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FACULTE DE SCIENCE
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DEPARTMENT OF PLANT BIOLOGY

BIOGAS PRODUCTION AND INTEGRATED ORGANIC FARMING IN STRATEGIC HUMANITARIAN SERVICES IN THE NORTH WEST REGION OF CAMEROON

Internship Report carried out in the Integrated Organic Farm (BIOFARM) Centre of Strategic Humanitarian Services (SHUMAS) in Bamenda and Kumbo of the North West Region.

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DEDICATION

This internship report is dedicated to my family, especially my sister, Leinyuy Saber Emelienne for the support she gave me during the period of internship in the North West Region and my wife, Sevidzem Ernestine L and my son, Wirsiy Clinton-Moise Nyuykonghe, for encouraging me.

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SUMMARY

The internship rationale is based on solving problems linked with farming and energy for cooking and heating in the North West Region of Cameroon. This internship report looks at methods that Strategic Humanitarian Services (SHUMAS) uses to solve these problems. Agriculture is the backbone of Cameroon's economy. Human population is growing and increasing demand for food. Chemical pesticides and fertilizers have been produced to fight pest and improve on soil fertility respectively and increase agricultural output. These chemicals used in farms are polluting groundwater, surface water, soils, reducing biodiversity and adversely affecting plant, animal and human health.

In the North West Region like other parts of Cameroon where agriculture is a way of livelihood, lifestyle and a communication or interaction with nature, the problem is becoming more severe. Poverty and unemployment has hit so hard in the rural communities of the North West Region where poor peasant farmers live. Many of these peasants live on less than a dollar per day. Population increase in the area has made land scarce and this is demonstrated by an upsurge in land conflicts. The vegetation in the North West Region is mostly grassland and the topography is hilly. This makes the soil fertility in the area to be fragile due to soil erosion. The peasant farmers used to increase soil fertility with the use of chemical fertilizers and pesticides to fight pests and increase agricultural output. Prices of fertilizers have risen above the affordability of the poor peasant farmers who are searching for different methods of farming. The population in the area now put in a lot of effort to till the soil and improve on its fertility, but realize very little due to poor farming techniques and poor pest management. The animals reared lack enough pasture to feed on and suffer from some diseases. These peasant farmers work more than ten hours per day in scorching sunshine or continuous rainfall for less and less output, but still run short of food a few months after harvest. This has made agriculture to be seen as unprofitable.

Most of the North West Region like many other parts Cameroon lack energy for cooking, heating and lighting. This is common in rural areas that are far away from the national electricity grid. The prices of fossil fuel have also risen and poor peasant farmers can no longer use it to meet energy needs. The North West Region is covered by a few small patches of forest found in some of its valleys. The peasant farmers have to travel long distances to fetch firewood from these small patches of forest for cooking and heating. This has promoted deforestation in the area. When this firewood is used for cooking it produces smoke that causes indoor pollution and this has been responsible for a large number of respiratory diseases world wide as sited by World Health Organization. Those mostly affected are women and their children who spend much time in the kitchen to prepare food for the family.
This internship report looks at biogas production as a solution to energy needs especially as many households around SHUMAS's Integrated Organic Farm keep animals whose waste or dung can be used to provide raw material for the production of this energy. The institutionalization of integrated organic agriculture for peasant farmers is also a means to increase agricultural output. The practice of integrated organic farming by SHUMAS provides serves as a demonstration and research centre to solve peasant farmers' agricultural problems.

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CHAPTER ONE

INTRODUCTION

1.1. BACKGROUND INFORMATION

This internship report presents activities carried out in the months of August and September 2009. The internship was aimed at professional insertion of student environmentalists. The internship was carried out in Strategic Humanitarian Services (SHUMAS), a non profit organisation based in the North West Region of Cameroon. This internship focused on biogas production for cooking and heating and the use of its by-products for soil fertility improvement and pest control. During the internship period much was learned too on integrated organic agriculture. The first part of the internship period involved getting acquainted with SHUMAS' activities and reading more on biogas production for cooking and heating, and also on integrated organic farming. The second part of the internship was done in the SHUMAS' Integrated Organic Farming Centre (BIOFARM) where much was learned by practical work on biogas production and integrated organic farming. Many other subsidiary activities were also carried out during this period of internship like project writing, radio programmes, participating fully in other project planning and implementation.

1.2. INTERNSHIP OBJECTIVES

The objectives of this internship on biogas production and integrated organic farming were as follows:

- To know how the biogas system functions to produce energy for cooking and heating;
- To know how the by-product from biogas production is used to improve on soil fertility and fight pests;
- To know how crop cultivation and reared animals can be improved without the use of chemicals in farms and how these organic techniques can benefit local peasant farmers;
- To see how the economic, food and environmental crisis can be solved by integrated organic agriculture and biogas production.

1.3. PRESENTATION OF SHUMAS

Strategic Humanitarian Service (SHUMAS) Cameroon is a Non-Profit Governmental Organization, created in 1993 as a local initiative, and later on legalized in 1997. It is located at mile 6 Nkwen, Bamenda and has a regional office in Kumbo, all in the North West region of Cameroon. It sphere of action is Cameroon with targeted groups being the rural population

and the urban poor. Its goal is to improve lives, reduce poverty and empower people. Since its creation SHUMAS has continued to tackle developmental issues in the country with the aid of its multi-complex or integrated approach. SHUMAS approach is participatory and it works hand in glove with its target groups in project development, execution and monitoring, so that beneficiaries can gain full ownership after completion. This has proven to yield positive fruits as most communities have gained skills to initiate their own development activities. SHUMAS's intervention includes:

- **Education**

Education is vital and constitutes part of the development of a people. It has often been said that the poverty of ideas is worse than the poverty of material resources. SHUMAS intervenes by promoting appropriate education in rural areas of Cameroon and supporting government action by contributing to the achievement of the international millennium development goals. SHUMAS intervenes in the construction of classrooms, refurbishing of existing school structures, donation of educational materials, construction of toilets, scholarship offers, teacher salary support activities and the provision of drinking water. Some of the achievements for 2008 are in the Government School (G.S) Menjung in the Boyo division of the North West region where it constructed three large classrooms, a toilet and provided benches, tables and chairs. SHUMAS also constructed three large classrooms in the Islamic Primary School (I.P.S) Bamali and a toilet. It also provided potable water, benches, table and chairs. This was done in partnership with Building Schools for Africa (BSFA) and Lambert Academy UK. Other schools that SHUMAS worked with include G.S Mbohkija, G.S Quebessi and Catholic School Golongui all in the North West region of Cameroon.

- **Social welfare**

This program promotes intervention that targets the most vulnerable population and people with disability. Persons with disability are often exposed to social stigmatization and mistreatment. SHUMAS intervenes in rehabilitating through socialization and moral enhancement workshops, capacity building workshops, life skills training through attachment with trainers in Bamenda and the provision of seed capital to trainees. Thanks to SHUMAS's intervention in collaboration with the beneficiaries, the following four disabled groups have been created and assisted: Bamenda Disable Group under SHUMAS (BADIGUS), Kumbo Disabled Group under SHUMAS (KUDIGUS), Wum Disabled Group under SHUMAS (WUDIGUS) and Binka Disabled Group under SHUMAS (BINDI). SHUMAS has also run a

rehabilitation centre in Bamenda where qualified people with disabilities train other people with disabilities in tailoring, hair dressing, handicraft work, traditional embroidery, shoe making and mending, etc.

