Australian Farm Business Management Journal
2020, Volume 17, Paper 3
ISSN: 1449-7875

Monitoring and Evaluation of Agribusiness Entrepreneurship in Papua New Guinea: A Case Study of Tree farming in the Markham Valley, Morobe Province

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Abstract

The research reported here was carried out to evaluate the impact of a tree farming project between PNG Biomass and the customary landowners of the Markham Valley in Morobe Province, Papua New Guinea. The research employed a mixed research design that includes both qualitative and quantitative data collection and analysis methods. The primary data were processed using MS Excel, MS Word, Statistical Package for Social Sciences and Nvivo Qualitative Data Analysis software. The research examined the farm management processes, land dealings and farm impacts. The study found that appropriate legal procedures were not followed by PNG Biomass for both the land dealing process and farm management practices. The evaluation of land dealings shows that land acquisition, land use agreement, compensation and legality processes need attention due to a lack of legal interpretation and representation in the land dealing process. Further analysis of farm input use indicates that the use of agro-chemicals and approaches to land conservation are a priority and need attention for sustainable tree farming practices and management. On the basis of our findings we recommend the use of a holistic approach towards project development with legal compliance to the relevant laws and regulation to safeguard the business operation.

***Key words*:** agribusiness entrepreneurship; farm impact; land dealings; legal compliance

Introduction

Agricultural business plays an important role in rural economies. Rural-based industry underpins most rural economic activities and it is the core business for sustainable development (SDSN, 2013). Proctor and Lucchesi (2012) stated that small-scale farmers enable the process of rural transformation, which improves food security and rural livelihood. The authors further stress that the growth of farm and rural agribusinesses are essential elements in improving the performance of rural labor markets.

The PNG Biomass tree farming project is an innovative approach to establishing a sustainable fuel resource for the Ramu power grid and fostering the development of rural communities in the Markham Valley of Morobe Province, Papua New Guinea (PNG). PNG Biomass is funded by Oil Search Limited. Biomass is a clean, renewable energy and climate-change-resilience project that attracts carbon credits and reputational benefits for the Markham Valley, Morobe Province and PNG. It will use wood chips from trees sustainably grown and harvested from tree farming to fuel a biomass power plant to provide up to 30 Megawatt (MWe) into the Ramu grid (PNG Biomass, 2020). The location is shown in Figure 1.

Figure 1. Map shows the PNG Biomass project area and proposed power plant site

Source: https://pngbiomass.com/power-plant/ramu-grid/, 14th September 2020

The landowners of the Markham Valley are providing PNG Biomass with access to land through a Clan Land Use Agreement (CLUA) and a Memorandum of Understanding (MOU). The CLUA is an accord (formal agreement) between the clan and the clan members of Markham Valley who lease land for the PNG Biomass project to undertake tree farming. It is a preliminary agreement between customary landowners of Markham Valley and the PNG Biomass project. The agreement describes specific land areas for PNG Biomass to access prior to the landowners obtaining land title and sub-leasing to the PNG Biomass project. This is the legal process of customary land development in PNG and a regulatory requirement for legal compliance purposes. In other words, the preliminary agreement does not fully guarantee land security for the PNG Biomass project development. The agreement details the purpose of the PNG Biomass project, the terms and conditions which include the standard rate for use of the land during the leasing and tenure period, and the landowners' obligation towards the PNG Biomass project.

The MOU is also a preliminary agreement between both parties, the landowners of Markham Valley and the developer (PNG Biomass). The MOU covers a large portion of the proposed land area and it also states the process for the formulation of land legality including the setting up of an Incorporated Land

Group (ILG), land registration and land title over a portion of the land for tree farming as matter of legal compliance. The MOU only secures the proposed land area for future development, providing terms and conditions for both parties. Both the CLUA and MOU allow PNG Biomass to lease land for a 2-3 year period. During the term of the lease, PNG Biomass is to establish and manage tree farming while the landowners benefit from the project through land lease payments, contractual work payments and other spin-off benefits.

