End of Project Report for the Kopafo (dry highlands) Site.

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1. Project Site Description.

Eastern Highlands is the only highlands province receiving rainfalls of less than 2000mm per annum (Allen and Bourke, 2009). The Ungai-Bena District is the driest area with monthly rainfall during the dry season ranging from 51–102mm (June – August). Kopafo with a population of more than 3,000 is located between the altitudes of 1500 - 1600 meters from the valley to the foothills with 14 hamlets (Figure1). The rolling grasslands are the dominant vegetation with patches of Casuarina and coffee near human habitation along the valley floors and near streams and river banks. Many topsoils are hydrandepts due to the deposition of volcanic ash soils. Humitropept soil type is dominating among the soil types of non-volcanic origin, which is a young and moderately weathered soil (Bleeker, 1983). More than 50 % of the studied and predominant soils are clay (Ulreich, 2016). Potassium is the most limiting nutrient in Kopafo soils; an important nutrient for tuber crops. Coffee and tomato are dominant income sources for farmers followed by livestock sales within the community. The impacts of dry seasons are severely experienced by the farming communities in these areas. Bush fires are the frequent hazards faced by the communities during the dry seasons.

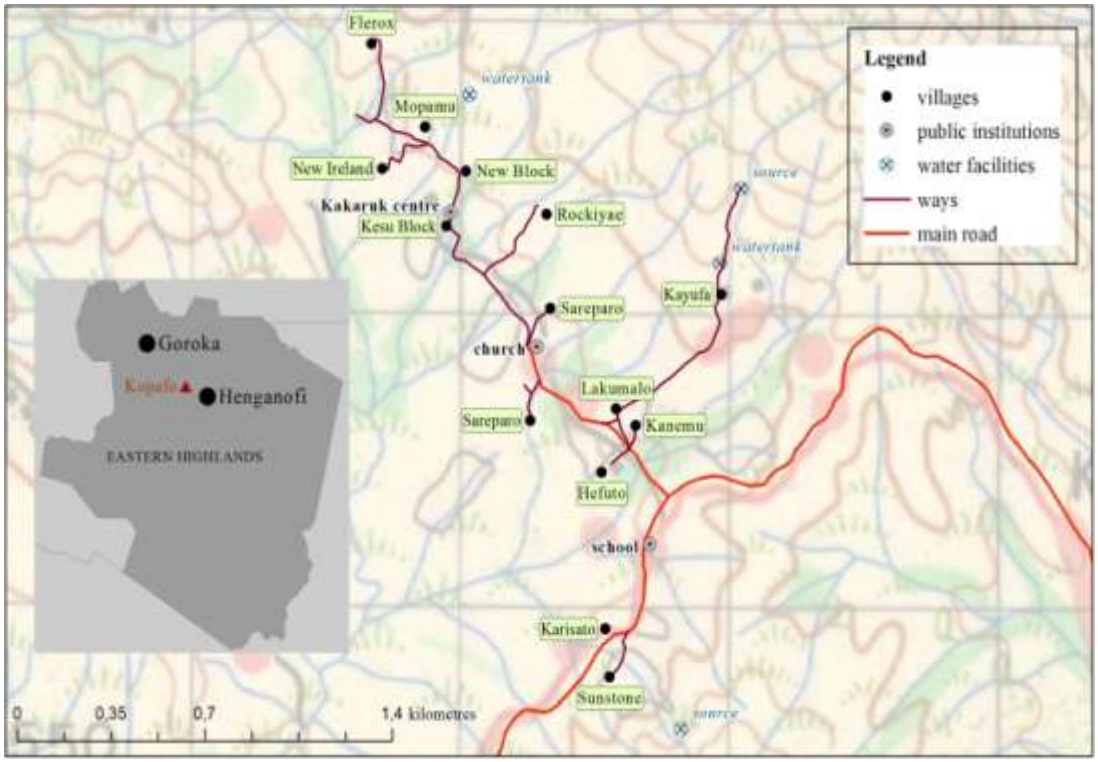

Figure 1. Villages hamlets , public institutions and water sources at Kopafo community (Ulreich, 2016).

2. Site Selection & Prioritization.

The Kopafo site was selected based on its known characteristic as a dry highlands area located alone the Okuk Highway. The initial fact finding site assessment visit revealed the following site specific characteristics which were slotted into SWOT analysis.

