N2Africa

Putting nitrogen fixation to work for smallholder farmers in Africa

Implementation of N2Africa Project in Ghana: Putting nitrogen fixation to work for smallholder farmers in Ghana




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Table of Content

1.0 INTRODUCTION

1.1 N2Africa Project

N2Africa is a large scale, science research project focused on putting nitrogen fixation to work for smallholder farmers in Africa by expanding area under production and improving the yields of legume crops to improve income, nutrition and food security of smallholder farmers. N2Africa is funded by 'The Bill & Melinda Gates Foundation' through a grant to Plant Production Systems, Wageningen University, in the Netherlands. It is led by Wageningen University in collaboration with the international Institute of Tropical Agriculture (IITA) and the International Livestock Research Institute (ILRI). The project works with many partners in selected African countries for the project. The core countries benefiting from this project are Ghana, Nigeria, Uganda, Ethiopia and Tanzania. In Democratic Republic of Congo, Kenya, Malawi, Mozambique, Rwanda and Zimbabwe, N2Africa will focus on disseminating outcomes from phase 1 and institutionalising legume expertise within the national system.

The project aiming at putting nitrogen fixation to work for smallholder farmers is being achieved by selecting legumes that are being grown and used in selected districts of the countries. In the selected countries, participatory on-farm demonstrations are being carried out aiming at increasing soil nitrogen (N) through Biological Nitrogen Fixation (BNF) by the use of inoculants. These demos are meant for the farmers to learn on how improved/certified seed together with inoculant plus fertilisers can work together to improve the yields of legumes. The increase in yields will also go a long way in improving food security as well as improving the livelihoods of the rural smallholder farmers.

1.1.1 First Phase

During this phase of the project, it is expected that at the end of the five-year period, N2Africa would have;

- Identified niches for targeting nitrogen fixing legumes;
- Tested multi-purpose legumes to provide food, animal feed, and improved soil fertility;
- Promoted the adoption and preparation of improved legume varieties;
- Supported the development of inoculum production capacity through collaboration with private sector partners;
- Developed and strengthened capacity for legumes research and technology dissemination; and
- Delivered improved varieties of legumes and inoculant technologies to more than 225,000 smallholder farmers through their Master Farmer Network.

Since it began in 2009, N2Africa set out to boost the number of farmers cultivating improved nitrogen fixing legumes specifically soybean, cowpea, groundnut and common bean. The first four-year phase recently came to an end, and researchers and partners met to evaluate the project and planned for the second phase with a successfully granted funding by the Bill & Melinda Gates Foundation. The results were described by N2Africa as being pretty impressive. The project has reached more than 225,000 smallholder farmers across eight countries with better genotypes of legumes and rhizobia inoculants. There is proof that using the full technology (improved varieties and inoculum, along with the addition of phosphorus fertiliser and improved crop management practices), can more than double legume yields and improve the performance of successive crops by as much as 50 per cent as a result of higher nitrogen levels in the soil (CIAT-N2Africa programme coordinator).

At the end of the first phase, the project realised that there were some questions that still needed to be answered and these were on the cards for the phase two. Firstly, the response of legumes to inoculants and fertiliser varies considerably, meaning that even with full adoption, yield increases will not be the same. Therefore, scientists needed to find out why this is so. Secondly, while many farmers are using improved varieties and some inoculants (and are often rewarded with increased yields), most do not adopt the full technology, and so do not benefit from the full potential. The question for phase two is how to improve the availability of improved seed and inoculants, and how to raise the number of farmers who use them in conjunction with phosphorus fertiliser and improved crop management practices. In addition, the project also aimed at expanding project to reach many smallholder farmers in the targeted countries in other new districts.

1.1.2 Second Phase

The Phase 2 of the project aimed at using the experience gained from Phase 1 to expand activities in 5 African countries, including Ghana, Nigeria, Uganda, Tanzania and Ethiopia. According to N2Africa, the project will reach many more farmers in Ghana and Nigeria, and extend the project to Ethiopia, Tanzania and Uganda within the next 5 years. The project is being led by Wageningen University together with the International Institute of Tropical Agriculture (IITA) and the International Livestock Research Institute (ILRI).

The phase 2 of the project is to increase biological nitrogen fixation and productivity of grain legumes among African smallholder farmers, and contribute to enhanced soil fertility, improved household nutrition and increased cash income. The legacy will be strong national expertise in grain legume production and N_2-fixation research and development. The capacity built will also sustain the pipeline and delivery of continuous improvement in legume production technologies tailored to local settings. Activities will focus on cowpea, groundnut and soybean in Ghana and Nigeria, on common bean, cowpea, groundnut and soybean in Tanzania and Uganda and on common bean, soybean, chickpea and faba bean in Ethiopia.