The research investigated the impact of tree farming in the Markham Valley. The tree farming is the partnership project between the developer (PNG Biomass), the farmers and landowners of Markham Valley. It assessed, evaluated and identified the effect of the partnership approach being used to implement the project. PNG Biomass provides the financial capacity, machinery, equipment and materials, together with technical expertise and training for farmers, while the farmers provide land and labour resources for developing the Biomass tree farming project.

The purpose of the research was to provide vital information about the effect of tree farming on the communities of the Markham Valley. The research was also intended to provide a database that will assist PNG Biomass and other agribusiness entrepreneurs improve their farm management systems. Further, the research may provide information about the appropriateness of the PNG Biomass project development strategies and their contribution to sustainability.

Research Methods

The research methods detail the study site, data collection methods and sampling strategy, data processing and analysis methods.

Study site

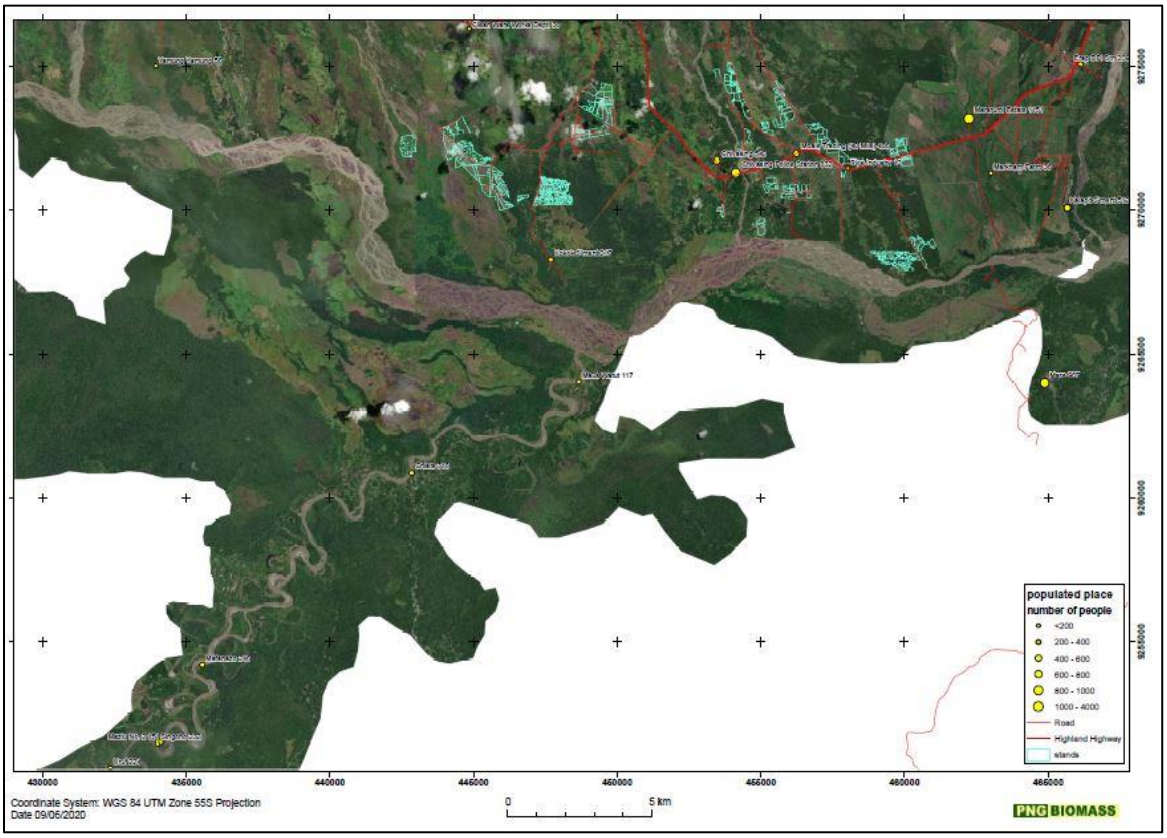
The study was conducted in the PNG Biomass project impact area of Markham Valley in Morobe Province, PNG. The raw data for the study was collected from landowners participating in the tree farming project. The trial plots have been established by these farmers in Chivasing and Tararan villages of Markham Valley. Figure 2 shows the map of the study area, and the tree farming trial plots sites.

