

# **IMPROVING AGRICULTURAL PRODUCTIVITY AND ENERGY SUFFICIENCY ON MARGINAL LANDS: THE AGRICULTURAL WASTE RECYCLING APPROACH IN THE NDOP ECOFARM, NORTH WEST REGION, CAMEROON**

## **ABSTRACT**

The Green Revolution, which promotes the extensive use of chemicals for improved productivity has witnessed enormous setbacks. Numerous small poorly equipped and very low-income farmers are unable to gain access to the new production means. As their income opportunities shrink, farmers are left with no options but to tend towards unsustainable activities that depletes the environment more; consequently precipitating the vicious cycle of poverty and environmental degradation characterized by, rising food prices, food security and energy crises. This study used the modified institutional analysis and development framework on the waste recycling approach to review the model for achieving agricultural productivity and energy sufficiency on marginal lands in the Ndop plain North West Region of Cameroon. It specifically analyzed the food and energy benefits alongside potential uptake by small-scale farmers. The results indicated that agricultural waste recycling provided improved market access; generate employment; increase income – increase purchasing power; improve household nutritional security and close the poverty gap (inequalities) amongst the rural poor in the community. Student t-test revealed a significant difference ( $t=-3.08$ ,  $P=0.006$ ) of farmers' livelihood before and after commencing agricultural recycling. Engaging in agricultural waste has enabled 8.5% of farmers to improve their livelihood and enhanced energy efficiency.

**Key words:** *waste recycling, agricultural productivity, livelihood diversification, poverty alleviation, increased income, improved diet, organic agriculture, marginal lands, clean energy, biogas.*

## 1. INTRODUCTION

Agriculture is the most important economic sector in developing countries, accounting for the largest proportion of employment with approximately 80 percent of the rural population involved Cook[1]. Concomitantly, it is the highest generator of waste USDA[2]. Despite the huge dependence on agriculture, by the rural poor, about 80 percent of their incomes are spent on food, to meet their dietary needs IFAD [3], as they cultivate food crops on a small scale, with the output not able to meet the needs of their families. More so, most of them cultivate on marginal lands, with fragile ecosystems and use their traditional knowledge and methods in farming. A majority of these farmers are therefore faced with hunger and malnutrition, due to food shortages.

The Green Revolution concept, which promoted the extensive use of chemicals, highly yielding seed varieties and extensive irrigation for improved productivity was a worldwide strategy to eliminate starvation and poverty. Unfortunately, it witnessed enormous setbacks IFPRI[4] -IFAD [5]. As stated by FAO[6], numerous small poorly equipped and very low income farmers were unable to gain access to the new production means. As their incomes continued to shrink, access to land became more difficult; the farmers were left with no option but to turn to unsustainable activities that deplete the environment. This had the effect of precipitating the vicious cycle of poverty and environmental degradation. This was characterized by rising food prices, food insecurity and energy crises. More so, the rural population usually have limited access to public utilities, in which case, the high rate of poverty prevented them from benefitting from these infrastructures, ADB[7], resulting in unsustainable practices.

Farming practices in the Ndop Plain have been predominantly traditional, most farmers practicing the slash and burn system for one or two years. Ndenecho [8] reported that the 'ankara system', which involves the burning of mounds of cleared grass covered with soil is common in the Ndop Plain. The 'ankara system' is considered a destructive practice given that 40 percent of nitrogen in the soil is lost in the process. Today, the burning of farmland to sterilize and provide an injection of rich ash still continues on a large scale. Whilst producing an initial injection of rich ash, its effect is short lived, as it burns microorganisms and

organic matter which slowly release fertilizer and water logging sponge. The burning also breaks down soil structure causing hard pan to develop. The burning of organic residue in the soil has a devastating effect on soil fertility. Most often the burning takes place just before the first rains which are usually very torrential, making the land vulnerable to soil erosion. Initially the impact was not felt by farmers because of abundant land which encouraged fallow; but with demographic pressure on farmland, no opportunity was given to fallow resulting in a rapid exhaustion of soil fertility.