Table 1. Kopafo SWOT analysis.

Strengths: • Grow a range of different staple crops besides sweet potato; when SP not sufficient they draw on other staples • Grow yam that can be stored (but kept in gardens) • coffee as cash crop and other options like citrus, tomatoes, yams (marihuana) • close to provincial centre and market • streams do not dry up easily during dry season • Generally good and sufficient access to water • Farmers water crops (only high value crops) using buckets	**Weaknesses:** • Do not use or no access to improved planting material • Decline in soil fertility and no action • Extended drought periods but also continuous rain and swampy soils in low lying areas • Pest and Diseases (esp. SP weevil, insects) and no action taken • No to little food storage to draw on in extended drought periods • Land tenure system and land size holdings • Livestock and people use same source of water • Excess labour, not much other economic activities that could absorb labour around • Erosion at hillside gardens due to heavy rainfall • Contamination of water sources by freely grazing cattle during dry season**.**
Opportunities: • Interested in new practices and technologies. • Introduction of goats (need less land to feed) • Soil moisture conservation and soil conservation measures especially in uphill areas • Introduction of simple micro-irrigation technologies and supplementary irrigation • Water resource management • Improving soil fertility (improved mound system) • Introduction of varieties resistant to Pest & Diseases and drought. • Use of PT system for sweet potato. • Relatively close to provincial centre	**Threats:** • Stealing incidences during dry periods – social peace • Relative closeness to provincial centre (cheap cost of lamb flaps – no interest in livestock; labour drift, entertainment,) • Population growth (land shortage) • More irregular weather patterns • Marijuana cultivation.

In a first of its kind project for the National Agricultural Research Institute (NARI), community members were engaged in a reporting back workshop to list their major constraints during drought conditions. Each community member was invited to participate in the prioritization of the major constraint in their area and wished to do something about it (Table 2). Only the top three to five priorities were considered for addressing by the project. These constraints were later converted to project outcomes and prioritized based on their needs and understanding of the concept. Both gender had a fair representation in the workshop.

Table 2. Results of a voting exercise options addressing agricultural production constraints and opportunities at the workshop in Kopafo.

Options voted on in Kopafo	Men	Women	total
1. Improving the production of sweet potato	23	13	38
2. Improving the production of other staple crops	32	5	37
3. Introduction of grain crops in my farming system	7	1	8
4. Using some of my staple crops for livestock feed	43	8	51

Options voted on in Kopafo	Men	Women	total
5. Using some of my staples crops for processing into flour etc	32	5	37
6. Increasing consumption of home=grown meat protein	9	6	15
7. Producing more meat from my livestock holding	10	8	18
8. Diversifying my livestock holding	10	3	13
9. Improving grazing practices and land management	6	4	10
10. Increasing soil moisture to increase food production	12	6	18
11. To protect and improve the soil of my garden for more food production	4	3	7
12. To have better mounds for stable yields	4	5	9
13. To improve my families health by protecting our water source and manage it better	32	14	46
Total votes	**224**	**81**	**307**
No. Farmers	**75**	**27**	**102**

The priorities can be summarized as greater number of farmers practicing value addition for staple crops through livestock feeding and improved management and use of available water sources for domestic use. Four technical components (Table 2) of livestock, crop improvement, crop diversification, soils and water team were involved to address the outcomes of these priorities during the lifespan of this project.

3. Interventions implemented at the site and summary of achievements

Table 3 shows an overview of outputs achieved and participation of different community members in relevant learning workshops and demonstrations that were conducted in Kopafo communities. There were usually a number of learning events conducted per output and some community members chose to participate in only one of the events while others participated in all events for that output.

Table 3. The various outputs and participation of community members in relevant technology demonstration and learning events at Kopafo Pilot site.