1.2 N2Africa project implementation in Ghana

The project is implemented on three work streams namely Research and Data, Monitoring & Evaluation (M&E) and Delivery & Dissemination (D&D).

Research and data

- Selection of best varieties of all legumes (Cowpea, Soybean and Groundnuts) involved in the project for high N fixation capacity and adaptation to abiotic and biotic stresses,
- Identifying best fit agronomic practices maximising potential benefits of legume and inoculant technologies on increasing and stabilising productivity.

Monitoring and Evaluation

- Quantifying current N fixation in the target farming systems and impact on livelihoods.
- Monitor impact of investment and adoption of the technology.
- Evaluate impact of the technology on farmers' livelihoods.
- Evaluate contributions of best fit agronomic practices to system productivity and livelihoods.

Delivery and Dissemination

- Identifying new opportunities for targeting legumes and inoculant technologies to increase BNF and enlarge the production areas of prioritised grain legumes.
- Creating strategic alliances for facilitating dissemination of technology
- Engage with other legume seed production and activities, farm input, commodity marketing and processing initiatives and nutrition programmes.
- Conduct collaborative technology dissemination campaigns and create awareness in rural communities of the impact zones.
- Provide short-term, high-level technical training in essential skills and BNF technologies.
- Training of trainers workshops on demonstration and adaptation on-farm trials for N2Africa partners' staff.

Information and/or data will be obtained for the afore-mentioned work streams through baseline surveys; participatory varietal and inputs demos or trials on farmers' fields. This internship study was more to do with the Research and data which is also much involved in setting-up of on-farm input demonstration trials aimed at achieving objective 2 under Research and Data in one of the target district in Northern Ghana (Yendi). However, the current farming systems of the farmers will also be assessed through a baseline survey. The internship was carried out in Yendi district in collaboration with Evangelical Presbyterian Development and Relief Agency (EPDRA) which is one of the dissemination partners for the N2Africa project in Ghana.

The project targeted seven districts in the three Northern regions of Ghana; namely Chiriponi, Savelugu and Yendi Districts in the Northern region, Binduri, Bawku west in the Upper East and Nadowli and Wa West is in the Upper west region. Three major legume crops are being used for the project namely;

Cowpea (Vigna unguiculata), Groundnut (Arachis hypogaea) and Soybean (Glycine max). These legume crops are the most widely grown legumes by smallholder farmers in the three regions making them suitable for the project.

The project is currently working with six partners for the implementation in the various districts. The partners are the; Ministry of Food and Agriculture (MoFA), Savannah Agriculture Research Institute (SARI), Kwame Nkrumah University of Science and Technology (KNUST), and three other local NGOs; Urban Agricultural Network (URBANET), Evangelical Presbyterian Development and Relief Agency (EPDRA) and Sungbawiara Foundation (SBF). However, there are other partners who will be working with N2Africa-Ghana but will only help disseminate the project technologies to other farmers who were not able to benefit from the project directly. These partners include Agricultural Development and Value Chain Enhancement (ADVANCE) project, Adventist Development and Relief Agency (ADRA), and PRONET-North.

1.3 Background and Justification on Soybean input demos for the internship study

The issue of soil fertility decline in Africa has come to light since many years, influencing top policy priorities to establish a range of initiatives with the aim of improving or solving the problem. Nutrient mining due to continuous cultivation, inadequate use of inorganic fertilizer inputs, and limited application of organic inputs are some of the reasons for the depletion of soil fertility in developing countries. Large number of African farmers generally consider soil fertility decline as the major limitation to farming (Smaling et al., 1997). Poor soil fertility has resulted in low crop productivity and is one of the causes of food insecurity in Africa. In Ghana, where the agricultural sector is dominated by smallholder farmers, the soil fertility situation is said to be a worrying one. The food insecurity problem has also been aggravated by human population growth, with decreasing farm sizes as a consequence. Therefore, there is a need to improve soil fertility and increase productivity thereby producing sufficient food for the expanding population. To achieve this, fertilizer use is usually proposed as a solution (Foth and Ellis 1997).