Data collection methods and sampling strategy

This research is a cross-sectional study that used a mixed research design (Creswell, 2003; Johnson and Onwuegbuzie, 2004; Cameron, 2009). It employed both qualitative and quantitative approaches. Onwuegbuzie and Johnson (2011) describe mixed method research as the use of both qualitative and quantitative approaches. The main instruments for qualitative data collection were focus group discussion, interview and then direct observation and evaluation. The two main quantitative data collection instruments were survey questionnaires and a field assessment matrix. The research involves purposive sampling for gathering and evaluating field data. The purposive sampling method suits data collection and analysis in mixed method implementation research (Palinkas et al., 2015).

The study randomly selected ten per cent of the total tree farmers as the sample to represent the whole population. The sample size was drawn from the total of 48 tree farming family household units that comprise of 4- 8 family members in the tree farming communities.

Figure 2. Map shows the study area and PNG Biomass project tree farming trial site



Source: PNG Biomass project tree farming profile map, August 2018.
Note: The tree farming stands are highlighted with blue icons.

The logic and decision for random choice was based on intentional selection of information-rich cases where evaluation has been conducted, in order to capture the in-depth stories of respondents through asking personal questions and opinion about issues experienced by the person interviewed, and so the respondent could provide answers without any prejudice. According to Barreiro and Albandoz (2001), the challenge facing a researcher is to make constructive decisions and develop strategies to collect credible information at a minimum cost while ensuring that the sample size adequately represents the whole population.

Data processing procedure

The primary field data were collected in accordance with the research objectives which were to evaluate farm management processes, land dealings and farm impacts. The measurements for both land dealings and farm impact evaluation were processed using the scoring ranking index approach that was developed by Bylin et al. (2004) as an on-farm assessment tool. The three main processes of grading used were:

(1) Rating of farm performance through field assessment and then scoring or grading by tabulating field data (see Table 1);
(2) Ranking of score data per the main field indicators (see Table 2);
(3) Interpretation of the results through percentage and color icons (see Table 3).

Process One: Categorising

The first process of grading was categorising and rating of farm performance through field assessment and then scoring or grading by tabulating field data using Statistical Package for Social Sciences (SPSS) software, version 22. The SPSS software tabulates field data from survey questionnaires and the field assessment matrix though descriptive analytical processes. The field condition was categorised and rated according to farm performance. The field conditions and performance of the sampled famers and tree farming land area were further graded using scoring by tabulating field data as shown in Table 1.

Table 1. Grading by rating and scoring (grading system)

Rating (R)	Conditions	Scoring/ Grading
R1 – "*Very poor*	Very poor	0
R2 – "*Poor*''	Poor	1
R3 – "*Fair*"	Fair	2
R4 – "*Good*";	Good	3
R5- "*Excellen*t''	Excellent	4
Total score (10)		

Process Two: Coding

The ranking of the score data was carried out according to the quantitative field indicators and qualitative responses to the questionnaire. The grading and scoring of the land management strategy in Table 2 is based on the following indicators: forest corridor, buffer zone, biodiversity and landscape.

These individual indicators were graded (scored) using the field condition and rating system as shown in Table 1. For example, according to the field condition assessment, buffer zone is being graded as "Good" which is being categorised as R4 (rated 4) and scored 3 points using Table 1. This method applies to other indicators of land management strategy in Table 2. In this case, the individual indicators for land management strategy were scored out of 10 points (see Table 1) with total grading and scoring out of 40 points (see Table 2). The grading and scoring were allocated to quantify the data for better understanding and interpretation about the development trend.

Table 2. Grading indicators (the questions for collecting field data), rating and scoring

	Grading Indicators	Grading	Scoring
1	Forest Corridor	R1 – "Very poor	0
2	Buffer Zone	R4 – "Good";	3
3	Conservation	R3 – "Fair"	2
4	Land Scape	R4 – "Good";	3

Process Three: Grading using color icons

The final stage in this grading process was the interpretation of scoring. The total score of a particular assessment was converted into a percentage and ranked into three main classes which were represented by the color icon(s) as shown in Table 3.

Data analysis methods

The data were processed using SPSS (version 22), MS Excel spreadsheets (version 2010) and Nvivo for quotes or narratives from farmers.