In line with the objectives of the Green Revolution, and as a strategy for Rural Development and poverty reduction, the Government of Cameroon created professional agricultural institutions, for the training of agriculture-extension workers. Through the Ministry of Agriculture and Rural Development, the marketing of fertilizer and pesticides were liberalized with appropriate credit lines to facilitate purchase. To make agricultural input accessible to farmers, the production and marketing of planting materials was privatized, by setting up a seed multiplication and distribution system based on private initiatives. On the contrary, these did not solve the problem of low food crop production. In a work by [9] -[10], low crop production was associated with inaccessibility and affordability due to high prices. The credit facilities became unable to meet the farmers' needs due to untimely distribution. As a result, farmers were not sure of having adequate harvests for consumption and sale to generate income in order to re-inburse the loan. Lambi[11], identified high population density leading to increasing pressure on land, climate variability and change, land fragmentation due to tenure inheritance with a maximum size of 1.54 hectares a farmer, and shift from crop production to intensive rice cultivation since it is being exported and attract more income. In a reconnaissance study carried out by the authors, other associated problems identified included few village agriculture extension workers to visit farmers. According to [11]-[12] land tenure played a major role in low crop production as most men control lands and women especially widows and women family heads have little or no access to own land, however, occasionally the land is leased to them. The restriction of these people to have permanent ownership of land has greatly reduced agricultural productivity. The pressure and scarcity of land also led to the reduction of fallow periods and in some cases, conflict over land use between farmers and grazers. With an average family size of six persons [11], little or no access to land, these farmers are forced to cultivate on marginal lands for livelihood and sustainability.

In order to meet up with these challenges facing the increasing population, especially regarding food and energy requirements, Eco-farms, an Agro industry based in Ndop, put up effective strategies where agricultural waste from farms to recycle into organic manure and energy recovered. This has led to improvement of agricultural production systems on marginal lands, improvement of nutritional values, recovery of energy from agricultural waste, provision and improvement of market access, creation of employment, and increased income and purchasing power. This has reduced the poverty gap (inequalities) amongst the rural poor in the community.

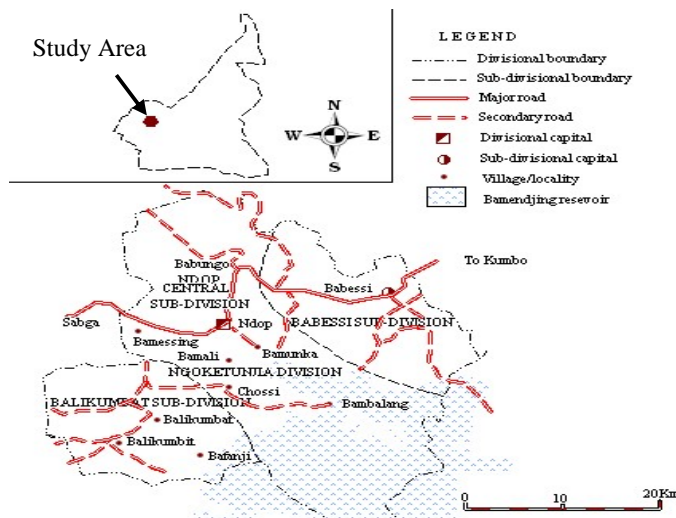
Using simple and readily available, easy-to-use and local technology, farm waste from agricultural activities (post-harvest waste), livestock, biomass waste (wood ash from husk) were recycled by local farmers through compost to produce organic manure and energy recovered from anaerobic digestion to produce biogas. The production and use of organic manure encouraged the practicing of Organic Agriculture (OA). Organic Agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including biological diversity cycle and activities IFOAM[13]. Organic Agriculture is advantageous because, it requires less financial inputs (which was a major challenge to the local people), while placing more reliance on human and natural resources, thus moving farmers towards sustainable agricultural practices. Pretty[14] stated that organic farming is a sustainable agricultural practice that has emerged as a viable alternative to Green Revolution particularly for the rural poor in most marginal areas. It is a strategy to improve agricultural productivity based on the use of low cost, and locally available technology, inputs and environmentally friendly agricultural system. According to Setboonsarng et al. [15], in Thailand, organic rice farming on marginal areas produced significantly high yields and improved the livelihood of participating farmers. Similarly, as reported by [13] in Europe Organic Agriculture is reported to be found in disadvantaged areas or areas unfavorable for conventional agricultural production.

This study is focuses on the characteristics farmers working on marginal lands who recycle agricultural waste to produce organic manure and improve on energy (recovery) sufficiency. The study was specifically set out to (a) identify the main crops cultivated and rank them based on consumption rates; nutritional value and generational level; (b) assess the crop output before and after the use of organic manure; (c) investigate income in the sales of crops before and after the use of organic manure and its influence on livelihood strategies through

diversification of livelihood options; (d) evaluate energy efficiency in relation to sampled farmers in the study area.