	Outputs.	Farmers Trained	Male farmers	Female Farmers	Model Farmers
O1(a)	Increased capacity of interested farmers in Kopafo community for using improved pig and goat feeding practices (a. Pig feeding).	32	21	11	4
O1(b)	Increased capacity of interested farmers in Kopafo community for using improved pig and goat feeding practices (b. Goat feeding).	19	12	7	3
O2	Increased capacity of interested farmers in Kopafo community for using improved chicken feeding practices.	26	17	9	7
O3	Increased capacity of interested farmers in Kopafo community for processing sweet potato and cassava into other food products	35	20	15	7
O4	Community has an improved capacity to manage available water sources for domestic and agricultural uses.	14	10	4	10
O5	Increased capacity by participating farmers to use improved soil management practices addressing constraints of soil erosion, water deficit and fertility.	61	31	30	5
O6	Farmer-preferred drought tolerant sweet potato varieties identified and available to the Kopafo community.	27	17	10	8
O7	Capacity for growing yam using improved locally acceptable	78	65	13	6

	production practices and farmer-selected varieties increased in the Kopafo Community.				
08	Capacity for growing cassava using improved locally acceptable production practices and farmer-selected varieties increased in the Kopafo Community.	25	11	14	3

Model farmers were identified amongst the farmers themselves, based on their interests and past experiences. The model farmers volunteered to take on new innovations using their land for crop variety trials, and livestock pen/ shed for livestock husbandry demonstration trials. These were mostly interested and resourceful or knowledgeable in their selected areas and other areas as well. The success of the project depended on the pro-activeness of the model farmers. Model farmers in one technical component were also able to participate in other areas based on his interests. For example, the model farmer for broiler chicken was also the model farmer in food processing or other components . The attendance of farmers depended on the local factors and the weather. Funerals, graduations and tribal conflicts and market days affected the farmer participation levels, but farmers made up for it in the next trainings. Not all farmer trainee names were listed by the visiting NARI staff, as it was difficult especially during field days.

The planned activities under each of the technical components were delivered through field demonstration trials, training demonstrations and field days and culinary and taste preferences for the introduced crop varieties were also done. Table 4 shows a summary of technologies or innovations introduced and farmer impressions during implementation.

Table 4. Technologies/ innovations disseminated as part of project interventions at Kopafo pilot site and farmer impressions.

Output	Description of intervention	Innovation	Farmer impressions during implementation
O1 (a)	Increased capacity of interested farmers in Kopafo community for using improved pig and goat feeding practices (a. Pig feeding).	SP silage and concentrate technologies.	• Improved pig weight gains/growths fed with the NARI introduced feed silage). • Pork tasted better for pigs fed with silage. • Silage feed reduces labour for pig feed preparation.
O1 (b)	Increased capacity of interested farmers in Kopafo community for using improved pig and goat feeding practices (b. Goat feeding).	SP silage and concentrate technologies.	• Improved feeding options using silage and pasture is seen to be good, though not all goats went for the silage feed.
O2	Increased capacity of interested farmers in Kopafo community for using improved chicken feeding practices.	Broiler concentrate feed technologies	• Introduced feed technology using low energy (LE) concentrate using cassava and sweet potato was very good and raised profits by 50% compared to the standard commercial feeds. • The NARI feed concentrate (LE) is not available in commercial shops for the projects sustainability.
O3	Increased capacity of interested farmers in Kopafo community for processing sweet potato and cassava into other food products	Low tech post harvest food processing technologies	• Farmers appreciated the cassava flour making skills acquired during the project that was used in the 2015 drought period. • Post harvesting technique to preserve, store and make cassava flour enabled women to increase their daily income. • Many farmers regretted later missing out on these post harvest trainings.
O4	Community has an improved capacity to manage available water sources for domestic and	• Biosand filter water purification	• Treadle pump to overhead tanks and low cost low tech drip irrigation to tomato and other crops was exciting.

	agricultural uses.	technologies. • Treadle pump and drip irrigation.	• Farmers mentioned that irrigation technologies would have been a top priority, had they been aware of the implications of their voting the priority project outcomes at the initial stage of the project.
O5	Increased capacity by participating farmers to use improved soil management practices addressing constraints of soil erosion, water deficit and fertility.	Erosion controls using hedge rows and drip irrigations	• Farmers received good training and information on the eroded soils on hillsides. • The increased number of collected bags of eroded soils at the base of the hills was an eye opener and informative to see soil erosion.
O6	Farmer-preferred drought tolerant sweet potato varieties identified and available to the Kopafo community.	Drought tolerant SP varieties	• Introduced practice of *one vine cutting planted on horizontal orientation* per SP mound yielded more and bigger SP than normal practice. • Introduced SP varieties did not do better than local varieties, because of the drought situation in 2015.
07	Capacity for growing yam using improved locally acceptable production practices and farmer-selected varieties increased in the Kopafo Community.	Yam husbandry practices (mini-setting; staking; density); new yam species	• Mini-setting yam seed techniques were new and received with excitement. • Stalking of African yam received higher yields than local varieties.
08	Capacity for growing cassava using improved locally acceptable production practices and farmer-selected varieties increased in the Kopafo Community.	Drought tolerant, low cyanide cassava varieties	• Cassava varieties introduced were not excitedly received as they have local varieties. • Post harvest technologies in cassava were well received.