Table 3. Grading and interpreting using percentage in range and color indicator

Color		Percentage (%) in Range	Interpretation
Green		(76 - 100) %	no issues and on-track
Yellow		(66 - 75) %	priority and needs attention
Red		(0 - 65) %	urgent and need attention

Excel was used to process numerical field data by creating a data base; SPSS was used to analyse quantitative data collected from survey questionnaires and field assessment through descriptive analysis; and Nvivo was used to analyse the quotes or narrative from farmers, particularly the qualitative answers which were converted to quantitative measurements through a data reduction and consolidation process. Irrelevant data were discarded.

Results and Discussion

The study addressed two main components of agribusiness tree farm management: land dealings and farm impact.

Farmland dealings evaluation

The evaluation of farmland-dealings was based on four main indicators of land dealings which were land acquisition, land lease agreement, compensation and land legality (tenancy) processes for tree farming agribusinesses in Markham Valley of Morobe Province.

Land acquisition and access

According to the findings from Table 4, the land acquisition process is graded at 67 per cent which was represented by the yellow icon and further interpreted as a priority needing attention. The level of priority was classified as high due to the fact that the land was regarded by PNG Biomass as an important resource or asset for tree farming and for the sustainability of the project development in the Markham Valley. PNG Biomass's business plan called for the acquisition of 24,000 hectares (PNG Biomass, 2020). Difficulties with the acquisition process limited the area of land acquired to 16,000 hectares, the land area which is currently under MOU. These difficulties included: land tenure and ownership issues, land disputes, fragmented social structures, organisation issues, livelihood hardship and monetary demands. The impact of these issues was compounded by a lack of visibility due to insufficient publicity for the PNG Biomass project.

Table 4. Land dealings evaluation

	Categories	Evaluation %	Grading	Level	Explanation
1	Land Acquisition	**67**		High	Priority and needs attention
2	Land Lease Agreement	**69**		High	Priority and needs attention
3	Land Compensation	**70**		Medium	Priority and needs attention
4	Land Legal Tenancy	**61**		High	Urgent and needs attention

Note: The grades are defined in Table 3.

The study reveals that there were serious issues in land tenure and ownership. Land in the Markham Valley is under customary ownership by local clans, and land-use decisions are made through clan meetings. The competing demands for the use of land often lead to confrontation and disagreement amongst the clan members and family units. In these circumstances it is often difficult to undertake an innovative development, especially when that development requires access to a relatively large area of land. The customary land in the Markham Valley, like most parts of Papua New Guinea, is owned by clans, but some customary land in the Markham Valley is already being distributed into family units whereby each family unit within a clan can implement their own agenda over the use of the land especially when that agenda involves the development of a business.

The findings of this study further reveal that the land acquisition process is being hindered by traditional land ownership and usage rights. It is important to note that land ownership and land usage rights may be held by different parties thereby further complicating access to large areas of land for innovative developments. Customary land rights exist where the principal landowners have inherited ownership of land through customary practices of the lineage inheritance system. Customary land user rights are held by people in the community who were allowed by the principal landowners to cultivate the land for subsistence farming. In many cases this usage right has been in place for many years. Some of the land being acquired by PNG Biomass was subject to these usage rights. These were the people of the community who laboured over the land and improved land fertility through subsistence farming. These people also cultivated food trees and perennial food crops such as mango trees and banana which still exist on land that is being converted to tree farming. The land-users have claimed compensation for existing food trees and perennial crops as well as the value of their labour, which was used to improve the land. The issue of land rights and user-rights led to disagreement, confrontation and dispute between customary landowners and the users of land over the portion of the cultivated land. The land disputes are also being caused by aggrieved parties over the portion of land for development. The land disputes have occurred between the two different clans and within the family units of a clan. The study identified that the common land disputes were about: boundary disputes, the effect of rural political power struggles within the rural setting organisational structure, and lack of benefit sharing as well as lack of communication and consultation within and amongst clan members and family units. The disputes over the land made it impossible for PNG Biomass to acquire the full 24,000 hectares the company planned on developing for tree farming (PNG Biomass, 2020).