- **Environmental protection and management**

The environment is a determining component of human life. Indiscriminate planting of eucalyptus trees on farm land and water catchments has, over the years, resulted in shortages of farmland and drying up of streams in North West Region. Women have to walk long distances to find farms and water. SHUMAS has intervened by nursing thousands of agro forestry indigenous tree species like Acacia. She has cut down more than 800,000 mature eucalyptus trees to recover productive farmland, improve water catchments and carry out sustainable afforestation. The 800,000 eucalyptus trees felled have been replaced by 500,000 indigenous tree species and more than a million seedlings are still in the SHUMAS tree nursery pending out-planting at eucalyptus felling sites and water catchments. A school environmental programme has also been another aspect of SHUMAS environmental protection and management. This programme has two main objectives namely (i) promoting sustainable environmental management through a practical education and (ii) enhancing rural primary education by seeking income sources provide for some education needs.

SHUMAS, in collaboration with some beneficiaries, has helped pupils to learn how to cultivate crops and plant local tree species that have many uses. The proceeds are sold and the money used in paying teachers and acquiring educational materials.

- **Health, sanitation and water**

Cameroon, situated in central Africa, has an estimated population of 16 million, but with 60% of the population is living in the rural areas. Rural people have common problems like bad roads, poor sanitation, and lack of clean potable water. SHUMAS has intervened in collaboration with foreign partners to donate medical facilities to some health centres in the North West Region, specifically in the Rohvitangtah community, Lui community, maternity in Oku and the Kitiwum Integrated Village Health Center, Bui division. SHUMAS is also giving scholarships to young girls and boys from some rural areas to study nursing in the ST LOUIS clinic in Bamenda so that they will help their various communities to improve their understanding of health conditions upon completion.

Water is a vital source for livelihood. Man needs water for almost 80% of his activities. Rural communities suffer a lot from water related diseases. Most often water is obtained from

streams, unprotected springs, lakes and rivers. This generally causes water born diseases. SHUMAS has worked to enhance and support sustainable rural development by coming up with water project schemes for rural communities. SHUMAS's objective is to improve rural access to potable water. So far clean water has been provided to at least 25 rural communities along with community training to ensure good management of water. SHUMAS has also constructed adequate stand taps for these communities.

- **Agriculture and womens' empowerment**

Agriculture is the backbone of Cameroon's economy. The rural population provides over 70% of the country's income. However, low crop and livestock yields are resulting from declining soil fertility, poor seeds, breeds, poor farming techniques etc. SHUMAS has contributed greatly to the enhancement of sustainable farming through the provision of a facility to promote integrated organic farming, which has proven to be economically and environmentally profitable. The project has enhanced crop and animal production using an integrated methodology and infrastructure. SHUMAS has also been working with women's groups to facilitate the marketing of farm products and build their capacity through improved agricultural techniques. These methods have improved the women's agricultural production. The provision of a large truck has also enabled women to market their products more effectively and economically. Marketing is always difficult because of the poor state of rural roads. This has improved the living standards of the rural poor and reduced poverty. In addition SHUMAS has so far provided 40 cassava mills, 21 corn mills, 80 'push-push' trucks (hand carts) and numerous other farming implements like hoes, cutlasses and wheelbarrows, to more than forty women's groups.

- **Integrated organic agriculture**

SHUMAS has an integrated organic farm and training center in Kumbo where it carries out crop production and animal rearing. The types of crops cultivated are beans, Solanum potatos (commonly called Irish potatoes), maize and vegetables. Animals reared are cows, goats, sheep, rabbits, pigs and birds (broilers hens and layers). Animals' droppings are used to produce biogas for food preparation and heating of the poultry. The biogas by-product is used to improve soil fertility and fight pests in the various crop areas. The SHUMAS's Biofarm Centre, presently runs a nine month training programme in organic farming for peasant farmers and their children to build their capacity on how to improve on farm yields without destroying the environment, biodiversity and the soil. Inorganic fertilizers and pesticides

prices have risen recently and are difficult for poor peasant farmers to afford. SHUMAS has developed this programme to solve the problem, improve on health and fight poverty through increased food security and self reliant activities that provide employment for peasant farmers' children.

Carrying out organic farming and working with these peasant farmers and their children through training programmes has enabled SHUMAS to gather much information on the problems faced in the field and from other successful local agricultural practices. SHUMAS has exploited this information to come up with improved agricultural techniques locally through organic farming. SHUMAS now needs to share these skills, experience and knowledge with peasant farmers working in the field through short courses.

1.4. SHUMAS's ORGANISATIONAL STRUCTURE

SHUMAS is managed by a board of trustees which chooses the President and General Coordinator that works with SHUMAS partners. The General Coordinator is responsible for the day-to-day functioning of the office and makes sure that the running of the organisation is smooth. The Programme Coordinator is next to the General Coordinator and is responsible for coordinating SHUMAS's programmes in the four departments (technical, personnel management, project management and finance). These departments are headed by Heads of Departments. The technical department is made up of field technicians. The personnel department coordinates activities of secretaries, drivers, contract workers and guards. The project department head manages activities of volunteers, project officers, students on internship and field supervisors. Field supervisors control activities of field inspectors and extension staff.

1.5. PLANNING, MONITORING AND EVALUATION IN SHUMAS

In the course of the internship much was learned on project planning, monitoring and evaluation in SHUMAS. The planning, monitoring and evaluation of projects in SHUMAS is done by its staff in partnership with the project's stakeholders including beneficiaries, funding institutions and traditional and administrative authorities to ensure that projects achieve their goals and address upcoming challenges. The challenges and difficulties encountered in projects are handled by project staff on a daily basis. All project staff meetings to search for the way forward and possible solutions to these challenges are held on weekly. General complaints and requests from beneficiaries are also reviewed to see how SHUMAS can help them. To solve unforeseen problems, beneficiaries are involved fully in project development,

implementation and monitoring. This gives them the feeling of belonging and develops the spirit of ownership, care and interest for the project.

During monthly meetings, the project staffs update the management of SHUMAS on project's recorded successes, challenges faced and difficulties encountered during the project execution. This event is organised to share skills, knowledge and experience, and help assess the progress of project work so as to come up with new strategies and methods to better handle encountered obstacles. Evaluators from SHUMAS visit the field to evaluate each project to see what was successful and what failed in order to use the experience gathered to prepare for better future project execution. Questionnaires are sometimes used to gather information from project stakeholders on what they think went well and what could be modified to improve on the project in the future. The process of planning, monitoring and evaluation has helped SHUMAS to grow and gain local, national and international recognition.