4. Challenges during Project Implementation.

Despite the very good site specific plans that were developed to implement project activities, project staff encountered certain issues that need mentioning that affected the project activity schedules (Table 5). Farmers also were culturally obliged to attend and participate in some important village activities like attending funeral ceremony of deaths in the village or other important village activities that they thought were more pressing to attend to than to attend NARI trainings. Social disturbances along with physical damage to road infrastructure due to adverse weather conditions along the main Okuk Highway had negative implications to the project activities. We were not able to conduct on farm drip irrigation studies with the farmers at the right time when postgraduate BOKU students were in the country for that work, but the work was done later by NARI staff. Other work by the technical components was delayed because of the road blockage. Planning anything during the peak coffee harvesting season also proved futile, as many farmers did not attend to our trainings. Table 5 list issues that affected the project implementations; either delayed or some stopped activities. During tribal fights or when there were family feuds we were only able to work with farmers that not involved or either side of the conflict. One of our leading yam model farmers and in soil and water she was denied the last work we had to do with drip irrigation on her tomato plots because of family feuds.

There was some mockery and banter for women who attended the post harvest trainings by some members of the community but these skills proved very crucial and profitable for those women who attended the sessions during the *2015 El Nino* drought period and some farmers regretted not attending those training sessions for food processing for storing and cooking with flour for both domestic consumption and sales, when they saw the success of others.

Table 5. Issues of significance that impacted the project implementation schedules

Issues arising during implementation and lessons learnt		**Type of action required/suggested taken to resolve problems and delays etc.**
1	People have other activities/happenings more pressing to attend to than NARI work. e.g. graduations, funerals, etc.	Communication with lead model farmers was critical at the initial stages and plan activities.

2	The nominated and trained model farmers did not impart their new knowledge with other members of the community. Cultural and clan related issues were raised as the reason. This prevalent problem should be considered while nominating the next lot of model farmers.	Discuss candidly practicalities of information and knowledge sharing within the communities between the clans, etc. Community members should be advised of the disadvantage they have because of this latent problem.
3	Coffee season, tomato buying days, school work, village court days, deaths are few village activities that farmers focus their attention and will not attend to trainings.	Keep in touch with the farmers and consult days before travelling.
4	False rumours spread around by some people and had high expectations of "pilot project" term.	Proper explanations of the project were done to those spreading false rumours, as well as others and address head-on.
5	Road blocks, bridge collapsed alone the main highway.	Delayed work plans implementations and irrigation on site were not done by BOKU students as planned.
6	Tribal fights between clans.	Some of the remaining activities had to be cancelled
7	2015 El Nino Impacts on Kopafo.	Soil conservation trial was discontinued to the impact of El Nino.

Although some soil conservation work had to be discontinued because of the impacts of the 2015 El Nino drought conditions, it was also an appropriate time to demonstrate drip irrigation technologies using simple low cost locally available materials. The easy to handle project distributed treadle pumps were taken to water sources where water was pumped up the 4 meters high overhead tank and later supplied to the crops using locally available bamboo pipes, pvc or rubber pipes.

5. Final Assessments and Comments

There was a lot of excitement, hype and expectations from the European Union funded project in Kopafo, and locals had their interpretations of the "pilot project" site as Kopafo. The initial slow implementations of the activities as planned reduced the momentum of the project and some farmers lost interests for a while. The new approach of farmers taking a lead role in what they expect from the project in terms of their local priorities was a new approach that also was breaking traditional extension approaches and may have astounded many farmers, who expected NARI officers to tell them what they should have and what not to have in their communities. The engagement of the womenfolk in all these community consultations and giving equal importance to their views was also new approach to a male dominant highlands society.