This study revealed that fragmented social structures and disintegration within and between clans and family units contributes towards disorganised land use decisions. In other words, there is no clear leadership structure to organise for, or collaborate and partner with, the developer for tree farming. This makes it difficult to negotiate, acquire and access land for development.

The livelihood hardship, monetary demands and needs also contribute towards confrontation, disagreement and land dispute over the ownership of, and monetary benefit derived from, the land. The study revealed that the land acquisition process by PNG Biomass is being hindered by this disagreement and dispute over the land use and the benefit that the landowners derive from the development of the land for tree farming. Another factor that hindered the process of acquiring land for tree farming is the inadequate project branding, particularly the visibility and publicity of the PNG Biomass Project. The study indicates that lack of community awareness about the importance of, and the benefits to be derived from, the project prevented PNG Biomass from securing the full 24,000ha that the company was seeking.

Land lease agreement

Table 4 also shows the evaluation result of the land lease agreement process between the developer and tree farmers. The study found that the land lease agreement was graded at 69 per cent and it was interpreted also as "priority and needs attention" by the developer. The priority was classified as high due to the fact that current land lease agreements between the developer and the tree farmers require review and refining of terms and conditions, as well as terms of reference, in order to satisfy all parties.

Land legal tenancy

The study also assessed and evaluated the land tenancy (legal) status of the PNG Biomass project in the Markham Valley. The finding indicates that land legality is being graded at 61 per cent with a red icon, and further interpreted as "urgent and needs attention" by the developer. The urgency of land legality is classified as high due to the fact that most of the customary land was acquired and accessed without Incorporated Land Group (ILG) and land title under the Land Act (1996) of Papua New Guinea. A study into the sustainability of land groups in Papua New Guinea by Karigawa, Babarinde and Holis (2016, p.2) point out that "ILG is the legal entity under Incorporated Land Groups Act (1974) of Papua New Guinea (PNG) that empowers the customary landowners in the development of their land by allowing landowners to participate in development projects, formalizing the existing natural corporations of tribes and clans, and further provide opportunity to customary landowners to bring their land into economic efficiency". According to Riwasino, Mulung and Henson (2018), successful tree farming entrepreneurship depends on customary landowners having legal land title. In other words, ILG is the legal process towards securing land title over customary land to enable subsequent sub-leasing to a developer for any business development.

Farm impact assessment and evaluation

The four main indicators used to evaluate the impact of the tree farming business were: farm input; environmental impact; social impact (infrastructure, training and development, occupational health and safety); and economic impact.

Farm input

The farm input evaluation is based on field assessment and evidence in regard to the use of agrochemicals for farm improvement and its effect on the local environment and surroundings (see Table 5). The two main agro-chemicals assessed and evaluated were organic materials (fertiliser) and pesticides (chemical). The finding shows that organic materials and pesticides were graded at 67 per cent and 69 per cent respectively. Both indicators were tagged as medium "priority and needs attention" due to the nature of agro-chemicals in relation to human and environmental hazards (risks) during the storage and the field application for farm management. The field observation, assessment and evaluation on PNG Biomass tree farmed land area shows evidence that chemicals used for weed control were over-applied. This has had an adverse effect on plant biodiversity and the ecosystem, which leads towards reduced soil cover with further effect on micro-organisms responsible for soil bio-synthesis process.

According to Bhandari (2014), agrochemicals are being used for improving farm performance and are also associated with adverse effects on the environment and surroundings. Carvalho (2017) argues that agrochemical residues contribute towards adverse impact on soils humus, terrestrial ecology and aquatic ecosystems, as well as the wellbeing of human society.

Table 5. Farm input evaluation

	Categories	Evaluation %	Grading	Level	Explanation
1	Organic Material (Fertilizer Use)	**67**		Medium	Priority and needs attention
2	Pesticide (Chemical use)	**69**		Medium	Priority and needs attention

Environmental impact

The evaluation was based on eight main indicators and parameters which were: soil quality, water quality, land conservation (buffer zone, cover plant and drainage system), biodiversity, wildlife habitat management (forest corridor) and landscape. The findings of the environmental impact assessment are shown in Table 6.