CHAPTER TWO

ORGANIC AGRICULTURE IN THE BIOFARM CENTRE

2.1. LOCATION

SHUMAS' integrated organic farming; training and demonstration centre (BIOFARM Centre) is situated at Bamdzeng, a small village community in Kumbo, Bui Division of the North West Region of Cameroon. Kumbo is located approximately 113km from Bamenda, the regional capital of North West Region and the distance between Kumbo central square and the BIOFARM is approximately 30km. This is where SHUMAS is carrying out integrated organic farming and biogas production.

2.2. SHUMAS's ORGANIC AGRICULTURE RATIONALE

SHUMAS's mission is "Improving lives, reducing poverty and empowering people so that they can meet their needs, without compromising posterity from meeting theirs". Chemical farming has proven dangerous to the environment. SHUMAS has worked with many rural communities in Bui Division and other parts of Cameroon and now 0understands the problems of rural people so well, especially in small household agriculture. It has carried out feasibility studies on problems faced by agriculture in Bui Division and other parts of Cameroon. Farming in the North West Region is done by small household families in rural areas. SHUMAS has come to realise that farming in the North West Region and many other regions is facing the following problems:

- Farming land is reducing as population is increasing and the demand for space for infrastructure is also increasing;
- Land is hilly and vegetation is savannah. This makes soils fragile and prone to erosion that reduces fertility;
- Many farmers are unable to afford increasingly expensive chemical fertilizers and pesticides;
- Poverty has hit so hard in rural areas of the North West Region that peasant farmers are unable to meet their basic needs by practicing agriculture;
- Youths in rural areas are unemployed and do not see agriculture as a source of livelihood because they lack the necessary agricultural skills to avoid the use of expensive farm inputs. There is an urgent need for the institutionalisation of a form of agriculture adapted to peasant farmers conditions and needs;

- Farmers suffer from hunger and malnutrition before the next harvest season because they sell their farm produce immediately as soon as it is harvested in order to settle debts incurred when buying fertilizers and in order to meet their basic needs;
- Farmers put in a lot of effort to till the soil and improve its fertility, but obtain poor yields due to poor farming techniques and poor pest management;
- The animals reared lack enough pasture to feed on and also suffer from diseases;
- Farmers have to work more than ten hours per day in scorching sunshine or continuous rainfall for less and less output, but still find themselves and their families held down by starvation just a few months after harvest;
- The rural poor population has no other means of livelihood than a form of agriculture that is proving unprofitable.

2.3. ORGANIC AGRICULTURE PROGRAMME CONCEPTION AND SUMMARY

Knowing all these problems faced by peasant farmers, especially in the rural areas, SHUMAS came up with an alternative means of farming, as a solution. This was done by conceiving an adaptable agricultural programme that tackles problems faced by rural people in agriculture and putting this into action. This programme has been called "Integrated Organic Farming" involving crop production, animal rearing, pasture improvement, biogas production and agro forestry practices in an integrated manner. This programme has the following objectives:

- To provide alternative means of farming that does not involve the use of chemical fertilizers and pesticides. The problems of prevailing high prices of these inputs and diminishing yields in peasant farms are addressed through the practice of organic farming;
- Provide a source of employment for youths and improve on the capacity of old farmers in crop cultivation and animal rearing through improved organic agricultural training;
- Protect the soil and biodiversity from harm by avoiding the use of chemical farm inputs like chemical pesticides and fertilizers;
- Fight poverty and food crisis by increasing agricultural yields through organic farming techniques;
- Protect the soil from erosion through (i) improved animal pasture to fight over-grazing and (ii) the practice of agro-forestry.

This programme has been institutionalised into short and long-term courses for peasant farmers and has also been serving as a demonstration centre. This BIOFARM Centre has been serving as a demonstration centre for peasant farmers and the public. Farming activities carried out by BIOFARM Centre are the same as those carried out by peasant farmers but different in that modern organic agricultural techniques are used. The Centre has been making research on common pests in the area and coming up with natural pest management methods. It also practices agro-forestry, natural soil improvement techniques and pasture improvement to increase farm outputs without using chemicals. SHUMAS also depends on the peasant farmers to know the problems they face in their farms. Research is carried out at these farms and advice given as to how farm output can be improved. One of the objectives of the Biofarm is educate the population generally about the advantages of organic methods and have them promoted at the national and local political level. This is being done through training courses and field action with farmers in their farms and inviting inspection from politicians and national and local government administrators. The Biofarm Centre tailors these courses to meet the needs of farmers and solve agricultural challenges. The short courses are more specialised. The participants on the nine month course on integrate organic agriculture have now finished the course and are expected to join SHUMAS in the field at their various destinations to show other farmers that organic agriculture is the solution to problems that plague agriculture in the rural areas of the North West region and many other regions of the Cameroon. These participants are expected to be ambassadors of SHUMAS and through hard work, determination and positive thinking to improve on their living standards and protect the environment. They are expected to be models to their communities, showing that organic farming can end poverty, provide enough food and employment opportunities and promote environmental protection. SHUMAS has also come to realise that the work to be done by graduating participants will not be without challenges and problems and has called on them to bring the challenges and problems they will encounter back to the centre where research will be carried out to come up with workable solutions. The success of the SHUMAS's Biofarm Centre in the future will depend on an analysis of problems in order to develop a pragmatic organic agricultural course content that really reflects field realities and builds farmers capacity to meet agricultural local challenges.

SHUMAS through this BIOFARM Centre is demonstrating that the present environmental degradation, climate change crisis, food crisis and economic crisis can be solved by teaching rural farmers how to protect the soil from erosion, protect biodiversity and the environment,

and improve farm output so as to increase living standards through chemical-free farming. SHUMAS supports the United Nation Secretary General, Ban Ki-moon's call on everyone in the 2007 Climate Change Conference in Bali, Indonesia, to get involved in the fight against climate change this spares no one. Part of the solution to these crises is to integrate peasant farmers by encouraging local action whilst thinking globally. Organic products have a high quality and improve on human health. SHUMAS hopes also to see peasant farmers' health improve when they consume organic products. Increasing the farm output of peasant farmers through organic farming will enable them fight hunger, malnutrition and make poverty history through eating qualitative and quantitative farm outputs while selling excesses.

2.4. CROP PRODUCTION

The types of crops produce in the BIOFARM are beans, potatoes, coco yams, yams and vegetables. There is also a nursery for spices, vegetables and some fruit trees. The internship focused more on the nursery, vegetable cultivation and soil improvement techniques. Nursery staff demonstrated how the nursery is managed and how seedlings are nursed. In the vegetable farms like the lettuce cultivation, weeding and watering was carried out.

Figure 1(a&b). Biofarm Centre nursery for fruit trees, vegetables and spices.

Working together with other staff of the BIOFARM increased my knowledge on many soil fertility improvement techniques like using animal waste to increase soil fertility and improve crop yields. The animal dung from the piggery, small ruminants (goats, sheep, and rabbits) and fowl droppings were used directly in the crop fields to increase soil fertility and improve yields. Cow dung was used to produce biogas and its by-product in the form of slurry used directly in vegetable plots as natural fertilizer.