Final site assessments in Kopafo took place in November 2015. The following Tables 6 and 7 show a summary of responses on technology performance and responses of representative farmers during focus group discussions.

Farmers mentioned in the final site assessment meeting that water harvesting and irrigation technologies would have been the priority one in the project had the farmers knew of the implications of their voting and prioritizing constraints in the first workshop after they had endured the *2015 El Nino* induced droughts.

7. References.

Allen, B.J. and Bourke, R.M. (2009). People, Land and Environment. In Bourke, R.M. and Harwood, T. (eds). Food and Agriculture in Papua New Guinea. ANU E Press, The Australian National University, Canberra.

Bleeker, P. 1983. Soils of Papua New Guinea. CSIRO, ANU Press.

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Table 6: Technology performance in Hisiu Community as assessed by representative community members

Technology	**Performance -Better -Same -Poor**	**Area Cultivated (for crops)**			**Do they plan to continue in the future (livestock)? -Yes -No**	**General Interest from the community- High (H) Medium (M) Low (L) Give Reason**	**Engage in Market. If Yes, What is the price?**
		Old practice	**New Practice**	**Plan to Expand, If yes by how many**			
Improved management and feeding practices of pig/goat for food and income	Better				Yes, but no access to concentrate so resort to usual feed	High, Pig experience faster growth rate extremely well.	
Processing and Value addition of Sweet potato for food	Better					Medium, more awareness needs to be done to ignite the interest	Yes, baked with flour 50t/scorn
Improved management and feeding systems for chicken	Better				Yes	High, chicken perform better, more profit/income	Yes, K30
Improved production practices and farmer preferred sweet potato varieties (3 varieties)	Same	2000-2500 m^2	1250 m^2	Similar sizes as 2000-2500 m^2 or more.		Medium, perform similar to traditional practice	Own consumption
Improved production practices for cassava and farmer-selected varieties	Poor	≈20 m^2-100 m^2/Plot	≈30 m^2/Plot	No, results were not favorable as the traditional practice/varieties		Low Interest for the introduced cassava because of its poor performance.	Own consumption
Improved production practices for yam and farmer-selected varieties	Better	162 m^2	≈100 m^2	Similar or greater that 162 m^2.		High, introduced yam was able to thrive during drought condition	Own consumption
Improved management and use of available water source for domestic use	Better					High, more people access clean drinking water and also for irrigation	

Table 7: Responses from Focus Group at Kopafo during final assessment on food production and priorities

Periods of Food Shortage	• Farmers confirmed that food shortage is usually experienced during the months of June to July and August to November and is usually caused by changing weather pattern from a dryer weather to a heavy rainfall weather pattern. • Normally June- July the place normally gets drier and the following months the place experience heavy rainfall till December. During this transitional periods, food crops that perform well in dry periods couldn't perform well resulting in food decline and vice versa for rainy periods. For instance, SP as their staple food yield well in dry season but not in wet season: that's when people run short of energy food but do rely on vegetables till late December
Views on whether improved technologies would improved food shortage period	• The model farmers responded that especially yam and introduced cassava processing and preservation technology were able to sustain them during the drought periods. • With the post harvest technology farmers were able to process their cassava and store and use them during the prolonged El Nino caused drought and such is proposed to be used to solve the food shortage experience during the year. • These introduced technologies were able to solve the food shortage situation. However, these vital technologies have to be disseminated into the community to more members and are used by other members of the community in order to reduce the food shortage problem faced by the community members.
5 Years ago, communities voted on certain priorities. Do these still remain important or have now changed?	• The farmers acknowledge the research process from problem identification to implementation selected appropriate technologies to solve identified needs. • Most of the intervention selected was appropriate and relevant/important; • The farmers mentioned that the time they voted was the time that most of the farmers were marketing their livestock (cattle, goats) and there was a lot of cash flow in the community of Kopafo therefore, most of them voted without really looking into the real issues affecting the community. • It was mentioned that every need as identified and technologies implemented were relevant and they still remain important to the community. • The farmers also thought that there are a lot water logged areas where fish pond construction is possible and they still have interest in inland fish farming given the availability of water.