### 1.1. Materials and Methods:

The Ndop plain is located in an Inter-Montane plain within the Bamenda Highland Plateau (BHP) and located between latitude  $5^{\circ} 40'$  and  $6^{\circ} 10'$  North of the equator, and longitude  $10^{\circ} 15'$  and  $10^{\circ} 5'$  East Lambi [11]. The average altitude is 1200m above sea level. Alluvial deposits comprising clay loam characterize this plain and sandy loam silt soils especially where farming is intensive, [8]. The population density is 96 persons per  $\text{km}^2$ . Average farm size stands at 1.54 hectares for a family averaging 6 persons, with 3 active farm workers [11].



**Figure 1. The location of Ndop Plain in the North West Region.**

The humid tropical climate feature of two seasons prevails in the area. The rainy season span from mid- March to mid –November. During this period, heavy rains accompanied by hailstones are common between June and September. Annual rain fall range from 1500 – 2000mm. The dry season runs from December to February, with average annual temperatures of  $21.3^{\circ}\text{C}$ . Despite the long period of the wet season with the land being flooded, the dry season leads to a water deficient milieu.

#### 1.1.1. Sampling Techniques:

A reconnaissance study was carried out to get a background knowledge of the study area. This was followed by a transect walk with the aid of two field assistants who were familiar with the area. Stakeholders were duly identified (farmers, millers, agricultural- extension workers, Eco farm workers). During the transect walk, major crops cultivated were also noted

and the Eco -farms milling and waste management unit was also visited. Using purposive sampling techniques, 100 farms were chosen based on the size of farms, (800 square meters). The identification and ranking of crops was based on the consumption rate, nutritional value, and income generation potential. To guide this study, secondary data included, review of documents like project proposals, field reports, and workshop proceedings on agricultural waste management. The participatory Rural Appraisal (PRA) tools, like Interviews, Semi Structured Interview (SSI), group discussions and key format interviews were used to collect data.

## **2. DATA ANALYSIS:**

Besides the modified Institutional analysis and developmental framework, the data were subjected to descriptive and inferential statistics.

### **2.1. Results and Discussions:**

#### **2.1.1. Identification and Ranking of the main crops cultivated based on consumption rate, nutritive value and income generation potentials.**

Amongst the crops cultivated, were Maize/Corn, Beans, Groundnuts, Huckleberry (vegetable), Rice, Cassava, Tomatoes, Pumpkin, Cocoyams, Yams and Sweet Potatoes which have been ranked as shown on Table 1. Maize was ranked first; it is the main staple food crop not only in Ndop but in most parts in the North West Region of Cameroon as it is usually transformed into various forms for consumption. Maize is used for brewery of beer and also by the local communities for the production of local beer otherwise called “Shah, corn beer and quasha”. Maize is also used in the production of animal and poultry feeds, consequently the demand is high. Beans which is a source of protein and has a high nutritive value was ranked second. It is widely eaten all over the country and also exported to neighboring countries. Groundnut with its high nutritive value was ranked third; it is commonly used as a food complement (soup) and usually transformed to cooking oil and eaten as snacks. Just like beans groundnuts is an important economic crop as it is both sold all over the country and exported to neighboring countries. Huckleberry (vegetable) was ranked fourth with a high nutritive value. It is sold in most urban areas especially in Douala the economic capital of the country. However it faces challenges of post-harvest preservation due to its high rate of perishability. Rice was ranked fifth. Though it is not much consumed by the local people, it has a very high market demand both in the country and other neighboring countries. Rice is both labor and capital intensive. In order to maximize profits, a large surface of land is needed. This poses a major challenge to the farmer. Small scale rice farmers sell to

cooperative, middlemen or large-scale farmers. Cassava was ranked sixth. Cassava is not commonly directly consumed but is often transformed into Garri (tapioca) and sold in and out of Cameroon. It can also be transformed to “water-fufu and boboloh” indigenous meals that are eaten all over Cameroon. Amongst the crops cultivated in the study area, rice and cassava are the highest generators of agricultural waste, which also contribute significantly to the recycling project. Tomatoes was ranked seventh, although it has a high nutritive value and is very high in demand; it is highly perishable and most farmers face challenges with post-harvest storage worsened by climate variability. These challenges make the production to be highly monitored and farmers do not always produce in large scale. Pumpkin was ranked eighth. The leaves and fruit are highly nutritive but due to their perishable nature, it is mostly consumed by the locals. However, the seeds (melon), which are very nutritive are in high demand. Pumpkins also act as cover crops and play a huge role in the conservation of the soil especially during the rainy season. Cocoyams and yams were ranked ninth and tenth respectively. These are biennial crops mostly sold to outsiders, while the consumption rate by the local population is minimal. Sweet potatoes was ranked eleventh. Although it is sold and eaten by the rural poor, it is planted mainly to act as soil protective major as it acts as a cover crop.

