment, employment opportunities and other spin-off benefits.

PNG Biomass tree farming is a value-added based project that enhances sustainable land use and promotes food security in the rural communities of Markham Valley. The project does not only provide employment opportunities but also solve social.

Research problem statement and objectives

PNG Biomass tree farming project started in the year 2011 whereby it provides enormous monetary benefit for the local communities in the Markham Valley over the years of project development. However, there is insufficient information available to confirm and verify the impact of project on rural people's livelihood and well-being. Hence, the study intended to investigate the farmers' opinion on role of farming on farmers' livelihood and well-being by evaluating farm sustainability and household unit living standard particular the PNG Biomass project tree farmers (growers) of the Markham Valley in Huon Gulf District, Papua New Guinea (PNG).

Research Site and Methodology

Study Area

Primary field data was collected from local communities of PNG Biomass project impact area in Markham Valley of Huon Gulf District, Morobe Province, PNG. Figure 1 shows the map of study area in Markham Valley of Huon Gulf District.

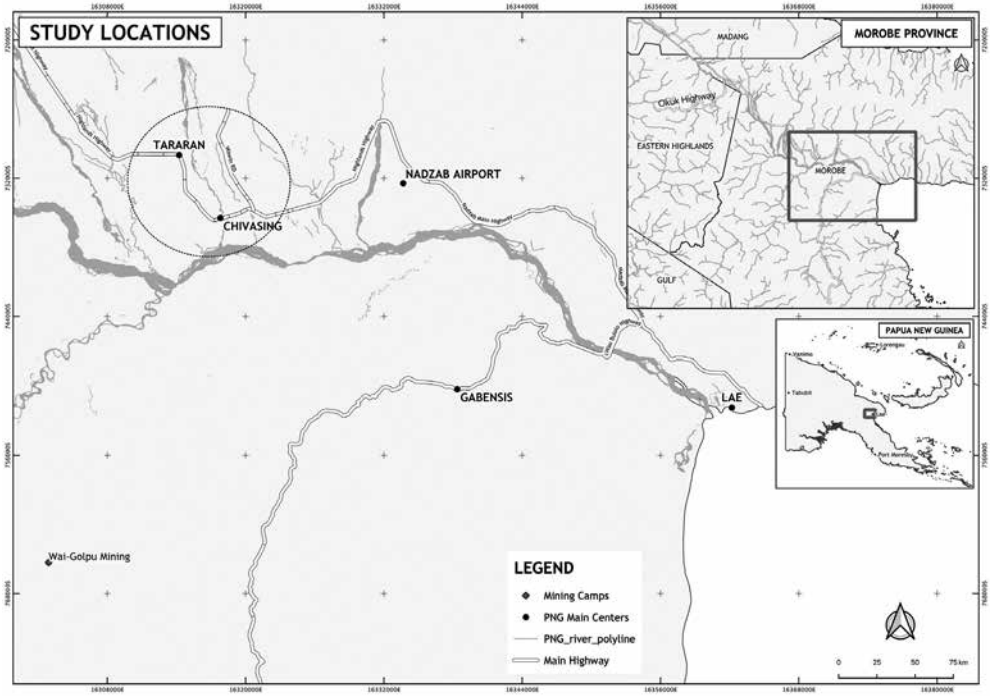


Figure 1. Map of study area, PNG Biomass Project in Markham Valley of Huon Gulf District, PNG. Source: https://www.google.com › earth, (January 2023).

Research design and method

The study involves a cross-sectional research design that provides a statistical data base. The cross-sectional design aims at finding out the prevalence of a phenomenon, situation, problem, attitude or issue by taking a cross section of a population once to give an overall picture (Setia 2016). The cross-sectional study, research design was based on both qualitative and quantitative research approaches, a mixed research design strategy. The cross-sectional research design is being instigated by contemporary issues and problems affecting peoples' livelihood and wellbeing due to the impact of project development over the period of time. The focus of cross-sectional research in this study was to systematically capture primary field data and then further analysis the data in order to provide solution to the research problem. Both qualitative and quantitative method are being used to collect primary field data for statistical analysis.

Theoretical concept and conceptual framework

The theoretical framework represents by various variables which include independent, intervening and dependent variables (Table 1). According to Patel (2009), variables are concepts, characteristics, or properties that can vary, or change, from one unit of analysis to another. Leggett (2011), point out that any event, situation, behavior, or individual characteristic that varies. In scientific research, selection and measurement of variables is an important task (Guyon and Elisseeff 2003). Guthrie *et al*. (2004) further elaborate that

it requires careful selection of units for the collection of, analysis and reporting of the data. An independent variable is that factor which cannot be manipulate in attempt to ascertain its relationship to an observed phenomenon whereas a dependent variable is the factor, which appears, disappears or varies as the researcher introduces, removes and varies the independent variable (Kaur 2013).

Table 1. The theoretical framework represents by the main variables. The three main variables of independent, intervening and dependent variables.

Independent Variables	Intervening Variables	Dependent Variables
• Socio-economic characteristics - Age - Education - Farm size - Family size - Income - years of farming experience - Operational land holding	• improve and sustainable farming practice and management; • positive behavioral change; • Greater livelihood improvement.	• farm practice and management efficiency; • influence of farming on farmers attitude, behavior and perception • effect of farming on farmers livelihood and wellbeing

Source. Author's own study, (January 2019).

The sustainable farming entrepreneurship conceptual framework (Fig. 2) is based on evaluating social, economic, environment and pyschological viability. The social aspect of sustainable farming concern about farmers' livelihood and wellbeing, economic sustainability is about financial management particularly farmers income and spending or expenditure of the tree farming business and environmental aspects that captures evalauting terrestrial ecology and hydro-biology and, its impact on the human environment. The psychological evaluation is based on farmers' attitude, behaviour and perception about farming entrepreneurship.