Table 6. Environmental impact evaluation

	Categories	Evaluation (%)	Grading	Level	Explanation
1	Soil Quality	**78**		Low	No Issue – On Track
2	Water Quality	**76**		Low	No Issue – On Track
3	Land Conservation (Buffer Zone)	**71**		High	Priority and needs attention
4	Land Conservation (Cover plant)	**67**		High	Priority and needs attention
5	Land Conservation (Drainage)	**51**		Very High	Urgent and needs attention
6	Biodiversity	**80**		Low	No Issue – On Track
7	Wildlife Habitats (Forest Corridor)	**67**		Medium	Priority and needs attention
8	Landscape	**78**		Low	No Issue – On Track

The research indicates that soil quality was graded at 78 per cent which was represented by a green icon and was interpreted as a parameter without any issue and on-track. The level of impact was low which means there was minimum effect of farming on the soil quality of the farmland. The finding also shows that the use of mechanical farm equipment such as bulldozers for felling trees and land clearing, and tractors for ploughing, have had minimum effect on the soil quality. This was because PNG Biomass developed and implemented Standard Operational Procedures for carrying out the farm activities that mitigate the adverse effect of mechanical damage to soil.

Water quality was another parameter of farm impact on environment which was assessed and evaluated. The result reveals that the impact of farming on water quality was graded at 76 per cent which falls under low level impact and is interpreted as a parameter without any issue and the activity is on-track. The field observation and evaluation also show that farm activities, especially use of mechanical farm equipment and agrochemicals do not have any adverse impact on water quality.

The land conservation (buffer zone) was graded at 71 per cent and further tagged with a yellow icon. The parameter was interpreted as high priority due to the fact that there was insufficient attention given to establishing buffer zones during the planning and development stage of the project. In other

words, buffer zones were not being marked out within the boundary of the farmed land. The absence of an established buffer zone will have an adverse effect on the ecosystem and surrounding environment. Ebregt and De Greve (2000) point out that buffer zones are important tools in both conserving areas of ecological importance and addressing development objectives for sustainable farming. USDA (2013) note that buffer zones are being established in farmed land in order to reduce soil erosion from wind and water as well as protecting soil and water quality.

The study also evaluated the status of land conservation (cover plants) on farmed land. The findings show that land conservation was graded and scored 67 per cent and further interpreted as "high priority and needs attention". Field assessment revealed that most of the farmland lacked vegetative cover, which may result in the degradation of soil humus and increases erosion of topsoil by rain water. Florentin et al. (2010) revealed that cover planting in small farms mitigates soil erosion and weathering of topsoil nutrients. The rehabilitation of farmland with vegetative cover prevents loss of topsoil and humus through soil erosion and runoff from the rain water.

The study finding about land conservation through drainage was graded at 51 per cent which falls under the category of a red icon and is therefore classified as "urgent and needs attention". It was classified this way due to the fact that immediate action is required from farm management to reduce the adverse effects in order to improve the conditions for farming. Glass et al. (2017) point out that a drainage system removes excessive water from the crop root zone. According to Giménez et al. (2015), soil drainage in farming removes excessive water and reduces water stress on crops. On-site field observation of PNG Biomass's tree farming project reveals the physical symptoms of water logging and water stress. As shown in Figure 3, trees are exhibiting the yellowish leaf colour typical of water logging.

Figure 3. Typical waterlogged area of tree farmed land in the Markham Valley

Source: PNG Biomass project tree farming photo (September, 2018).

The study also considered the impact of the project on the biodiversity of the farmed land. The study finding was that biodiversity evaluation was graded at 80 per cent which is represented by a green icon. It was further defined as a parameter without any issue and the activity of the farming is being carried out without adverse effect and was regarded as on-track. The study also reveals that farm practice and development is not having any effect on the biodiversity of ecosystem in the surrounding environment. It was due to the fact that the PNG Biomass project developed appropriate Standard Operational Procedures, which guide field activities.

The conservation of wildlife habitat and the establishment of forest corridors in farmland is another method that is used to protect the environment and biodiversity. The study found that wildlife habitat (forest corridor) was graded and scored 67 per cent and interpreted as "priority and needs attention." The study reveals that farm planning, development and management in the PNG Biomass project is not creating the forest corridors necessary for wildlife habitat and management purposes. The establishment of forest corridors may provide passage and easy access for animal life to move between the farmland and natural stand vegetation.