Figure 2. Weeding in the lettuce farm

Another soil improvement technology used is agro-forestry where some soil fertility improvement trees, like tephrosia and scrotin, are planted in farms to increase crop yields. Tephrosia enriches the soil with nitrogen needed by crops and the leaves of Scrotin trees are very rich in soil nutrients and enrich the soil when they fall off from the trees. The Scrotin trees on the Biofarm have also been playing the role of providing shade and wind breaks, thus protecting crops.

Figure 3. Tephrosia trees for soil enrichment in the maize section

In the Biofarm, the soil is also managed through the practice of mixed cropping. For example, beans are planted together with corn. Beans fix nitrogen in the soil through nodules found on their roots and corn uses the nitrogen to grow. With the Biofarm staff we prepared some compost manure with the use of grass, animal dung, cattle urine and soil. This was

prepared to be used for the cultivation of vegetables during the dry season. This is a regular practice to teach course participants how to prepare compost manure.

Figure 4. Compost manure

2.5. ANIMAL PRODUCTION

The Biofarm has a piggery, poultry (layers and broilers), cattle and small ruminants (goats, sheep and rabbits). These animals are reared for the following purposes:

- Training of integrated organic agriculture participants on animal rearing;
- Production of animal dung to be used as natural fertilizer;
- Production of animal dung as raw material for biogas production;
- Fattening for consumption and marketing;
- Work on the farms like the cattle that plough the fields before crop cultivation.

The animal production unit focused on animal dung production and pasture improvement. Together with staff in the animal unit, we worked on animal waste management and pasture improvement. The work also involved the planting of animal fodder like Guatemala and Bracharia in the newly ploughed fields.

Many reared animals on farms lack sufficient pasture to graze on despite the availability of large grazing fields. The grazing fields are often covered with the bracken fern that prevents the growth of good pasture for animals. SHUMAS embarked on improving pasture in its fields by planting Guatemala and Bracharia for its animals. There is already a good quantity of Bracheria planted that we harvested to feed pigs. The tractor available in the BIOFARM has helped in ploughing the grazing field for the planting of improved pasture. The Biofarm

Centre has served as a demonstration centre to other farmers who are now carrying out pasture improvement in their grazing fields by planting Guatemala and Bracharia crops. On many occasions they come to rent the tractor from the BIOFARM to plough their fields for fodder planting. The North West Region has for many years been known to be one of the highest cattle production regions, but recently this has dropped by over 20% due to the increase in bracken fern in the grazing fields.

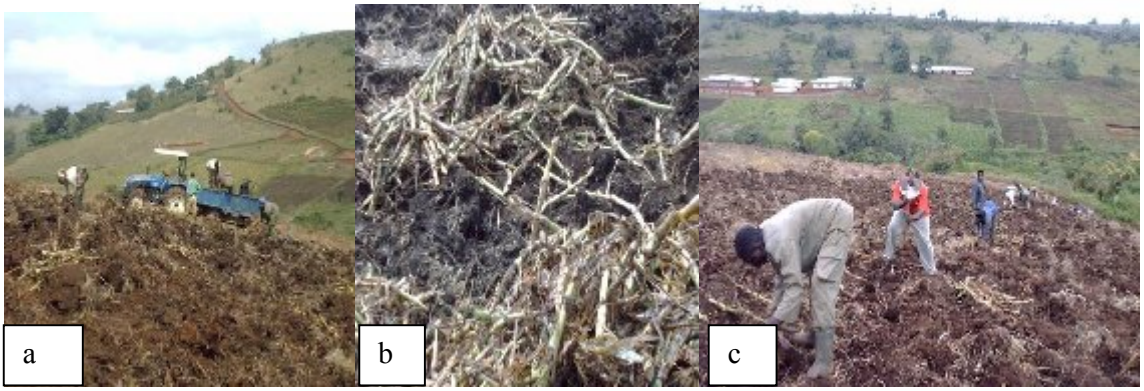

Figure 5(a,b&c). Guatemala crop planting for pasture improvement

The animal dung produced has been used directly as fertilizer or passed through the biogas system to produce biogas and its by-product used as natural fertilizer and natural pesticide. To maximize animal dung production some animals are confined like rabbits, birds and pigs and their waste is collected. Cattle, goats and sheep are allowed to graze in the field during the day and in the evening they are enclosed for security reasons and also to make sure that their droppings (animal dung) during the night could be easily gathered. The place where cattle spend the night is cemented to make sure that the urine can be collected for it is very rich in nitrogen which is good as fertilizer when kept for about three weeks or used to prepare compost.