Many soils across Africa are deficient in nitrogen, making it difficult for smallholder farmers to produce the yields needed to feed growing populations. In so doing nitrogen requirement is by far the greatest of all major nutrients (Woldeyohannes et al., 2007) and projected to rise significantly (FAO 2012). However, in developing countries like Ghana smallholder farmers often cannot afford costly inorganic fertilizer. The situation is further magnified by poor infrastructure and lack of credit services. For many farmers in Africa, the cost and accessibility, or lack thereof, puts nitrogen fertiliser beyond their reach. But what if they could harness free nitrogen from the atmosphere? Therefore, there is a need to reduce the dependence on inorganic nitrogen fertilizer thereby minimizing environmental degradation while improving crop productivity. As stated by Shamseldin and Werner (2004), biological nitrogen fixation (BNF) can reduce the need for mineral fertilizer. In each season, grain legumes could fix about 15 - 210 kg N ha^{-1} in Africa (Dakora and Keya 1997). Therefore farmers from this part of the world can grow legumes such as Cowpea, Groundnut, and Soybean which ‘fix’ nitrogen into the soil.

Soybean (Glycine max (L.) Merril) is an oil crop whose cultivation is gaining popularity in northern Ghana. Soybean grows well in warm and moist climates with an optimum temperature of 26.5°C to 30°C. Soybean is rich in protein and it is used to fortify various foods in order to improve their nutritional quality (IITA, 1990). It is also important in the supply of high-quality animal feed and green manure (Miller et al., 1997). However, production of soybean is challenged by poor crop establishment, inappropriate planting depth, use of unimproved seeds, low soil fertility and lack of effective nodulation (Lawson & Quainoo, 2008). Selective breeding has improved grain composition, increased pest tolerance and increased yield potential. Aside crop breeding; rhizobium inoculation is a major agronomic factor that can significantly influence the yield potential, soil fertility and economic returns for smallholder farmers in northern Ghana. An artificial inoculation which is very cheap and increases the efficiency of the plant to fix free elemental nitrogen (N) from the atmosphere also serves as insurance for getting good pulse crops. The legume has been characterized to be more responsive to the use of symbiotically fixed N source than the application of fertilizer N (Board & Hall, 1983). Phosphorus has also a key role in the energy metabolism of all plant cells, particularly in nitrogen fixation as an energy-requiring process. Nodules are strong sinks for phosphorus which reaches concentrations three folds higher than in other organs (Vadez et al., 1999). It has therefore been recommended that artificial inoculation of seeds with an appropriate strain of Rhizobium with basal P fertilizer application at a rate of

30 kg ha^{-1} before sowing will increase soybean yields (Lamptey et al., 2014). Rhizobial inoculation has the capability for soil fertility improvement in cereal-based cropping systems in the Guinea savannah agro-ecology (Carsky et al., 1996) since the bacteria are able to fix about 300 kg ha^{-1} atmospheric nitrogen leading to increased grain and biomass yields (Keyser & Li, 1992). According to Okereke et al. (2004), lack of effective nodulation of soybean as a result of ineffective indigenous Rhizobial strains and also unavailability of suitable soybean varieties are among the causes of poor yields. There is therefore a wide gap between the crop's potential yield and actual yields.

1.4 Objectives of the study

The internship study, therefore, was conducted with the following objectives:

- To understand the current farming systems of smallholder farmers in the Yendi district of Northern Ghana.
- To investigate the effect of Rhizobium inoculation, P fertilization and their combinations on plant growth parameters such as plant establishment and height, nodule development, Biological Nitrogen Fixation (BNF), grain yield and residue production of soybean sown on farmers' fields (on-farm demonstrations) in the Yendi municipal of northern Ghana.

2.0 MATERIALS AND METHODS

2.1 Study Area

The study was carried out in the 2014 farming season from May to July in the Yendi district of northern Ghana (latitude 9 44' 08" N and longitude 0 00' 59" W) in the Guinea Savannah agro-ecological zone of Ghana (Fig. 1). The area is characterised by a unimodal rainfall pattern with an annual rainfall of 1040 mm normally distributed fairly within the cropping season. The study area has a mean monthly temperature of 22°C during the rainy season and a maximum of 34°C during dry season. Agriculture in the study area is predominantly on a smallholder basis. Production is also largely rain-fed with limited mechanization and inadequate use of improved technologies such as high and stable yielding crop varieties, good agricultural practices, fertilizers, and other agro-inputs. The smallholder farmers are dispersed, and this makes provision of support services expensive and ineffective. The most important food crops grown in northern Ghana are maize, rice, sorghum, pearl millet, cassava, groundnut, cowpea and soybean. For most farm families, cereals are the most important staples. Farming takes place on soils with low organic carbon (< 1.5%), total nitrogen (< 0.2%), exchangeable potassium (< 100 ppm) and available phosphorus (< 10 ppm, Bray 1) (Adu, 1995). Again a large proportion of soils in the region are shallow with iron concretions lying below the soil surfaces (Adu, 1969).