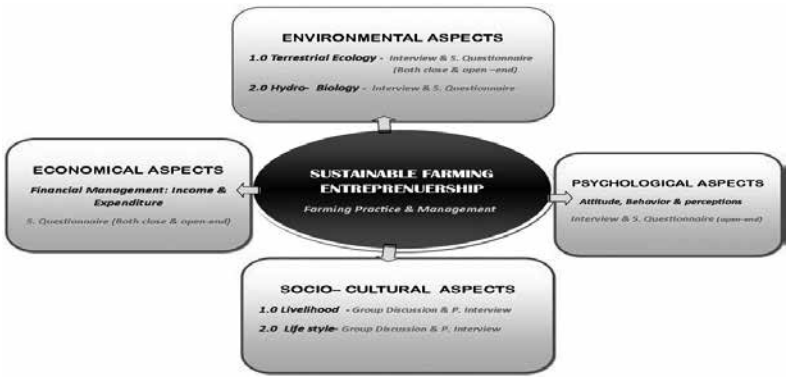


Figure 2. The Sustainable Farming Entrepreneurship Conceptual Framework.
Source. Author's own study, (January 2019).

Data collection instrument

The main data collection instruments were survey questionnaires, interview, field observation and assessment. The survey questionnaires are being used in this study to collect specific data of interest for analysis in order to provide answers to the research problem statement. The two main approaches were distribution of survey questionnaires to the tree farmers whereby the farmers themselves filled in the blank questionnaire, and interview the concern tree farmer through face to face interview and then jotted the sediment from the farmer during the conversation.

The interview was carried out to capture the in-depth stories of respondent through asking personal questions and opinion about issue experience of the person interviewed in regard to the cause-effect relation of the PNG Biomass project and tree farming business. During the interview, specific question about the impact of the PNG Biomass project is being asked and the interviewee responded to the question by answering and providing views, opinion and reaction towards the effect of the project in the community.

The interview captures the farmers view and opinion on farm sustainability, farmers living standard and wellbeing. During the interview process, specific questions were asked regarding farm sustainability of social, economic, environment and cultural aspects as indicated on the flow chart (Fig. 3). For example, the farmers' views on social sustainability were captured in regard to availability of timber for building and fuel wood.

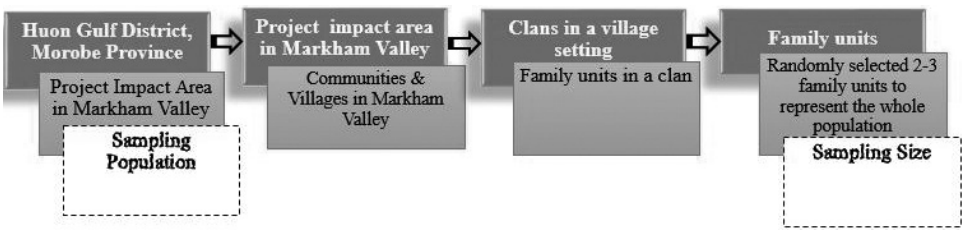


Figure 3. Sampling Population Flow Chart.
Source: Author's own study, (January 2019).

Further, the survey and interview were conducted to investigate impact of farming on farmers living standard and wellbeing. The questions were based on farmers' household indicators which include: education level, health status, and the living conditions of farmers. The underlining factor was to investigate poverty status of the farmers' household. The data were processed analysised using Multidimensional Poverty Index (Fig. 4).

After the interview, field observation and assessment were conducted to verify and confirms farmers' views and opinion on farm sustainability indicators particular social, economic, environment and cultural aspects. The observation and assessment was carried out to evaluate the impact of PNG Biomass project in Markham Valley of Huon Gulf District.

Sampling Strategy and Sample Size

The purposeful sampling technique was employed to collect primary data from the study area. According to Taberdcost (2016), purposeful sampling is an approach whereby vital information is being obtained from selected site from other choices. In other words, primary data from study area were collected through identification and selection of information-rich cases related to the phenomenon of interest.

The two main sampling techniques applied during the study were criterion and random purposeful sampling. The purposeful criterion sampling technique was employed to collect information rich case in which it captured the in-depth stories of respondent during interview process Patton (2002) point out that "criterion sampling involves selecting cases that meet some predetermined criterion of importance" (p.238). Palinkas *et al*. (2015) further added that criterion purposeful sampling is more applicable for implementation research which is more consistent with recent or current trend of developments.

The purposeful random sampling for collecting quantified data in a sample population. It is based on a population of interest and developing a systematic way of selecting cases that based on advanced knowledge of how the outcomes would appear (Benoot *et al*. 2016, Naderifar *et al*. 2017)

In this study, primary data were collected from 8 clans with total population of 500 people who leased land area for tree farming business. The choosing and selection of sample size involving randomly selecting 2-3 family units from each clan to represent the whole population as a sample size.

Data Processing Procedure

The primary data from the field were processed and analysised under farm sustainability, and the farmers' living standard and well-being.

Farm Sustainability Evaluation

The farm sustainability evaluation was based on four main indicates: social, economic, environment and cultural effects of farming. The primary data collected from the field were analyzed using data reduction and consolidation process.

Process 1: Data Reduction

The data reduction was the first process whereby primary data collected from the field through field notes, interview transcripts, and observations are being assembled or put together in order to minimize or reduce and further discard irrelevant data. The reduced data is being organized through coding using Microsoft excel and Statistical Package for Social Sciences (SPSS) software and then further summarize to give a manageable size for the data.