The result from Table 6 also reveals that landscape evaluation was graded and scored at 78 per cent, represented by a green icon and defined as "no issue and on track." The study found that the use of mechanical farm equipment does not have any effect on the landscape. This was because PNG Biomass have developed and implemented Standard Operational Procedures for carrying out operation and activities to mitigate effect of farming on environment and the landscape.

Social impact (Occupational Health and Safety Audit)

The study investigated the status of Occupational Health and Safety (OHS) in the farming activities. According to Alli (2008), OHS measures are used to mitigate health and safety hazards in the workplace and surrounding community. The general Environment, Health and Safety guidelines prepared by the International Finance Corporation (2007) state that reasonable precaution should be taken to protect the health and safety of workers during the operational phase of projects.

The evaluation was carried using three main indicators of OHS. These include: farmers' participation, farmers' welfare and wellbeing, and farmers' safety. The results are presented in Table 7. The study found that farmers' participation evaluation scored 76 per cent which is being classified as "no issue and on track", due to the fact that PNG Biomass involves landowners in farm management activities including awarding tree planting and infrastructure development contracts to landowners.

The OHS audit also evaluated the farmers' welfare in the farming business. The study found that farmers' welfare was graded and scored at 78 per cent. It was represented by a green icon and interpreted as "no issue and on track". In other words, farming businesses do not have any issue with regard to the welfare of the farmers. This result shows that farmers' health and hygiene is being well managed by the developer in compliance with occupational health and safety policy and regulation. One of the preventative measures taken by the developer was equipping farmers with Personal Protective Equipment during the preparation and application of agro-chemicals. Similarly, the result for farmers' safety in farming evaluation was graded and scored at 80 per cent, indicated with a green icon and also interpreted as "no issue and on track".

Table 7. Social impact (Occupational Health and Safety Audit)

	Categories	Evaluation (%)	Grading	Level	Explanation
1	Participation	**76**		Low	no issue and on track
2	Welfare	**78**		Low	no issue and on track
3	Safety	**80**		Low	no issue and on track

Social impact (Training & Development)

The second social impact assessment was carried out on training and development of the farmers. The two main areas of study were technology transfer and training needs. The results are as shown in Table 8.

The study found that technology transfer was graded at 76 per cent, tagged with a green icon and classified and interpreted as "no issue and on track". This result reflects PNG Biomass's policy of involving landowners in developing and implementing farm management practices. The concept treats the project as a joint venture between PNG Biomass and the landowners. PNG Biomass provides the finance, innovative materials, tools and equipment which the farmers use to carry out their farming activities.

The study also evaluated the training needs for farming enterprises. The study found that training needs were graded at 69 per cent, were represented by a yellow icon and were interpreted as "priority and needs attention." Training needs were so graded due to the fact that most farmers are unskilled. Training needs will be identified by PNG Biomass management and provided to the farmers. The training will be designed to improve the ability of farmers to effectively implement farm activities.

Table 8. Social impact evaluation (Training and Development)

	Categories	Evaluation %	Grading	Level	Explanation
1	Technology Transfer	**76**		Low	No issue and on track
2	Training Needs	**69**		Medium	Priority and needs attention

Social impact evaluation (Road Infrastructure)

The study also evaluated the impact of road infrastructure development and maintenance in the PNG Biomass project impact area on the Markham Valley. The four main aspects of road infrastructure audit were: road construction (new), road construction (repairs and maintenance), culvert & bridges (new), and culvert and bridges (repairs & maintenance), as shown in Table 9.

The evaluation of "road, culvert and bridge construction (new)" were graded at 67 percent which is being represented by a yellow colour icon. The yellow colour icon further interpreted and classified as high "priority and needs attention". It is being classified this way due to the need to develop the plantation road network that may link all newly established farmland and provide easy access for the farm management practices. Linking new road, culvert and bridge construction to the existing road network will also improve the local communities' and farmers' access to the main road and markets for sale of their crops, finding paid employment, shopping and access to Government services. According to Kiprono and Matsumoto (2014), agricultural farming practices, productivity and market participation

increases with better road access. Mahesha and Lokesho (2017) added that infrastructure development, especially of road networks, is vital for agriculture and overall economic growth as well as improving quality of life.