Map of Ghana indicating Yendi Municipal

The study area is however famous with high levels of food insecurity and poverty. Nearly one million people in the northern region of Ghana are faced with an annual food deficit and are net buyers of food (GSS, 2008) which is a major concern to the government of Ghana and its development partners of which N2Africa is part. About 80 percent of the population depends on subsistence agriculture with very low productivity and low farm income (MoFA, 2010).

2.2 Assessment of current farming systems in the area

The current farming systems in the study area were assessed using a structured questionnaire developed by N2Africa for a baseline survey. This assessment was carried out in one month (May and June 2014). Basic information for the analysis was obtained from primary data collected with the aid of the structured questionnaire including the livelihood of the farmers as well as how legumes are being utilised. The farming systems of the farmers were determined by asking them about their crop production and management as well as their farm land sizes. Demographic variables were collected including respondents' age, level of education for a person in their households and household size were also collected. Data were also collected on the production of legumes including their knowledge on the application of inoculants and number of times legumes are consumed in the household.

A total of 60 smallholder farmers living and farming in their communities were randomly selected and interviewed in the communities with the help of a staff from EPDRA. The sampled farmers for the study belong to the N2Africa-EPDRA targeted Farmer Based Organizations (FBOs) in the Yendi district. Out of the 60 farmers, 75% were males and the rest were females as depicted in table 1. The FBOs in the district have been grouped into four zones, each community hosts an FBO. Five communities were selected randomly from each zone, totalling twenty communities. Out of these communities, three farmers, each representing a household from each community were randomly selected and interviewed. In all, 60 farmers (45 male and 15 females) from 20 communities drawn from the four zones in the district were involved in the study.

	Number	Percentage
MALE	45	75
FEMALE	15	25
TOTAL	60	100

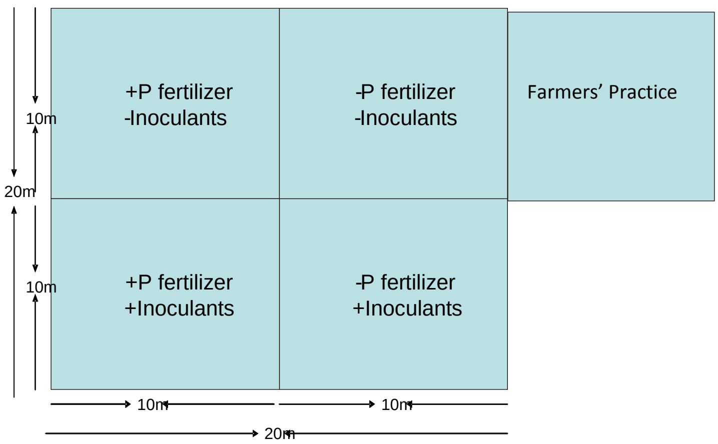
2.3 On-farm demonstration trials in the area

At the beginning of the 2014 farming season in June, a number of farm lands in the district belonging to farmers from 30 Farmer Based Organizations (FBOs) from 23 communities were selected to host demonstration trials on their fields. The trials compared the performance of Soybeans using N2Africa technologies involving inoculant and P-fertilizer with current Soybean farming practices by local smallholder farmers. Out of the 30 trials, 15 were on Soybean with inoculants and P-fertilizer, 5 on Soybean with inoculant and Fertisoil (an organic fertilizer), 5 on Cowpea with P-fertilizer and Fertisoil and another 5 on Groundnut with four different varieties (Varietal trial). However, this study only considered the 15 trials for the Soybean with inoculant and P-fertilizer.

2.3.1 Trial lay-out and Treatments

Each plot represented a treatment with a total of five (5) treatments and each plot measured 10 m x 10 m (total trial area is 500m^2). The suggested trial layout for the plots is shown below. The treatments were randomized on the plots. All the five plots were kept at one place with 1 m boundary between plots and adjacent to each other, rather than scattering them in different locations on the farm, so as to minimize differences arising from different soil types, cropping history, soil moisture, etc.