Process 2: Data Consolidation

The second process was data consolidation in which reduced data organized through coding in order to establish new data sets. The consolidated data were analyzed using formulae below to determine the sustainability of the project development and management.

Sustainable Farming Entrepreneurship Index (SFE Index)

$$\text{Sustainable Farming Entrepreneurship Index} = \frac{[(NR \times 1) + (R \times 2) + (SR + 3)]}{\text{Total number of sample (TNS)}} \times 100$$

Weight: L= 1 M = 2 VM = 3

Little (L): Much (M): Very Much (VM)

Figure 4. Formula and Calculation.
Source. Source: Author's own study, (January 2019).

The respondents were asked about level of farm sustainability concerning social, economic, environmental and cultural sustainability as shown on Table 2. The respondent ranked and scored by choosing one of the three: (i) Little (1), (ii) Much (2), (iii) Very Much (3). The figures in the bracket were the weights assigned to each level. For example, the interviewing farmer was asked, "what is your view and opinion about the impact of tree farming project on skills and knowledge under social sustainability"? If the farmer respondent and ranked, 'very much', it was scored 3 as it is the weight assigned to the level. These also applied to other indicators for farmers' view on the social sustainability.

For example, three farmers were interviewed whereby first respondent graded as little, second farmer level as much and the third respondent ranked as very much in which scoring were 1,2 and 3 respectively. Using SFE formulae to calculate, the total scoring will be 650 points on SFE index

$$\frac{[(1+4+9) \times 100]}{3}.$$

Table 2. Farm Sustainability Assessment & Evaluation.

	Ranking
1.0 Social Perspective	
Timber for building material	
Fuel wood source	
Aesthetical value	
Recreational value	
Food and nutrition value through inter-cropping	
Knowledge and skills	
2.0 Economical Perspective	
Cash income through lease and contract payment	
Cash income through inter-cropping	
Other spin-off monetary benefits	
3.0 **Environment Perspective**	
Improve soil fertility	
Reduce soil erosion	
Biophysical aspects e.g. the land are becomes much better and attract animal life	
Improving Ecosystem-	
Water storage and supply	
4.0 Cultural Perspective	
Spiritual richness	
Cultural heritage site	

Source. Author's own study, (January 2019).

However, the SFE Index with highest value was ranked as the first; next highest as second and so on in a descending order to the lowest. If FSE index of skills and knowledge was highest, it may have ranked first followed by other indicators in the social sustainability.

Socioeconomic Characteristics of Sustainable Farming Entrepreneurship (SFE)

The socioeconomic characteristics analysis for sustainable farming was determined by FSE index calculation and analysis that tabulated on chronological order as shown on Appendix I (Table 9). From Appendix I (Table 9), the two top highly scored and ranked sustainable faming indicators were selected to do socioeconomic analysis of sustainable farming entrepreneurship.

Standard Deviation (SD) Calculation and Process.

The **SD** calculation is based on formulae (See Fig. 5) and it involves process describe below.

Step 1: Find the mean of the data set, which is represented by the variable μ.

Step 2: Find the distance from each data point to the mean (i.e., the deviations) and square each of those distances.

Step 3: The symbol ∑∑sum means "sum", so add up the four values that found in Step 2

Step 4: Divide the result from Step 3 by the variable N, which is the number of data points.

Step 5: Find the standard Deviation (SD) by taking the root square and then round it off to nearest.

$$\mathrm{SD}_{\mathrm{sample}} = \sqrt{\frac{\sum |x - \bar{x}|^2}{n-1}}$$

Figure 5. Standard Deviation Formula and Calculations.
Source. Retrieved from http://www.khanacademy.org › summarizing-quantitative-data, (JANUARY 2019).

Table 3. Mean (Units and Measurement).

Characteristics	**Units**	
Income &years of farming experience	Kina per year	K/Yr
Income & fam size	Kina per hectare	K/Ha
skills & knowledge, and year of farming experience	Population per year	Not applicable
Skills & knowledge, and farm size	Population per hectare	Not applicable

Source. Author's own study, (JANUARY 2019).

Farm Impact: Farmers Livelihood and Wellbeing

The farm impact on farmers' livelihoods and wellbeing was evaluated using Multidimensional Poverty Index (MPI). It was based on three (3) main dimensions of a household characteristic which were health, education and living standard. The dimension and indicators of analyzing field data are being indicated on Table 10 (Appendix II).

MPI formula and calculation

Formula.

MPI =H x A

Where **MPI** is the Multidimensional Index, **H** is the percentage of people who were **MPI** poor (incidence of poverty) and **A** is the average intensity of MPI poverty across the poor (%). Figure 6 represent the process of MPI calculation.

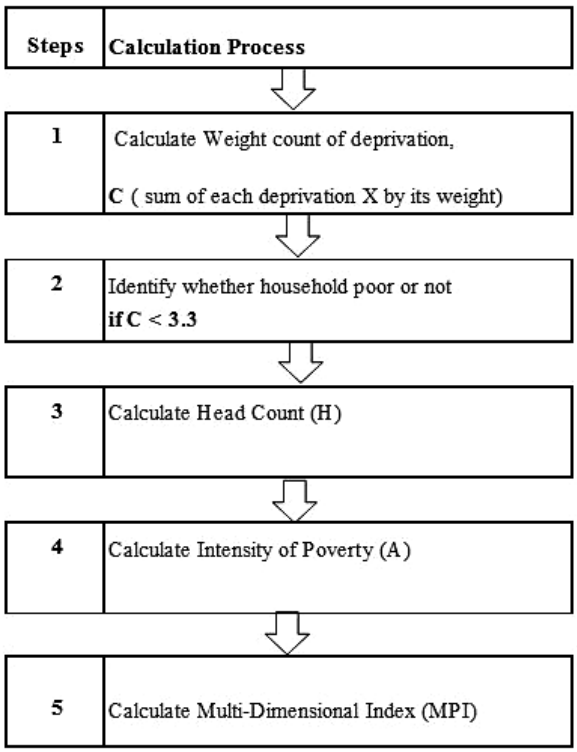


Figure 6. The process of Multidimensional Poverty Index (MPI) calculations.
Source. Author's own study, (January 2019).