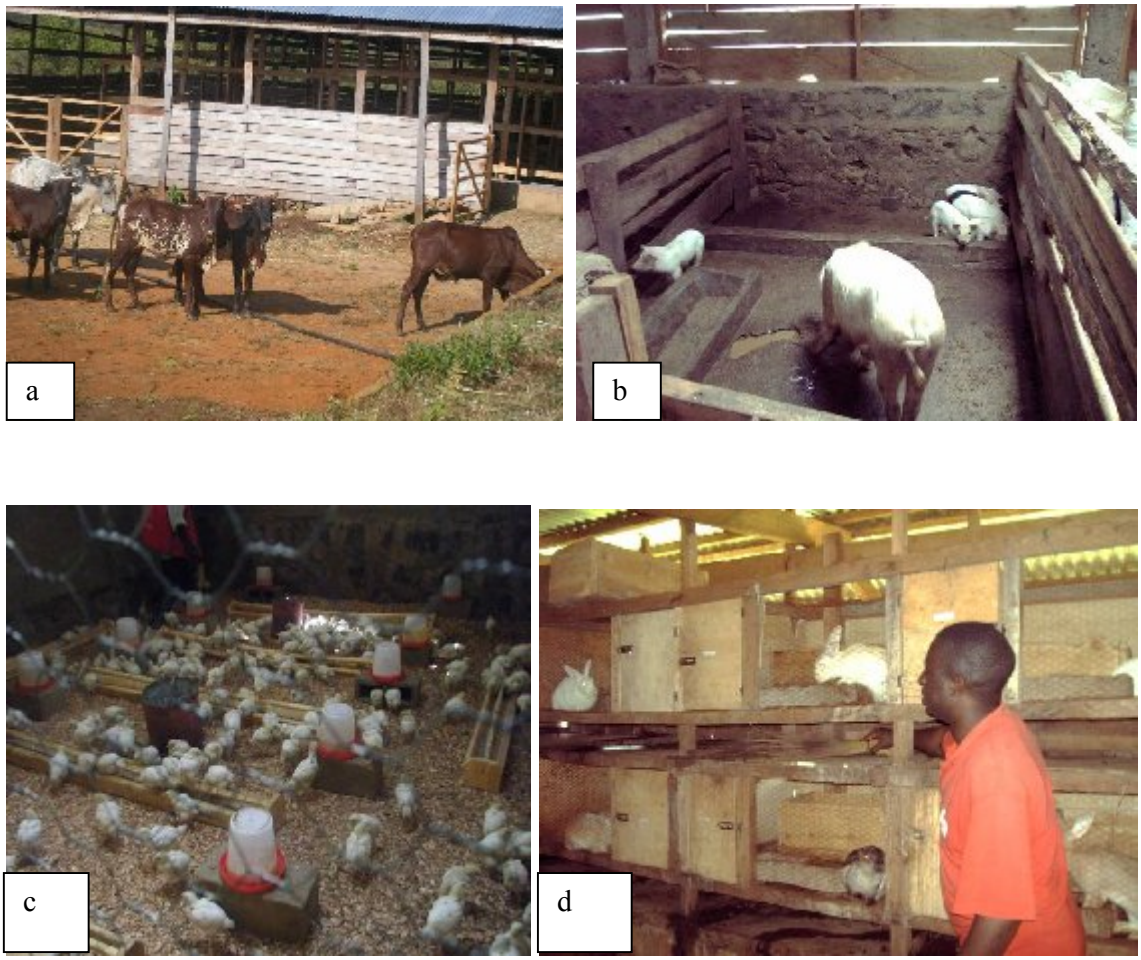

Figure 6(a,b,c&d). Animals confined to collect animal waste for farm manure

2.6. ROLE OF THE GALLERY FOREST IN THE BIOFARM

The Biofarm Centre has some patches of forests in valleys found on its land. These forests host a wide range of useful trees, plants and wildlife species. These forests provide the following services:

- It is a source of beneficial insects. Honey bees and other insects found in this forest are involved in pollination for crop fertilisation;
- Bee farming for honey production is also practiced in these forests. Participants in training courses learn about bee farming in this forest;
- The forest produces a beautiful scene or tourist site for both volunteers and visitors. This forest is rich in different types of trees;
- These forests are sources of water that is used by the Centre for agriculture and drinking;

- It is a source of agro-forestry seeds (seeds that are important in soil fertility improvement), and seeds for trees that provide wind breaks, shade and pest control. Many of the forest trees and plants are very useful in agriculture. Seeds of certain trees dried and nursed for planting in the crop fields. Many of the trees and plants enrich the soil with nitrogen. This forest is known to be a good seed bank for agro-forestry
- These forests serve as a wildlife refuge for many animals. SHUMAS decided to preserve all forest galleries found in its land. Unlike other forests in the vicinity that undergo destruction from bushfires, animal encroachment and exploitation for firewood, the forest at the Biofarm is free from these problems. Many animals have found refuge in them, especially in the dry season when bushfires are so common. The forest hosts some monkeys that are hardly seen but are noticed to be present only through the chewed remains of certain tree fruits known to be their favourites. You could see many animals around these forests occasionally or hear them chattering mainly during the night.

Figure 7. Forest gallery in Biofarm Centre valley

2.7. CAPACITY BUILDING

SHUMAS has institutionalised integrated organic agriculture by providing short and long term courses on integrated organic agriculture for peasant farmers and the public to improve their agricultural output and preserve the environment. The Centre has the following units*: Crop production unit, Animal production unit, and Clean and Renewable energy unit.* The courses carried out for now are long term courses that run for a period of 9 months and presently accommodate 35 trainees. These trainees are trained with the use of locally available materials which are affordable by all. The training cycle is 60% practical and 40%

theory. These trainees are trained in soil conservation techniques, use of organic fertilizers, production of improved seedlings, renewable energy, animal and crop production, pasture improvement etc. After graduation, it is expected that the participants will be able to replicate the knowledge acquired in their communities, hence fighting poverty and unemployment and fostering economic development in their various Divisions. SHUMAS expects these trained individuals to be models in their communities for other farmers to emulate. The Centre provides training to poor peasant farmers from surrounding villages who copy the same agricultural activities.

Formulated short specialize courses by SHUMAS are expected to take off soon and farmers will benefit from the experience, knowledge and expertise of SHUMAS in various aspects of integrated organic farming. Short courses are being developed now for the Centre. The Centre has chosen to start with courses on organic Solanum (Irish) potatoes cultivation, natural pest management, integrated animal rearing and biogas production and making these techniques widely understood and accepted by the general public. These selected short courses will meet the needs of many practicing farmers.

Local farmers have been coming to the Centre to request information and training on how to grow potatoes, manage animal and plant, control animal pests and diseases, improve on animals' yields and know more about the biogas plant. This call for assistance has persisted in and SHUMAS decided to solve this problem by organizing shorter training courses to meet the specific needs of these local farmers in domains where demand has been high. SHUMAS has used its experience, skills, knowledge and success stories in practicing integrated organic agriculture to be the basis of the short training courses. The nine months courses has proven to be so good in giving peasant youths' general practical knowledge on agriculture, but too long for practicing farmers' specific needs. Farmers practicing in the field face more specific challenges.

Figure 8. Course participants

2.8. INTEGRATED ORGANIC FARMING

SHUMAS has engaged in integrated organic farming and seen a great improvement in crop and animal yields. It has also been able to get energy for heating and cooking in the Centre from the practice of this type of agriculture. The animal dung produced has been used as natural fertilizer and also as raw material for the biogas plant to produce energy that is used for cooking and heating. The by-product from the biogas plant has been used as natural pesticide and fertilizer. The corn that is grown is used for preparing animal feed and also for consumption in the Centre. After corn harvest, the corn stems and leaves are harvested and preserved for consumption by animals in the dry season when there is little pasture. Agro-forestry techniques are used to improve soil fertility and ensure high crop yields. Tephrosia and Scrotin are seen all over the farm and play many roles in crop production. Tephrosia plant enriches the soil in nitrogen and Scrotin's leaves enrich the soil in nutrients, provide shading to crops and also serve as wind breaks. Bee farming is practiced in the gallery forest found in the valleys. This activity produces honey and the bees are useful insects to the Biofarm as they help in pollination. Improved pasture like Guatamala and Bracharia is now being planted in grazing fields. There are plans to engage in more integrated livestock rearing and management and it is realized that it is less expensive engaging in the rearing of many types of animals in an integrated manner. SHUMAS will use fowl droppings to feed fish in fish ponds (still to be established) and pigs. The animal dung from pigs and cattle can be used to culture earthworms for fish food and the slurry (by-product) from the biogas plant could also be sent directly to the pond to promote algae growth. The slurry and other animal waste could be used as fertilizer for animal fodder.

Local farmers will soon be trained on this method of animal farming through short training courses so that they can increase their income. Farmers will be able to rear pigs, cows, fowls and fish in an integrated manner.

CHAPTER THREE

BIOGAS PRODUCTION IN THE BIOFARM CENTRE

3.1. BIOGAS PRODUCTION RATIONALE

The BIOFARM Centre is located in an area where the population faces a lot of problems getting energy for cooking, heating and lighting. The area is far away from the national electricity grid. This area is covered by grass fields and has some small patches of forest found in some of its valleys. The peasant farmers have to move long distances to fetch firewood especially from these small patches of forest for cooking. This has caused deforestation in the area. When firewood is used for cooking it produces smoke that causes indoor pollution and this has been responsible for a large number of respiratory diseases world wide as sited by World Health Organization. Those most affected are women and their children who spend much time in the kitchen to prepare food for the family.