Soybean P fertilizer and inoculants trial layout design



The following five treatments: using the Soybean variety "Janguma" were used for the trial. The treatments were as follows;

1. A control plot which is planted to soybean without using any fertilizer or inoculum (-P/-I)

2. A plot planted to soybean and TSP is applied at a rate of 1.48 kg/plot (+P/-I)
3. A plot planted to soybean seed which is inoculated (-P/+I)
4. A plot to which TSP is applied (at a rate of 1.48 kg/plot) and planted to inoculated soybean (+P/+I)
5. Farmers' practice

2.3.2 Seed Acquisition and the Soybean Cultivar

The seeds used for the input trial were improved soybean variety known as Jenguma which was developed and released by Savannah Agricultural Research Institute, Nyankpala of the Council for Scientific and Industrial Research. It is an improved Soybean variety with a very high shattering resistance and a maturity period of 115 days. The cultivar grows well under warm and moist climatic conditions with an optimum temperature of 26 to 32°C. It grows on well-drained fertile loamy soils with a pH of 5.5 to 7.5. According to PROTA (2006), the crop has a potential yield of 5.0 t/ha and is very rich in protein and oil.

2.3.3 Inoculation and Sowing

Commercial Rhizobium inoculant, Legumefix (containing 1x109 cells/g) was used for the study. The Legumefix was imported from Legume Technology Limited, UK and kept at 4°C prior to inoculation of the seeds for sowing. The seeds were inoculated at the rate of 1 kg seed per 5 g of Legumefix. The soybean seeds were measured out in a plastic bowl and moistened with ordinary tap water and then stirred uniformly with a wooden spatula. The inoculants was added to the moistened seed in the container and again stirred gently and uniformly until the seeds were fairly and evenly coated. The seeds were then spread on a plastic sheet under a shade to air-dry for at least one hour to allow the inoculants to adequately adhere to the surface of the seeds (as shown in the photo below).

Photo: Pictorial procedure for teaching farmers on how to mix the inoculants and seeds. Photo by Gregory Mensah.

To avoid direct exposure of the coated seeds to sunlight, the seeds were sown immediately at two seeds per hill at 50 cm (inter-row) x 10 cm (intra-row) and were immediately covered. The un-inoculated seeds were sown before the inoculated ones in order to avoid contamination of the former.

2.3.4 Management Practices

All the demo fields were ploughed using a tractor and harrowed manually using a Hoe. Three manual weeding operations should be carried out using the hand-hoe at two, five and nine weeks after sowing. However, because of time constraint related to the internship, I was not able to witness all the three weeding operations. An example of the first weeding was witnessed on some of the demos as depicted in the photo below.

A farmer weeding one of the demo fields. Photo by Gregory Mensah.

The trials were conducted under rain-fed conditions. Mineral fertilizer (Triple Superphosphate) was applied uniformly at the rate of 30 kg P/ha (1.48 kg P/plot) at two weeks after sowing by burying the fertilizer material in trenches dug at 10 cm away from the planting lines. The plants did not suffer from any major pest and disease attack during their growth until the time I left the project hence no spraying was done.

2.4 Data Collection

Data collected on the field trials were only the crop establishment and plant heights. Other parameters such as nodule development, Biological Nitrogen Fixation (BNF), grain yield and residue production were not taken as a result of the shorter time frame of the internship.

2.4.1 Rainfall data

Rainfall data for the cropping season (from March to July 2014) involving the total rains and the rainy days were obtained from the Ministry of Food and Agriculture (MoFA) in the Yendi district. The peak of the rains in Ghana usually starts from May until August. It is also during this period that the farming season starts in most part of the country. From figure 1, the highest rainfall was recorded in June, though data collected for the month of July was up to the 14^{th}.