**Table 1. Identification and ranking of crops and income of the sales of crops before and after the use of organic manure**

	Before the use of organic manure			After the use of organic manure					
Crops	Quantity	unit price	total	Quantity	unit price	total	Qty change	income change	% change
Corn ***	8	18000	144000	30	18000	540000	22	396000	73.33
Beans ***	4	20000	80000	25	20000	500000	21	420000	84.00
Groundnuts ***	10	25000	250000	30	25000	750000	20	500000	66.67
Huckleberry***	2	20000	40000	10	20000	200000	8	160000	80.00
Rice **	5	18000	90000	12	18000	216000	7	126000	58.33

			0			0			
Cassava **	3	15000	4500 0	10	15000	15000 0	7	105000	70.00
Tomatoes **	8	5000	4000 0	15	5000	75000	7	35000	46.67
Pumpkin **	20	2000	4000 0	33	2000	66000	13	26000	39.39
Cocoyam **	3	20000	6000 0	5	20000	10000 0	2	40000	40
Yams **	3	15000	4500 0	3	15000	45000	0	0	0
Sweet potatoes**	2	8000	1600 0	2	8000	16000	0	0	0
			8500 00			26580 00			

Table 1. shows the output of crops before and after the use of organic manure. The crops with three asterisks (\*\*\*) meet the three criteria used in ranking: consumption rate, nutritive value and high income generation potentials, while those with two asterisks (\*\*), have two of the three criteria. Besides Cassava, Cocoyams and Yams that are biennial, others crops are planted twice a year. Corn/maize, Beans and Groundnuts were ranked as the first three crops produced before and after the use of organic manure, with a tremendous increase in quantity. After the use of organic manure the yearly harvest of these crops changed by, 22 bags, 21 bags, and 20 bags respectively. After the use of organic manure, beans showed a higher percentage changed as the number of bags increased from 4 bags to 25 bags after the use of organic manure from the eco-farm. There was also an increase in the production of huckleberry, tomatoes and pumpkin (all vegetables) after the use of organic manure. However, these farmers were faced with the challenges of post- harvest storage due to their perishable nature. The productivity of these crops was also affected by climate variability, making the farmers to regulate the quantity planted. Due to the delicate nature of these crops, the farmers used their indigenous knowledge in tendering the crops until maturity (by protecting them from attacks by insects, and animals browsing on their leaves). Wood ash was often used as insecticide and repellants for animals that browse on the leaves. Wood ash



which is waste from biomass containing Calcium, Magnesium, Potassium and phosphorus was also used as a valuable source of plant nutrients and soil amendments to increase soil fertility. It also acted as a liming agent to counteract the effect of atmospheric deposition of acidic materials which can lead to soil acidity. The change in the quantity of output experienced for rice and cassava was not significant. The production of rice is capital and labor intensive making it a challenge to small scale farmers. Similarly, a very small quantity of cassava is consumed or sold, thus, it is transformed to “garri or fufu” for it to be consumed and sold making it capital and labor intensive. Amongst the crops planted, rice and cassava were the largest generators of waste. For the sustainability of the use of organic manure, the farmers are encouraged to cultivate them. Cocoyams and yams are planted mainly for home consumption. However the excesses are usually sold in the market. Pumpkin and sweet potatoes are planted to help protect the soil from erosion, given the vulnerable nature of the land.

#### **2.1.2. Incomes from the sales of crops before and after the use of organic manure and its influence on livelihood.**

Assuming there was no change in the quantity of home consumption and based on the same unit price before the use of organic manure, the study showed a significant increase in farmers’ income after the sales of the farm produce, (see Table 1).

The total sales of farm products before the use of manure stood at 850,000FCFA (eight hundred and fifty thousand francs CFA) and after, it rose to 2, 658,000FCFA (two million, six hundred and fifty eight thousand francs CFA,) thus, revealing a net increase of 1, 808, 000FCFA (one million eight hundred and eight thousand francs CFA). This increase is attributable to access to market. Ndop is basically an agricultural town and has local market days known to traders and middle men in the region. On this market days, these traders/ middle men go to Ndop to buy. Consequently farmers do not incur any transport costs. Most of these crops are not perishable. The farmer use their indigenous knowledge in preservation, especially with the grain- like products, which are stored in a local suspended “band” in their kitchens where they use either fire wood or charcoal for cooking. The heat or smoke keeps weevils and other insects from entering or from catching mold. In the course of preservation excess crops are hauled and sold during periods of scarcity and at very high prices these farmers also prepare seedlings and sell at very high prices during planting seasons. Most of the crops that are transformed have a very high market and attract much income. Corn for example, is used by the brewery industries both at a large scale and local transformation. Most agro-pastoral industries also use corn in the production of their animal feed. Cassava,