The co-relation analysis of main household poverty indicators

The co-relation analysis was carried out in order to analysis the independent variables of household poverty against dependents variable of Multi-Dimensional Poverty Index (MPI). In this study, the independent variables of household poverty were based on four main household indicators: (1) family size, (2) children (< 6 years old), (3) children under (< 18 years old) and (4) children (> 6 years old to 18 years old). The dependent variable were the indicators and off-cut for the main indicators of household poverty and these were: (1) children completed > grade 5, (2) > 6 years old (completed Gr.8 and above), (3) infant dead, (4) no health services, (5) bush material house, (6) no electricity, (7) no access to clean drinking water, (8) household using firewood, (9) no access to adequate sanitation and (10) household has no car. The result of co-relation analysis is being shown in Table 8.

Data Analysis Methods

Data analysis is a process of evaluating raw data from the field using analytical and logical reasoning, purposely to find out each component of data collected and provided. Kawulich (2005) describe data analysis as the process in which a researcher uses to convert the data into a story that describes the phenomenon or participants' views, using the emic perspective. In other words, the primary data collected from field is being compiled together and then analysis to form the database of findings or conclusion to the issue investigated. In this research, primary field data collected through interview, survey questionnaires, field observation and assessment were analysised, processed and interpreted using Ms excel and Statistical Package for Social Sciences (SPSS) software in order to provide statistical database for interpreting the research problem statement.

Result

The results from the study were discussed under farmers' view on farm sustainability, socioeconomic characteristics of farmers and the effect of farming on farmers living standard and well-being.

Farmers' View on Farm Sustainability

The four main indicators of farmers' view on farm sustainability in which study investigated were social, economic, environmental, and cultural aspects.

Social Sustainability of Farming

The farmers view on social sustainability of farming were timber for building, fuel-wood, knowledge and skills, shade and recreational value, food and nutrition value, and aesthetical value. Table 4 represents farmers' views and opinion on social sustainability of the farming.

The result shows that the knowledge and skill were ranked first and scored 1800 on Sustainable Farming Entrepreneurship (SFE) index. The second preferred reasons for farming were timber for building and fuel wood since both scored 1570 on SFE Index.

Table 4. Social sustainability of the farming.

Social Sustainability Indicators	Little (L)	Much (M)	Very Much (VM)	SFE Index	Ranking
Knowledge & Skills	10	20	70	1800	**1**
Timber for Building	10	30	60	1570	**2**
Fuel wood	10	30	60	1570	**2**
Recreational Value	50	40	10	380	**3**
Food & Nutrition Value	50	40	10	380	**3**
Aesthetical Value	60	30	10	370	**4**

Source. Author's own study, (January 2019).

The lowest ranked reasons for farming were recreational value, followed by food and nutrition, and then the aesthetical value. The farming for recreational value, and food and nutrition were ranked third in which both scored 380 on SFE index. The least and fourth ranked social sustainability was the farming for aesthetical value with FSE index of 370.

The statistic also indicates that there was no significance difference between social sustainability reason of aesthetical, foods and nutrition, and then recreational value since most scored lowest between 250 and 400 on SEF Index.

Economic Sustainability of Farming

The four main farmers view on economic sustainability of farming were employment creation, cash income from land lease areas and contract work (seasonal work) payment and then income from intercropping of food crop planted within inter-row of newly planted tree farmed land areas.

The findings of economic sustainability from farming are being shown in Table 5. The study found that the reason for cash income from land lease payment was ranked first with SFE index of 1800 and then followed by cash income from contract work (seasonal work) payment that ranked second with SFE index of 1570. The farming for employment creation was ranked third with SFE index of 1340.

Table 5. Economic sustainability of farming.

Economic Sustainability Indicators	**Little (L)**	**Much (M)**	**Very Much (VM)**	**SFE Index**	**Ranking**
Cash Income (Land Lease Payment)	10	20	70	1800	**1**
Cash Income (Contract Work Payment)	10	30	60	1570	**2**
Employment Creation	10	40	50	1340	**3**
Income from intercropping	20	40	40	1100	**4**

Source. Author's own study, (January 2019).

The lowest and fourth rank indicator for economic sustainability was farming to generate income from intercropping practices that scored 1100 on FSE index.

Environmental Sustainability of Farming

Table 6 shows the farmers view on environmental sustainability of farming. Finding reveals that the reasons for improving soil fertility and reducing soil erosion whereby both ranked first and scored 1570 on FSE index which means there is no significant difference between them.

The second ranked environment sustainability perspective was found to be reason for improving the biophysical environment which scored 1340 on FSE index.

Table 6. The environmental sustainability of farming.

Environmental Sustainability Indicators	Little (L)	Much (M)	Very Much (VM)	SFE Index	Ranking
Improve Soil Fertility	10	30	60	1570	**1**
Reduce Soil Erosion	10	30	60	1570	**1**
Improve Bio Physical-Environment	10	40	50	1340	**2**
Improve Ecosystem	20	60	20	640	**3**
Improve water storage & Supply	50	40	10	380	**4**

Source. Author's own study, (JANUARY 2019).