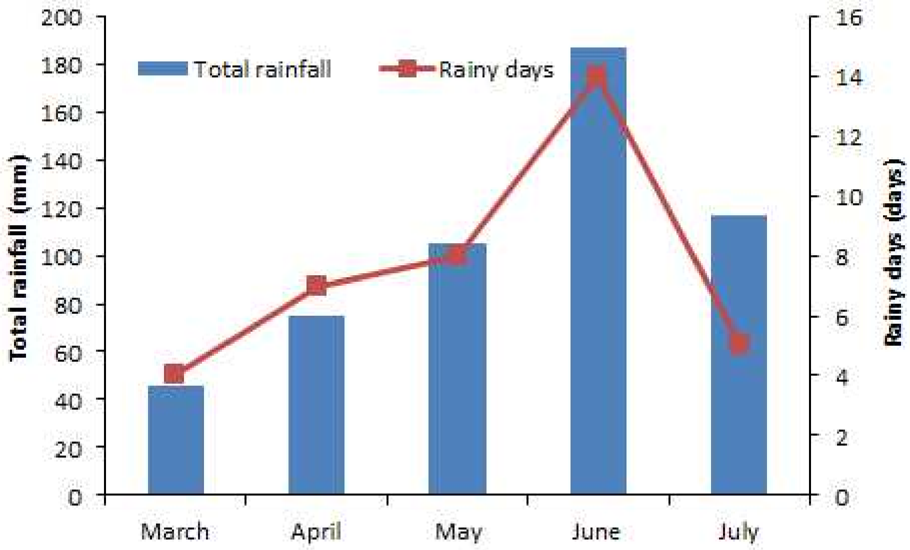


Figure 1 Total rainfall and number of rainy days from March to 14th July 2014

2.4.2 Crop Establishment

This parameter was taken by counting the emerged plants on the three innermost plant rows of each plot at one and two weeks after sowing which was expressed in percentage as number of emerged plants divided by expected number of plants multiply by 100.

2.4.3 Plant Height

Five plants were randomly selected from each of the three innermost plant rows each from both the inoculated and un-inoculated plots and tagged for measurements. The heights of the fifteen selected plants from each treatment were measured from the base of each plant to the last terminal leaf of the plant at one, two and three weeks after sowing using a measuring tape.

2.4.5 Data Analysis

Data collected were subjected to spreadsheet for simple analysis and treatment means compared using the average values. I must say that data from two treatments (P only and P with inoculant) were not taken due to the delay in the application of the P fertilizer. The delay was as a result of a delay in rains at the time the application was due.

3.0 RESULTS AND DISCUSSION

3.1 Assessment of current Farming systems in the district

3.1.1 Farmers' Demographic status

Seventy five percent of the farmers interviewed were males and 25% were females randomly. More males than females were interviewed in the survey due to culture and perception related to farming in most Ghanaian communities. Many females even though they were also farmers were reluctant to be interviewed or speak because they felt they were not involved so much in farming activities in their households as in most parts of Ghana, farming seems traditionally an all-men's affair.

The respondents were fairly middle aged, with 53.0% between the ages of 31-50years, 35% could be classified as youthful between the ages of 18 and 30 years and 11.7% above the ages of 50 years and could be classified as old (Fig. 2). This therefore means that most farmers in the district are fairly older with the youth of the region migrating to the southern part of the country to look for salaried jobs instead of farming. This may have future repercussions on agriculture production in Ghana since the youth is not seeing farming as a profession.

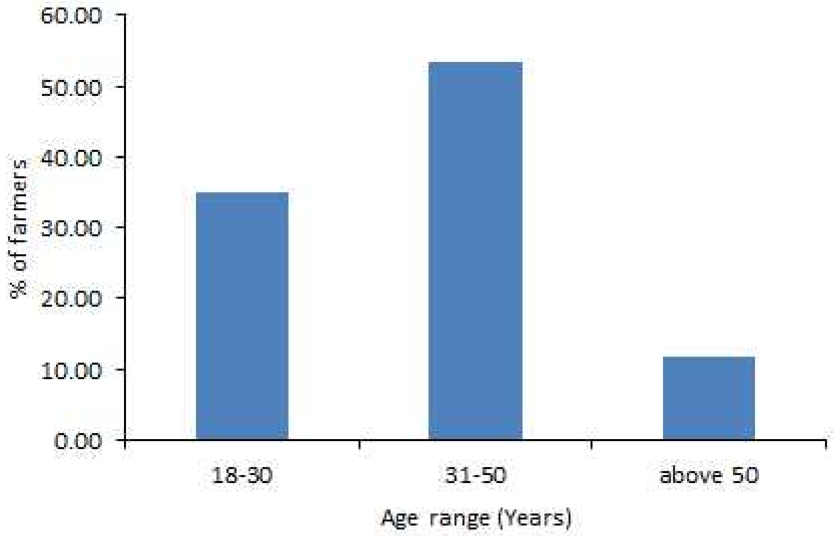


Figure 2 Age ranges of respondents or farmers

All the respondents had a person in their household who has had a formal education. For example while 33.3% of persons in the household had basic level education, 41.7% had secondary education and 25% have had tertiary level education (Table 2). This means that every household had someone who has had some education which could be seen as a credit to the farmers since most of the farmers are able to educate some members on their household. The average family size of the respondents' household was about 10 with a mean of 5 children per household.