Prices of petroleum products are skyrocketing and rural people can no longer afford to use petroleum products like kerosene to meet their energy needs. SHUMAS was going to face the same problems in its Biofarm Centre. SHUMAS searched for an alternative solution to these problems by engaging in biogas energy production for cooking and heating. This was conceived as SHUMAS engaged in animal rearing. SHUMAS in collaboration with a research student from the University of Dschang, Cameroon, Tize Koda Joell, developed a biogas plant that has been producing biogas in the Centre. This biogas is used to prepare food for the staff and participants doing the nine months course. Some of this bio-energy is used for heating the poultry. This biogas is functioning well and has helped SHUMAS to preserve the patches of forest found in its land. The awareness of biogas technology for use by the surrounding population is another step that needs to be taken by SHUMAS to meet its mission of “Improving lives, reducing poverty and empowering people so that they can meet their needs, without compromising posterity from meeting theirs”. This will help preserve the patches of forest which have been over-exploited, reduce poor peasant drudgeries in fetching firewood and provide a clean source of energy to the rural population. Biogas technology is clean and does not contribute to climate change.

This biogas technology is suitable for the population around the Center because every family around engages in animal rearing (sheep, goat, cattle) either in a small scale or large scale, but lack energy to meet their various needs. The animal dung produced by these animals has not been properly put to use. The surrounding population needs to be trained in how to build and operate biogas plants.

3.2. PRINCIPLES OF BIOGAS PRODUCTION

Biogas production is the creation of bio-fuel using the anaerobic decomposition of organic materials from plant or animal origin. Anaerobic decomposition of organic materials occurs when biodegradable matter from a living or once-living organism decays with the help of microorganisms in an oxygen-free environment. Biogas is often celebrated by environmentalists for its relatively low carbon output. It can act as a substitute for fossil fuels as an energy source for heating, cooking and moving vehicles. Biogas production typically occurs in a biogas plant on a large or small scale, depending on the materials available and the quantity of gas needed.

A biogas plant has two principal components, a digester and a gas holder. The digester is an airtight container in which the organic waste is dumped and decomposed, and the gas holder is a tank that harnesses the gases emitted by the slurry. Bacteria within the digester tank breaks down the waste and, as it decomposes, gases such as carbon monoxide, methane, hydrogen and nitrogen, are released.

Through a pressurized system, the gas holder conducts the flow of these gases upward into a hole in the drum of the holder. The hole is specially designed to allow gases to pass freely into the holder while preventing any gases from escaping back into the digester. When the gas is ready to be used the gases are put in contact with oxygen in a controlled environment to create a combustion reaction. This combustion produces an energy source for such processes as heating, cooking and vehicle propulsion.

Biogas production can occur in different types of plants, depending on the amount of gas needed, the amount of waste at hand, and whether the digester is designed for batch feeding or continuous feeding. Batch feeding systems decompose mostly solid wastes that are added to the tank in instalments, while continuous feeding models feed mostly liquids to the digester. Biogas production can be achieved in above or below ground plants. Both models have advantages and disadvantages. An above ground biogas plant is easier to maintain and able to benefit from solar heating, but needs more care in construction. A below ground biogas plant is cheaper to construct and easier to feed, but more difficult to maintain.

Anaerobic digestion will occur best within a pH range of 6.8 to 8.0. The bacteria responsible for the anaerobic process require nitrogen and carbon elements, as do all living organisms, but they consume carbon roughly 30 times faster than nitrogen. Assuming all other conditions are favourable for biogas production, a carbon - nitrogen ratio of about 30:1 is ideal for the raw

material fed into a biogas plant. A higher ratio will leave carbon still available after the nitrogen has been consumed, starving some of the bacteria of this element. These will in turn die, returning nitrogen to the mixture, but slowing the process.

Anaerobic breakdown of waste needs temperatures lying between 0°C and 69°C, but the action of the digesting bacteria will decrease sharply below 16°C. Production of gas is most rapid between 29°C and 41°C or between 49°C and 60°C. This is due to the fact that two different types of bacteria multiply best in these two different ranges, but the high temperature bacteria are much more sensitive to ambient influences. A temperature between 32°C and 35°C has proven most efficient for stable and continuous production of methane. Biogas produced outside this range will have a high percentage of carbon dioxide and other gases than within this range. Microbial diversity in biogas digesters is great and about seventeen fermentative bacterial species have been reported to play important roles in the production of biogas. Furthermore, it is the nature of the substrate that determines the type and extent of the fermentative bacteria present in the digester.

Systems intended for the digestion of liquid or suspended solid waste (cow manure is a typical example of this variety) are mostly filled or emptied using pumps and pipe work. A simpler version involves using gravity waste liquid or suspended organic solid waste is feed to the tank and the digested slurry is allowed to overflow the tank. This has the advantage of being able to consume more solid matter as well, such as chopped vegetable waste, which would block a pump very quickly. This provides extra carbon to the system and raises the efficiency. Cow manure is very nitrogen rich and is improved by the addition of vegetable matter.

Biogas production is often preferred to fossil fuel energy sources, such as oil or coal, for environmental and economic reasons. The rising concentration of carbon, a greenhouse gas, in the atmosphere has become a central issue in the problem of global warming. Though both biogas and fossil fuels emit carbon, fossil fuels release carbon that has been buried for many years in ancient biomass and eventually removed from the carbon cycle. Carbon released during biogas production and use has been stored in the form of organic matter only recently and is still part of the cycle. Therefore it does not cause as much carbon concentration in the atmosphere.

Proponents of biogas production also prefer biogas to fossil fuels because it is a low cost, renewable source of energy, and it uses wasted materials. Biogas production can take place on a small scale and this makes it a viable option for many regions of developing

nations. Critics of biogas argue that food crops grown for the purposes of biogas production will create a global food shortage. However this criticism usually relates to the use of crop land to grow biofuels such as jatropha and palm oil. In many regions of the world tropical forest has been cleared to grow palm oil as a cash crop for both processed food and fuel. In addition to deforestation this may also cause water pollution, soil erosion and have a negative impact on oil producing nations. In some cases, especially in the USA, food crops have been grown to provide ethanol as a transport fuel. SHUMAS is using animal waste and not food to produce biogas

3.3. THE BIOFARM BIOGAS PRODUCTION PROCESS

Activities in the biogas plant of the Centre are carried out on a daily basis. Every morning animal waste mostly from cattle is mixed with water and fed into a mixing tank in a 1: 1 ratio. After feeding into the mixing tank it is stirred to promote its movement by gravity to the digester. In the digester, there exists an anaerobic condition that leads to the formation of methane gas and other gases. The produced methane (biogas) is collected in an inverted drum above the digester. The walls of the drum extend down into the slurry to provide a seal. The drum is free to move to accommodate more or less gas as needed. The weight of the drum provides the pressure on the gas system to create flow. The produced biogas flows through a small hole in the roof of the drum. A non-return valve here is a valuable investment to prevent air being drawn into the digester, which would destroy the activity of the bacteria and provide a potentially explosive mixture inside the drum. The drum is slightly smaller than the tank, but the difference is small to prevent loss of gas. The biogas is transferred through the pipes to the kitchen where it is used to prepare food and to the poultry where it is used for heating.