In contrast, repair and maintenance of roads, culverts and bridges falls under the green colour icon and further classified as "no issue and on track". This was due to the fact that PNG Biomass is continuously improving the existing road network, culverts and bridges that serves local communities, farmers and PNG Biomass project.

Table 9. Social impact (Road Infrastructure Audit)

	Categories	Evaluation %	Grading	Level	Explanation
1	Road Construction – New	**67**		High	Priority and needs attention
2	Road Construction – Repair & Maintenance	**76**		Low	no issue and on track
3	Culvert & Bridges Construction – New	**67**		Medium	priority and needs attention
4	Culvert & Bridges – Repair and Maintenance	**78**		Low	no issue and on track

Economic impact (Financial Benefit Evaluation)

The economic impact assessed the effect of tree farming on farmers' income. Rapsomanikis (2015) stressed that any increase in the productivity of labour in agriculture increases rural income. The main areas studied were land lease (rental) payment, contract work payment and other spin-off benefits such as cash income from inter-cropping of food crops. The finding of financial benefit evaluation is shown in Table 10.

The study found that land lease payment was graded as 73 per cent whereby it was classified by a yellow icon and interpreted as "priority and needs attention". Payments due under the CLUA are not timely and not in accordance with the schedule set out in the Agreement. The CLUA between PNG Biomass and the landowners explicitly describes the obligation of each party. According to the CLUA, PNG Biomass is obligated to make an annual land lease payment to the lessors (the landowners) on the date and month of the agreement and consignment; however, payment was sometimes delayed and not paid in a timely manner.

The evaluation of payment for contractual work was graded with 67 per cent in which it was categorised under a yellow icon. The representation was interpreted as "priority and needs attention", due to the fact that it was not paid on time as required by the contractual agreement. The study observed that payment delays generate community grievances and complaints, which sometimes lead to physical confrontation, temporary cessation of field activities and the destruction to property, such as cutting and destroying the sapling trees.

The study also evaluated other spin-off benefits being derived from tree farming. The economic impact analysis of other spin-off benefit from farming was graded 76 per cent, represented by a green icon and classified as low with "no issues and on track". The study found that tree farming integrated well with

the existing subsistence farming system whereby the famers were able to generate additional farm income by inter-cropping food plants between the trees. These crops also provide food for farmer households. According to ILO (2014), rural households seek income from both farm and non-farm sources. Lopez et al. (2010) identified forestry-related output and employment as important components of the rural economy.

Table 10. Economic impact evaluation (Monetary Benefit Audit)

	Categories	Evaluation (%)	Grading	Level	Explanation
1	Land Lease (Rental) Payment	**73**		High	priority and needs attention
2	Contract Work Payment	**67**		High	Priority and needs attention
3	Other Spin-Off Benefits	**76**		Low	no issue – on track

Conclusions

The study was conducted to evaluate land dealings and farm impacts associated with the PNG Biomass tree farming project in Markham Valley, PNG. The study found that land use in the Markham Valley was bound up in complex ownership and usage rights that were often in dispute. It is particularly difficult for an outside party, such as PNG Biomass, to establish secure usage rights. The absence of a clearly defined ownership structure leaves the developer vulnerable to the idiosyncratic demands of competing interests.

Further evaluation of farm impacts identified the trend, risk and mitigation measures required for sustainable tree farming agribusiness. The study identifies the use and control of agro-chemicals as a crucial part of farm management practice in order to mitigate social and environment risks. The study further found that the establishment of buffer zones, forest corridors, cover-plant and drainage system on the farmland improves land conservation and the best management practices for sustainable tree farming business.

PNG Biomass faces challenges implementing the tree farming agribusiness project in the Markham Valley. The study found that legal compliance is lacking for both the land dealing process and farm management practices. In other word, appropriate legal procedures were not followed in this regard to PNG Biomass tree farming business development. A holistic approach should be adopted towards project development and legal compliance to the relevant laws and regulations should be prioritised to ensure that the business operation is safeguarded.

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