when transformed into “garri and fufu” is not only sold in the neighboring urban areas but also exported to nearby countries. Most of the rice produced in Ndop is exported to neighboring Nigeria and sold at very high prices. The brand of rice is not grown in Nigeria. Generally on market free days, most of these products are displayed along major roads that link other urban areas, thus sold to travelers.

Hypothesis: There is no significant difference in the livelihood of the farmers before and after the commencement of agricultural recycling. Student t-test statistical technique was used to test this hypothesis. The result is presented in Table 2

**Table 2. Student t-test statistical analysis of the difference in the livelihood of the farmers before and after commencement recycling.**

	Period	N	Mean	Std. Deviation	t-cal	p- value	d.f
Income	Before	11	15090.9091	7147.79050	-3.068	.006	20
	After	11	241636.3636	243566.94058			

The result on Table 2 reveal that there is a significant difference in the livelihood of the farmers before and after the commencement of agricultural recycling ( $t=-3.08$ ,  $p=0.006$ ) at the 5% probability level..

### **2.1.3. The influence on livelihoods:**

The increase in productivity led to an increase in household income as a result of access to markets, and consequently, livelihood diversification strategies. As a result, beneficiaries of these increments in income engaged in other tertiary and secondary activities as detailed on the table below.

**Table 3. Livelihood Diversification**

s/n	Occupation	No of per
1	Bike Riders	85
2	Local brewery “shah and corn beer” with corn	85
3	Restaurant operators	72

4	Petit trading – provision stores	32
5	Photographing	5
6	Poultry farming	15
7	Piggery	11
8	Telephone operators (call box)	28
9	Road sides food traders – at check points (groundnut paste, cassava pastry, beans cake, fried groundnuts and corn,)	51

As seen on Table 3. Farmers who experienced increase in incomes from the sales of agricultural produce, were able to diversify livelihood activities. It was possible for these farmers to carry out other activities other than farming because of its unskilled nature, coupled with the fact that agricultural activities were mostly in the morning to the early hours of the afternoon. For example after farming, they went to their business centers, restaurants, local wine joints; in some cases they worked in their poultry and piggeries early in the morning before going to their farms. Again, farming was not done on a daily basis, but thrice a week and the other days were devoted to the other activities. These farmers also empowered their children, relatives and other community members by creating employment; such as bike riding, photographing, telephone booth operators (call box), road side food vendors, to name but these. Poultry and piggery farming complemented their protein and oil intake thus a guarantee food security. While these farmers continue to get money from their farm produce, they also have incomes from the diverse livelihood activities, consequently narrowing the poverty gap, improved livelihood while maintaining environmental integrity.

## **2.2. Energy Efficiency (benefits of energy)**

On a daily basis, the piggery of Eco farms generated averagely 25kg of waste, which is used with waste from mill and farm waste to generate power in the biogas plant. This energy is used to run the mill and generate electricity. Before the construction of the biogas plant, approximately 50 liters of fuel (petrol) at the cost of 40,000fcfa (forty thousand francs CFA) was used in running the mill. Before the construction of the biogas plant, the farmer milled 1kg of unhull rice at 100fcfa (50kg at 5,000fcfa), and after the construction of the Biogas plant, the cost of milling 1kg of unhull rice dropped to 7.5 FCFA (50kg at 375fcfa).

### 3. CONCLUSION

Because of demographic pressure, achieving agricultural productivity and energy sufficiency on marginal lands in the Ndop Plain is a major concern. This study, which assessed the consequences of the use of organic manure and energy derived from the recycling of agricultural waste and its impact on livelihood sustainability, concluded that the quantity of crops cultivated before and after the use of organic manure increased. Increases in the quantity of crop production led to greater access to market; increase in income and enhanced livelihood diversification. There was also a reduction on the expenditure on energy after the installation of the biogas plant. There was a significant difference in crop production before and after the use of organic manure with a student 'T' test value of 3.08 at 95.% confidence interval. Generally the management of agricultural waste improves agricultural production and energy sufficiency, but will be more successful if it is integrated in the Rural Development plan by the government of Cameroon, as it is in the case with the IFOAM in South East Asia.

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