The lowest and third ranked cultural perspective was preservation of archaeological site in which scored 390 on FSE index.

The study further conducted socioeconomic characteristic analysis to evaluate farmers two main characters (farm size and farmers' year of farming experience) with two top ranked indicators about farmers' view on farm sustainability which were income from land lease area and skills and knowledge gained from farming.

Socioeconomic characteristics of Sustainable Farming Entrepreneurship (SFE).

The socio-economic characteristic analysis for sustainable farming was based own two top ranked indicators which were farmers view on cash income from land lease area payment, and skills and knowledge gained from farming business (Table 9). The socioeconomic characteristics of farm sustainability for both indicators, farmers view on income from land lease area payment and, skills & knowledge gained from farming were analysised and discussed using descriptive analysis (Table 7).

Farmers View on Income from Land Lease Area Payment

The result from table 7 represents the relationship between farmers' view on income from land lease area payment and their years of experience in farming. Findings shows that mean income from land lease area payment with farming experience (0-2) years was 2.333, farmers fall under farming experience of (3-4) years was 3.000 and then farming experience of more than five years was found to be 2. 667.

Further socioeconomic analysis of relationship between farmers' view on income from land lease area payment and farm size (operational land holding) indicates that the mean for farmers with farm size of (0-5) hectares was 2.00, farm size of (6-20) was 2.750 and farmers' falls under category of more than 21 hectares (large farm) was found to be 2.500.

Table 7. The socioeconomic characteristics of farm sustainability.

Characteristics	Range	Categories	Variables							
			Incom (K) (N=7)				Skills & Knowledge (N=7)			
			N	%	Mean	SD	N	%	Mean	SD
Years of Farming	0-5	0-2 years (low)	2	29	2.333	0.577	4	57	2.667	0.577
		3-4 years (medium)	1	14	3.000		1	14	3.000	
		> years (high)	4	57	2.667	0.577	2	29	2.333	0.577
Farm Size	0-35	0-5 Ha (small)	1	14	2.000		1	14	3.000	
		6-20 Ha (medium)	4	57	2.750	0.5	4	57	2.500	0.577
		> 21 HA (large)	2	29	2.500	0.707	2	29	5.000	0.707

Source. Author's own study, (January 2019).

Farmers View on Skills and Knowledge

Study into farmers' views on skills and knowledge gained from farming and between the different categories of farmers' years of farming shows that the mean of farmers' years of farming under (0-2) years was 2.667, under (3-4) years was 3.000 and then farmers with more 5 years of farming experience was 2.333.

Further study into relationship between the farmers' view of acquiring skills and knowledge from farming, and the farm size (operational land holding) shows that the mean of farm size under (0-5) hectare was 3.000, the mean of farm size under (6-20) hectare was 2.500 and farm size more than 21 hectares was found to be 5. 00.

Evaluating Farmers' Living Standard and Wellbeing using Multidimensional Poverty Index (MPI)

The study evaluates farmers' household living standard and wellbeing. The main assessment tool used for measuring household was Multidimensional Poverty Index (MPI) which is being developed by University of Oxford in year 2010 (Alkire and Santos 2010). The three main indicators were lack of education, poor health and poor conditions of living. The process or steps for calculating multidimensional poverty index (MPI) are being discussed under research methodology (Fig. 6).

According to Multidimensional Poverty Index (MPI) calculation and analysis, the first process in MPI calculation and analysis was to found out the weight count of deprivation. Finding shows that the weighted count of the deprivations (c) for farmers in a household was found to be 6.5. The second process was to identify whether household poor or not if $C < 3.3$. Since C (weight count of deprivation) was calculated to be 6.5 which means the farmers house hold was found to be multi-dimensionally poor as it was above the bench mark level of 3.33. The third process involves calculating the head count (H) which was the proportion of population who were multidimensionally poor. The multidimensional head count calculated was 1.45. The fourth stage of Multidimensional Poverty Index (MPI) calculation was to calculate the intensity of Poverty (A) that was the proportion of

dimensions or weighted component indicators “d” across which on average poor people is being deprived. Statistical analysis indicates that the intensity of poverty was found to be 5.33. The fifth and final stage was to calculate Multidimensional Poverty Index (MPI) by multiplying the headcount ration (H) by the intensity of Poverty (A). Finding shows that the MPI of farmers in Markham Valley was 7.84.

Further research and analysis were carried out about relation between the independent variable of household poverty and dependent variables of Multidimensional Poverty Index.

The co-relation analysis of main household poverty indicators

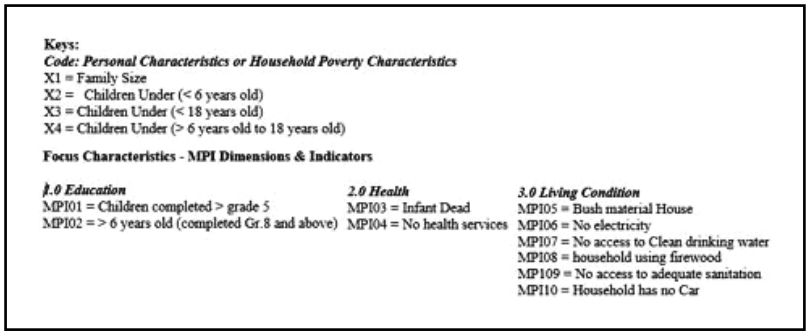
Table 8 represents the correlation between the main characteristics of the household and household poverty. The result indicates the relation between the children’s different age group and their education level within farmers’ household unit. Finding shows that there was a highest significant relation between the children under (< 18 years old) and children more than 6 years’ old who completed grade eight (8) and above, followed by children under (> 6 years old to 18 years old) and children more than 6 years’ old who completed grade eight (8) and above. Finding also shows that there was significant correlation between children completed >grade 5 and no electricity. The study further reveals that there was relation between bush material house and no electricity, and then followed by relation between household using firewood and no access to adequate sanitation.