Figure 9. Biofarm Centre biogas plant

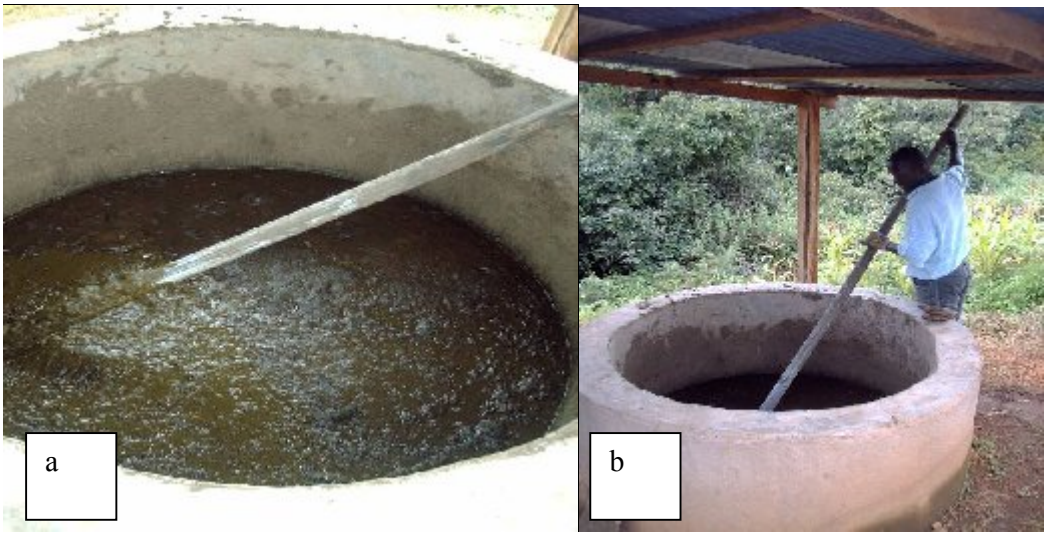

Figure 10(a&b). Biogas mixing tank with fresh cow dung

Figure 11. Inverted drum on digester with no biogas

Figure 12. Inverted drum on digester raised by the presence of biogas

Figure 13. Biogas by-product (slurry) tank

The daily feeding of animal waste through the mixing tank pushes the old animal waste in the digester out by gravity to the discharge tank. The biogas by-product in the discharge tank (called slurry) is collected and used as fertilizer in the crop areas and also to act as a natural pesticide. This fertilizer is better than other organic manure in that mineralization has occurred and nutrients are directly available to crops. The biogas by-product contains no infectious bacteria as they are unable to pass through the digester without being killed.

3.4. USE OF BIOGAS SLURRY FOR SOIL FERTILITY AND PESTS CONTROL

Cow dung is mostly used for biogas production. Slurry resulting from cow dung anaerobic digestion in the biogas plant is composed of 1.8 - 2.4% nitrogen (N2), 1.0 - 1.2% phosphorus (P2O5), 0.6 - 0.8% potassium (K2O) and 50 - 75% organic humus. The anaerobic condition involved in biogas production mineralizes organic matter through the increased incubation period. The application of slurry improves the physical, chemical, and biological characteristics of the soil. The anaerobic digestion decreases the C:N ratio and increases the concentration of immediately accessible plant nutrients. The slurry could be sold as fertilizer, used in crop fields to improve soil fertility, be sprayed on pastureland as liquid fertiliser, or used as a nutrient medium for aquaculture.

The slurry is used on vegetable (huckleberry and cabbage) plots to increase soil nutrients needed by these crops to do well. High yields have been recorded in these areas due to the application of slurry as manure. The presence of nitrogen, phosphorus and potassium in slurry, highly needed by plants for growth in various concentrations, is responsible for the high crop yields.

The slurry that is produced by the biogas plant in the BIOFARM Centre is collected in another tank. This tank containing this slurry is always free from flies and insects while in the tank where the mixed cow dung with water is present, many flies are always seen present. This slurry has been noticed by the farm staff to contain some special characteristics that could be used to fight pests in crop fields. The huckleberry fields were seen at one time to be affected by a certain pest and the staff of the farm decided to continuously water it with slurry which they had discovered to be free from flies. After some time it was discovered that the pest had disappeared. Since then, the staff of the BIOFARM have been using slurry for pest management in the vegetable fields. There is still need for more research on the possibility of producing a natural pesticide from this slurry. This will provide opportunity for it to be sold to other farmers.

3.5. USE OF BIOGAS ENERGY IN THE BIOFARM CENTRE

Cow dung is highly used to produce biogas in the Centre. About one cubic foot of gas may be generated from one pound of cow manure at around 28°C. This has been known to be enough gas to cook a day's meal for 4-6 people in India. About 1.7 cubic metres of biogas equals one litre of gasoline. The manure produced by one cow in one year can be converted to methane which is the equivalent of over 200 litres of gasoline. The energy value of biogas varies between 4.5 and 8.5 kWh/m^3, depending on the relative amounts of methane, carbon dioxide and other gases present. Both methane and carbon dioxide are odourless.
The biogas is used for cooking food for the course participants and staff - usually about 50 people. The biogas is connected to the kitchen where food is prepared. It is the only source of energy used for cooking at the Centre except for staff who prepare their own food using cooking gas prepared from fossil fuel.

Figure 14. Course participants line up for food prepared with biogas

The biogas is also used for heating the poultry. Bamdzeng in Kumbo where the BIOFARM is located is at the top of the hill and is very cold for the survival and proper growth of poultry. Biogas has been used to provide the birds with the heat that is necessary for their growth and well being.

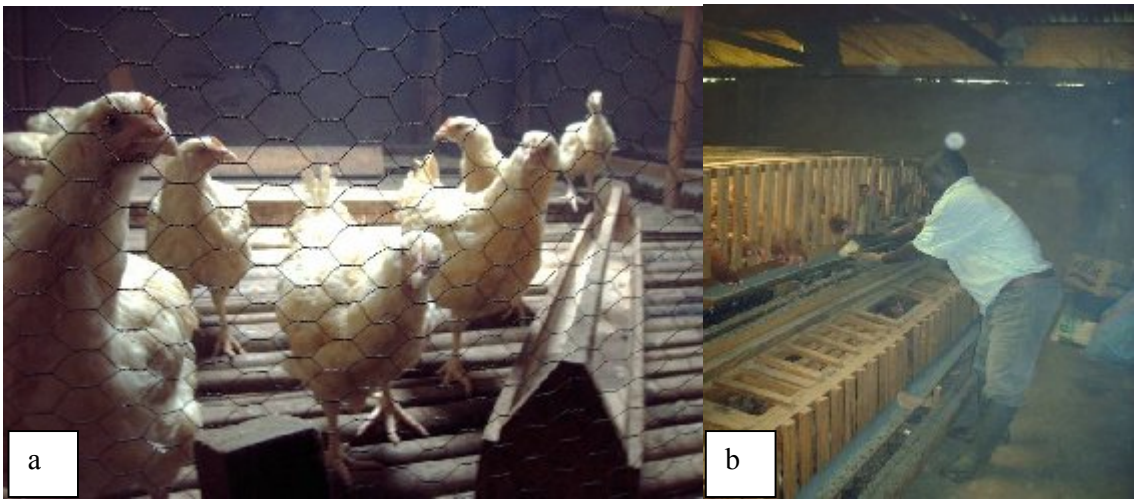

Figure 15(a&b). The poultry heated with energy from biogas

3.6. BIOFARM CENTRE'S ENERGY SELF RELIANT PROGRAMME

The Centre is far from the national energy grid system and now uses biogas for cooking and heating. Energy for lighting the Centre comes partially from fossil fuel to run the generator. The Centre has the vision of being self reliant in biogas, wind and solar energy in the future thus contributing to the fight against climate change. The Centre has two windmills that provide energy for lighting the administrative block, classrooms and some residential areas. Energy from the windmill is also used to charge the telephones of participants and staff. There are plans to install more windmills to meet the lighting energy needs of the centre. The wind speed in the locality is strong enough to produce much energy for the Centre.