Table 1 Highest education level completed by a person in the household

	Frequency	Percent
PRIMARY	20	33.33
SECONDARY	25	41.67
POST-SECONDARY	9	15.00
COLLEGE/UNIVERSITY	6	10.00
TOTAL	60	100.00

3.1.2 Farmers' income status/levels

All the farmers that were interviewed obtain the highest proportion of their household income from crop farming, though some other income sources were mentioned, for example the sales of livestock, casual labour on other farmers' field, petty trading and other small businesses as depicted in Fig 3. The highest proportion of income which came from crop farming could be attributed to the fact that there are no jobs that can recruit inhabitants in the visited communities and that the only option is farming. Once again it is known that nearly all production of cowpea (95%) and soybean (97%) in the country emanates from northern Ghana (SRID, MoFA, 2012) which means the major occupation in this part of the region is crop farming. In addition, one opportunity within the geographical area is the fact the region possesses vast land area for farming purposes which is an advantage to farmers in the area. Only 7% of the farmers interviewed were found to be salaried workers besides farming, for instance some farmers were found to be working as teachers in basic schools and on other government projects such as the Savannah Accelerated development Authority (SADA) in the district.

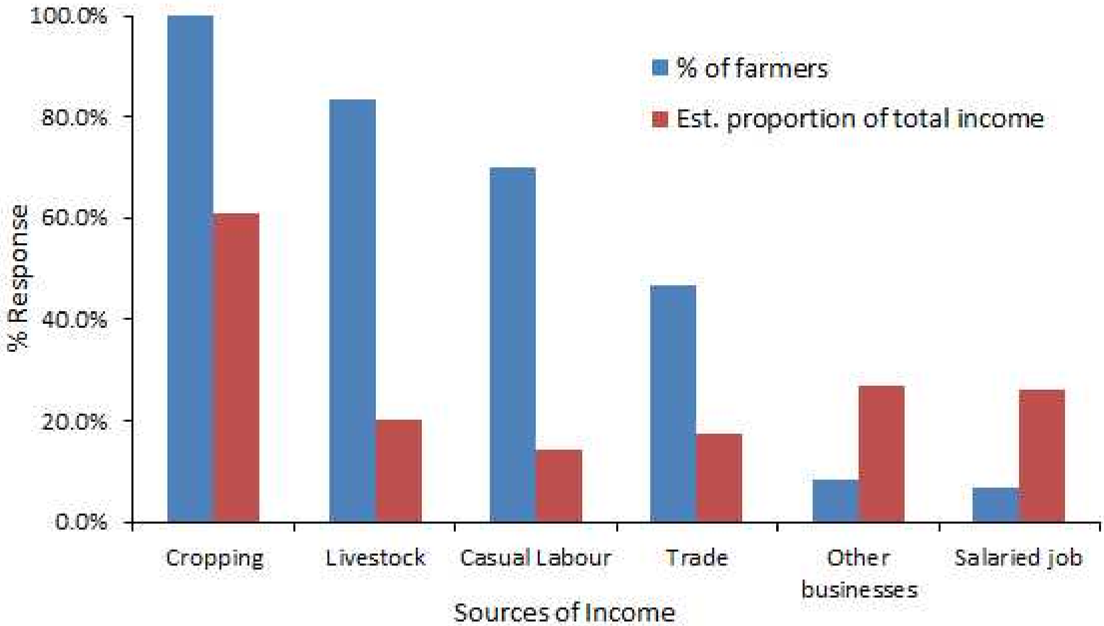


Figure 3 Main sources of income in the farm household

Farmers were also asked whether they possess some valuable goods in their households. The most mentioned valuable items were the farms, livestock, houses, motorbikes and their bicycles. It can be realised that all the valuable goods mentioned are related to their main source of income (cropping).

3.1.3 Farming System

3.1.3.1 Livestock production

Ninety three percent of the farmers interviewed rear livestock whereas only 7% are not into any animal rearing aside their crop farming. This statistics shows that the majority of farmers in the district rear farm animals together with their crop farming which creates an opportunity for integrated crop-livestock farming system. Again the production of both crops and animals suggest how resource-endow the farmers are. The majority of the households are into animal production because the geographical area is very suitable for this production since the vegetation on a large portion of the land in the area is grasses. Secondly, the vast area of land also creates an opportunity for extensive animal production without incurring any high cost. Animals reared in the various households range from Cattle, Sheep, Goats, and Pigs to Poultry. About ninety percent of the farmers interviewed rear Poultry, either fowls or Guinea fowls or both together with either cattle, sheep, Goats or Pigs. The average size of poultry reared in a particular household was about 17 individual birds (Fig. 4). Forty-three percent of the households are also into Cattle rearing whereas about 63% are into Sheep and/or Goats but only 8% are into pig production because the district is dominated by Moslems of which pigs are seen as a taboo to their religion. The average size of individual animals for Goat and Sheep was about 11 with only 8 individuals for pigs as shown in Fig 4. To add to the above discussion, I must say that the livestock sector in the district is dominated by small-scale operators who are mainly crop farmers keeping livestock to supplement their incomes and/or for security purposes and that the animals are being reared extensively. There were very few well-organized commercial poultry farm which I could not visit.