Table 8. Evaluation of Co-relation between Household Indicators and Household Poverty Dimensions and Off-cuts.

	X1	X2	X3	X4	MPI01	MPI02	MPI03	MPI04	MPI05	MPI06	MPI07	MPI08	MPI09	MPI10
X1	1													
X2	.048	1												
X3	-.447	-.091	1											
X4	-.262	.530	.395	1										
MPI01	.032	.130	-.068	.103	1									
MPI02	.531	.041	-.912**	-.562*	.235	1								
MPI03	.195	-.114	-.271	-.155	-.111	.297	1							
MPI04	-.057	-.418	-.297	0.000	.026	.184	.272	1						
MPI05	-.178	-.312	.062	-.425	-.040	.042	.365	.284	1					
MPI06	-.089	-.312	-.139	-.283	-.566*	.042	.365	.284	.639*	1				
MPI07	-.098	-.309	.051	-.310	-.465	.065	.300	.234	.426	.426	1			
MPI08	-.386	-.386	.027	-.245	-.245	-.220	.158	.123	.433	.433	-.158	1		
MPI09	-.386	-.386	.027	-.245	-.245	-.220	.158	.123	.433	.433	-.158	1.000**	1	
MPI10	-.057	.171	-.218	0.000	.310	.239	.234	.182	.178	-.284	.272	-.123	-.123	1

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).



Source. Author's own study, (January 2019).

Discussion

The study discussed two main views of famers about tree farming agribusiness in Markham Valley were farm sustainability and the effect of farming on farmers' living standard and well-being.

Farmers View on Farm Sustainability

The study discussed the farmers view on four main farm sustainability indicators which were social, economic, environmental, and cultural aspects.

Social Sustainability of Farming

The farmers' view on social sustainability of farming (Table 4) shows that the skill and knowledge was ranked first. This finding indicates that the farmers acknowledged and appreciated tree farming business as part of improving their skills and acquiring knowledge for large scale farming practices. According to Robinson- Pant (2016), transfer skills and knowledge in agricultural improve rural livelihood through social change and rural transformation process. In other words, the empowerment of farmers by developer with innovative and strategic approach towards farming may have a positive impact and influence on farmers' attitude and behaviour toward farming business.

The next preferred reasons for farming were timber for building and fuel wood due to the biophysical environment of savannah grassland and shortage in timber and fuel wood in the community. Finding also shows that aesthetical, food and nutrition value, and recreational value for tree farming is being defined by the farmers as least important in terms of social sustainability. This was perhaps due to limited knowledge and understanding about aesthetical value, food and nutrition and recreational as well as other benefits derived from trees. Lunenburg (2010) point out that individual person may have different perceptive, knowledge, belief and opinion toward development project. However, the World Bank (2007) reports about agriculture and rural development, emphasis that agricultural commercialization through farming and food production improves nutritional outcomes for the farmers' livelihood and wellbeing.

Economic Sustainability of Farming

Study investigated about farmers' view on economic sustainability of farming. According to findings, cash income from farming through land lease area and contract work payment were ranked highest due to the fact that focus of farming is being defined by the benefit of cash income (money) generated by the PNG Biomass project to the landowners, the tree farmers (growers) of Markham Valley. Richardson *et al*. (2013) stress that lease arrangements enhance farmers' farming business operation growth and sustainability. According to UNDP (2015) report, contract farming is commercially viable farmer–enterprise relationships built on equity, mutual trust, and shared benefits.

The farming for employment creation was ranked next highest because the landowners already engaged and involved in participation of farming through paid wage employment on a full time basis and also cash income generate from contract work (seasonal work) engagement.

The least reason for economic perspective for tree farming was found to be off-farm benefits such as intercropping of food crop within inter-row of newly planted tree crops since the farmers observed as occasional in which it was regarded as the least important reason for the economic sustainability of farming. Dary and Kuunibe (2012) describe non-farming economic activity which include off farm income activity as seasonal and low return activities. However, Bubela (2016) stress that off-farm income such as intercropping of food crop planted within newly planted tree rows shift from supplementary income source to an important risk management tool for new farming business ventures. In other words, intercropping practice contribute towards generating supplementary income, however, it helps offset short term financial constraints and need for newly established farm business enterprise.

Environmental Sustainability of Farming

Study shows that farmers view the reasons for improving soil fertility and reducing soil erosion as highest rank environmental sustainability. This was due to the fact that farmers considered both reasons for venturing into farming business. Faleyimu and Akinyemi (2010) point out that planting a tree helps conserve soil on land by reducing soil erosion, increasing soil organic matter, improving soil structure and further assist in nutrient cycling.

The reason for improving the biophysical environment was the next highly ranked environment sustainability perspective. This finding affirms about the farmers' aspiration for changing the bio-physical environment of savannah grassland into forest land area that improves the surrounding environment which create conducive for living. Collins (2012) explains that innovation in farming influence landscape design and change of landscape features.