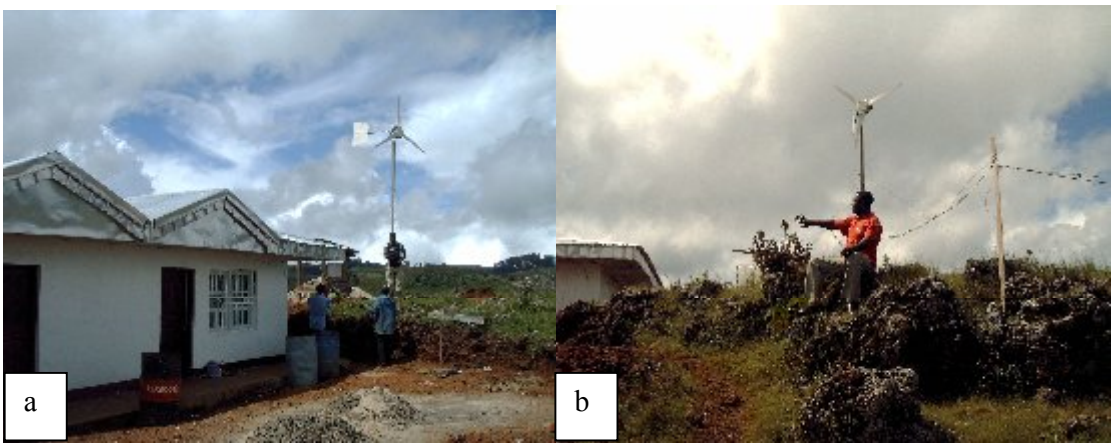

Figure 16(a,b&c). Windmill for lighting and telephone charging

There are also plans to make use of a solar system to get more energy. The available small rivers in the vicinity will be dammed for irrigation purposes and feasibility studies will also be carried out to see the possibility of developing small hydropower systems.

CHAPTER FOUR

OTHER ACTIVITIES CARRIED OUT, CONCLUSION AND RECOMMENDATION

4.1. OTHER ACTIVITIES CARRIED OUT

4.1.1. Jury member in organic farming trainees' theses presentation

During the period of internship participants in the nine months organic agriculture course presented their theses in front of the various juries at the Centre in partial fulfillment for the award of a diploma in organic farming. I was assigned to be part of a jury team. Together with other members of the jury we read the theses of the various participants assigned to us and prepared questions that were put to the participants during their presentations. The participants did research on various agricultural domains like fishery, goat and sheep rearing, cattle rearing, Solanum potatoes cultivation and many other topics. My critical thinking mind was improved upon during the exchange we had with participants and much was also learned on organic agriculture.

Figure 17(a&b). A Course participant presents her thesis in front of the Jury

4.1.2. Radio programme on integrated organic agriculture

The internship period fell in a time that SHUMAS needed to visit Kumbo Community Radio to sensitise the public on SHUMAS's integrated organic agriculture activities especially on its importance in promoting food security, fighting economic and environmental crises, and serving as a demonstration and training centre to peasant farmers. We worked as a team to develop the radio programme and presented it as a team. This programme was carried out successfully and it created an impact in communities. We received a lot of comments and

feed-back following the programme and the comments were positive and encouraging. The programme was recorded and copies are available. It was an exciting learning opportunity.

4.1.3. Project writing

During the period of internship much was learned on project writing. I was assigned to write a project proposal in collaboration with the SHUMAS management. This project was to develop short specialized training courses for peasant farmers on organic Solanum(Irish) potatoes cultivation, integrated animal rearing, natural pest management and biogas production. Developing this project proposal involved group work to share experience and knowledge on needed information. This was a great opportunity where the importance of team work in making things work better was discovered. The project was submitted recently.

CONCLUSION

It was a great experience doing internship in SHUMAS and its Biofarm Centre. It created a positive impact in my life and built my capacity on integrated organic farming, biogas production, project writing, team spirit, participatory approach methods, being result focused in all work done and using a bottom-top approach in making things work for communities while protecting the environment. There are a lot of opportunities for internship and research for students interested in renewable energy, organic agriculture, agro-forestry, auditing, biodiversity conservation, anthropology, sociology etc to exploit in SHUMAS. From all work done with SHUMAS there is much potential that could be better exploited if more collaboration, networking and partnership is created with all farmers, agricultural researchers, university students and policy makers in this sector. This will make organic farming and natural pest management a success in the North West Region and the rest of Cameroon. This success story will then be replicated all over the nation.

RECOMMENDATIONS

- There is a need to carry out much research on the pesticide characteristics of biogas by-product slurry to know the active ingredient present and see how this can be used as a natural pesticide for pest management in farms. This pesticide, if developed, will encourage farmers to practice organic farming and also be used to lobby government to set up policies that favour organic farming;
- The management of SHUMAS needs to carry out soil analysis at the Biofarm. This will enable it to know the soil quality and hence make decisions on the type of crops to

grow for practical lessons and commercial purposes. Knowing the characteristics of the soil will help to decide the crop's needs in natural manure and the type of crops suitable for good revenue generation.

- SHUMAS needs to popularise biogas technology in neighbouring villages to the other areas where animals are kept. This will provide these people with energy for cooking and heating that is environmentally friendly. The raw material for biogas production will come from their animals' waste. This will reduce pressure put on the scarce forest resources in the area for firewood, end all drudgeries involved in firewood fetching and improve human health. Many rural areas are blocked from developing due to lack of clean energy that is considered a catalyst for development.
- SHUMAS needs to develop a good marketing strategy to sell its organic farm produce. Many people like consuming organic products but are unable to distinguish organic farm products from those produced using chemicals. SHUMAS could create an organic product shop in the towns of Kumbo and Bamenda to market its organic farm produce;
- SHUMAS needs to initiate a campaign that will push government to put in place a policy for the certification of organic farm products.
- SHUMAS needs to make its activities known to the public through media programmes, development of quarterly newsletters and different project leaflets to share information about its activities, successes and challenges. Its website needs to be updated with recent activities. This will open the way for collaboration, networking and partnership with farmers, researchers, university students and policy makers in the various sectors to share skills, knowledge and experience to promote sustainable development.

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