The environmental sustainability reason for improving water storage and improving ecosystem were the least and not favoured by farmers, due to lack of understanding about ecosystem and biophysical relationship between trees, the environment, and surroundings. Further, the farmers' lack understanding about the carbon sequestration process of trees and the environment that contributes towards reducing the greenhouse effect, global warming,

and climate change. According to containment theory of Walter Reckless (1961) and Flexon (2014), human perspective and behaviour towards social outcome is the interplay between internal and external forces. External force is one of the contributing factors toward perceptual barriers. In other words, limited information and knowledge contribute toward misunderstanding about the importance of tree farming and Biomass project at larger scale. In this case, publicity through awareness program can help farmers improve understanding about importance of tree farming and environmental sustainability.

Cultural Sustainability of Farming

Statistical analysis shows that reason for preserving cultural heritage was ranked highest due to the fact that farmers view tree farming associated with their cultural linkage. According to informal interview with Kelly Jim of Tararan village in Huon Gulf district reveals that their clan name ('Feref') is associate and derived from native tree species known as Nonnie tree (Morinda citrifolia).

The spiritual richness was ranked next highest due to the fact that forest and environment have spiritual significance and connection with cultural norms and values of the Markham Valley society. According to informal interview with Sam Meyab of Chivasing village in Huon Gulf District, rural people in Markham Valley have traditional believe that they acquire spiritual power from the sacred forest land areas. The archaeological significant is being ranked the least due to the fact that cultural sites are being scarce and found only on certain anointed sites or grounds which made it as least important. Further research and analysis were done on the socioeconomic characteristics of sustainable farming entrepreneurship.

Socioeconomic Characteristics of Sustainable Farming Entrepreneurship (SFE)

The discussion for socioeconomic characteristic of sustainable farming entrepreneurship was based on two main indicators, which were farmers view on cash income from land lease area payment, and knowledge and skills gained from farming business (Table 9).

According to the result from socioeconomic characteristic analysis about farmers' view on income from land lease area payment (Table 5) shows that farmers' years of experience in farming business does not influence any farm income since their average means is inconsistent throughout the different category of farming experience. Further socioeconomic analysis of relationship between farmers' view on income from land lease area payment and farm size (operational land holding) indicates that farm income increase with farm size and then gradually reduce income with more than 21 hectares of land area. The findings also reveal that farmers' income was inconsistent with the years of farming and farm size. The main factor that affects farmers' income were farm activities and operational land holding (farm size). The farmers generate more income when they involved in more activities for farm operation per year. The farmers' income also influences by number of land area leased to the developer. Those farmers who increased their land lease over the years of farming tend to benefit from land lease payment whereas farmers provide less, have reduced

income. Munć and Božić (2017) point out that increase farm size and field crop production contributed towards increase income per active members of family household employed in agriculture.

Study into farmers' views on skills and knowledge gained from farming and between the different categories of farmers' years of farming shows that those farmers under (3-4) farming years of experience agreed that farming improve their skills and knowledge in farming. The main factor that contributes towards inconsistent response from farmers under various categories of farming years' experience was due to timing and development stage of farming. The farmers who provide the land during the stage whereby the developer improve farm management practice tends to participate and learnt modern techniques in farming. Japan International Cooperation Agency (2009) emphasizes that leaning to improve skills and knowledge about agricultural innovation can be influenced and motivated by applying innovation to their own situation or current trend of living.

Further study into relationship between the farmers' view of acquiring skills and knowledge from farming, and the farm size (operational land holding) reveal that those farmers with more than 21 hectares of farm land agreed about improving their skills and knowledge in farming. This result shows that farmers who provide more land area for farming spend more time in farm activities and practices thus improve their skills and knowledge. In other words, farm activities increase with increased farm land area whereby a farmer participates in more farm activities that increase their skills and knowledge in farm management practices. Study was also conducted on the influence of farm income on farmers' living standard and wellbeing using Multidimensional Poverty Index (MPI).

Evaluating Farmers' Living Standard and Wellbeing using Multidimensional Poverty Index (MPI)

Multidimensional Poverty Index (MPI) is the important tool for measuring and evaluating effect of farming on farmers' livelihood and wellbeing. It is a recent techniques design to capture the poor people's experience of poverty deprivation experience. AKIRE and Santos (2010) point out that MPI is design to focus on income to reflect the multiple deprivations that a poor person faces. Dotter and Klasen (2014), stress that MPI provide a household – level multidimensional poverty measure.

This study evaluates farmers' household living standard and wellbeing, and reveals about the status of farmers' household living conditions. The result shows that most farmers' household found to be at poor stage regardless of income earning from the farming business. The finding also reflects the farmers' characteristic and attitude toward managing their income and also budgeting including their approach towards spending. Finding reveals about farmers lack of understanding towards the budgeting of their income and spending meaningfully to sustain their livings. Klinefelter *et al*. (2008) point out that budgeting is part of risk management strategy that aim towards achieving long- term goal, that is the long term recurrent needs and sustainable living standard and livelihood. Further research and analysis was carried out about relation between the independent variable of household poverty and dependent variables of multidimensional Poverty Index.

The co-relation analysis of main household poverty indicators

The correlation analysis was carried out between the main characteristics of the household and household poverty (See table 8: result section). Finding shows that there was a highest significant relation between the children under (< 18 years old) and children more than 6 years' old who completed grade eight (8) and above, followed by children under (> 6 years old to 18 years old) and children more than 6 years' old who completed grade eight (8) and above. This finding reveals that children under (> 6 years old to < 18 years old) completed grade eight (8) and above in a farmers' household unit. In other words, children age group falls under (6 -18) years old have completed or attending both primary and secondary education as well as tertiary education This result reveals that most farmers intended to invest the income (money) from farming business into their children's educations. The livelihood studies by Morton and Kerven (2013) indicate that the high priority needs in a community were found to be adequate water, health care, and access to education.

Finding also shows that there was significant correlation between children completed >grade 5 and no electricity. This indicates that more children of farmers completed grade five (5) lives in the house condition without electricity or completed their primary education from the household that does not access to electricity. Cook *et al*. (2007) stated that rural electrifying is linked to development prosperity in terms of energy uses and poverty reductions.

Further study reveals that there was relation between bush material house and no electricity, and then followed by relation between household using firewood and no access to adequate sanitation. This result confirms about the status of farmers' households. The key indicators of the house build from bush material without electricity, usage of firewood for cooking, and not access to adequate sanitation shows that farmers in Markham Valley were found to be multidimensionally poor. The findings affirm the poverty status of the farmers regardless of financial impact of the farming business. Dorward *et al*. (2001) stress that the lack of livelihood asset is the symptoms of poverty. According to Krants (2001) and Neely *et al*. (2004) poverty reduction is stage where improvement in the lives of rural poor is achieved by increasing and improving income levels, basic household needs and services including access to productive resources, increase agricultural yields and changes in household food security.

Conclusion and Policy Implication

Conclusion

The farmers view on farm sustainability founds that the focus of farming was based on cash income from land lease area, and improving their skills and knowledge in farming through participation in farm activities in which both scored 1800 on SFE index. Regardless, farmers lack clear understanding of tree farming and their co-relation with ecosystem and the environment particularly the role of tree plants toward carbon sequestration process and their bio-physical relation with environment which contribute towards minimize climate

change effect and global warming.

Socio-economic analysis shows that farm income increases with farm size. Those farmers who provide more leased land area for farming tend to earn more income from farming. Study into farmers' views on skills and knowledge shows that those farmers with more than 21 hectares of farm land agreed about improving their skills and knowledge in farming. This result shows that farmers who provide more land area for farming spend more time in farm activities and practices thus improve their skills and knowledge.

Further study into farmers' living standard and wellbeing using multidimensional poverty index found to be multidimensionally poor with MPI value of 7.84, which is far above 3.0 benchmark and cut-off mark for world standard poverty classification. This result confirms about poverty status of the PNG Biomass project farmers in Markham Valley regardless of positive impact through monetary benefits (cash income from land lease area payment) and improving skills and knowledge of farm management practice. The farmers continue to struggle to live a decent life that accommodates improve living standard and wellbeing. This was due to fact that the farmers lack clear understanding of budgeting from farm income in order to spend meaningfully to sustain their living.

Policy Implication

The study recommends for wider community awareness about the importance of PNG Biomass tree farming project and the non-monetary benefits such as carbon sequestration that contribute towards reducing climate change effect and global warming. The study also recommends for financial literacy training in order to improve farmers' knowledge in farm income management, usage and control.

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Appendices

Appendix I: Farm Sustainability

Table 9. The farmers view on farm sustainability.

Sustainability Indicators	Little (L)	Much (M)	Very Much (VM)	SFE Index	Ranking
Knowledge & Skills	10	20	70	1800	**1**
Cash Income (Land Lease Payment)	10	20	70	1800	**1**
Timber for Building	10	30	60	1570	**2**
Fuel wood	10	30	60	1570	**2**
Cash Income (Contract Work Payment)	10	30	60	1570	**3**
Improve Soil Fertility	10	30	60	1570	**3**
Reduce Soil Erosion	10	30	60	1570	3
Employment Creation	10	40	50	1340	4
Improve Bio Physical-Environment	10	40	50	1340	**4**
off-farm benefits (Income from intercropping)	20	40	40	1100	**5**
Shade	20	60	20	640	**6**
Improve Ecosystem	20	60	20	640	**6**
Cultural Heritage	20	60	20	640	**6**
Spiritual richness	30	60	10	400	**7**
Archaeological site	30	70	10	390	**8**
Creational Value	50	40	10	380	**9**
Food & Nutrition Value	50	40	10	380	**9i**
Improve water storage & Supply	50	40	10	380	**9**
Aesthetical Value	60	30	10	370	**10**

Source. Author's own study, (January 2019)

Appendix II. Multidimensional Poverty Index (MPI)

Table 10. The Dimension and indicators of the farmers' living standard and wellbeing using Multidimensional Poverty Index (MPI). Table 10 shows the three (3) main indicators and ten (10) Dimension of multidimensional Poverty Index (MPI). The table also provides brief explanation of each dimension.

	Dimensions	Indicators		Explanation
A	**Health**			Each indicator is weighted equally at 1/6
		Child Mortality	**1**	Child mortality: deprived if any child has died in the family in past 5 years
		Nutrition	**2**	Nutrition: deprived if any adult or child for whom there is nutritional information is stunted

B	**Education**			Each indicator is weighted equally at 1/6
		Years of Schooling	**3**	Years of schooling: deprived if no household member has completed six years of schooling
		School attending	**4**	Child school attendance: deprived if any school-aged child is not attending school up to class 8
C	**Living standard**			Standard of Living (each indicator is weighted equally at 1/18)
		Cooking Fuel	**5**	
		Toilet (Sanitation)	**6**	deprived if the household's sanitation facility is not improved (according to MDG guidelines), or it is improved but shared with other households
		Water (drinking)	**7**	deprived if the household does not have access to safe drinking water (according to MDG guidelines) or safe drinking water is more than a 30-minute walk from home round-trip
		Electricity	**8**	deprived if the household has no electricity
		Floor	**9**	deprived if the household has a dirt, sand or dung floor
		Assets	**10**	Assets ownership: deprived if the household does not own more than one of: radio, TV, telephone, bike, motorbike or refrigerator and does not own a car or truck