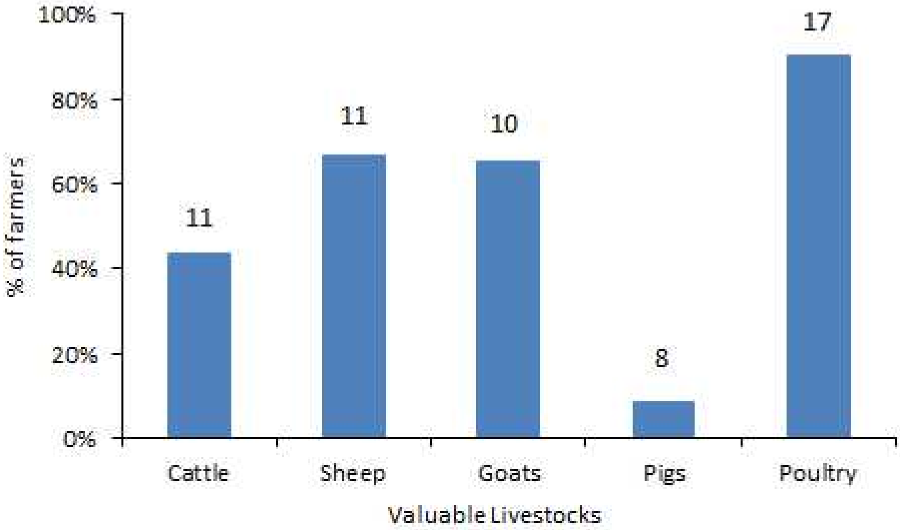


Figure 4 The various animals reared in the communities with individual averages per animal.

3.1.3.2 Land Use

The northern Ghana which comprises -Northern, Upper East and Upper West regions - accounts for over 40 percent of agricultural land in Ghana and is considered the breadbasket of the country (MoFA, 2010). This shows that land availability for farming in northern Ghana is not a challenge. From the survey, it was observed that more than 80% of the farmers own lands ranging from just 1 to 10 ha including fallow lands (Fig. 5). From the study almost all the farmers were practicing land fallowing to replenish the fertility of the soil.

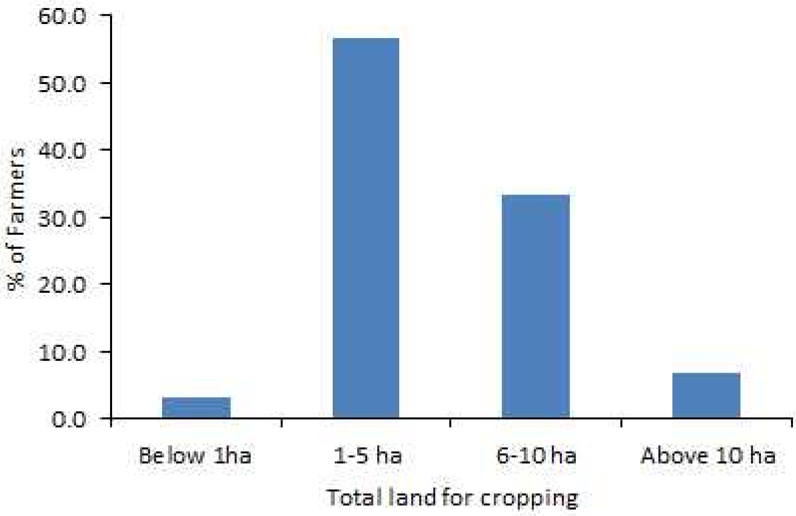


Figure 5 Total available land including fallow lands

From the survey, most lands were left fallow between 1 to 3 years with some few farmers not practicing this system at all (Fig. 6). The few farmers who were not practicing land fallowing had smaller land sizes available to them, especially those owning land less than 1 ha. Although the area possesses vast agricultural lands, agriculture in the district is predominantly on a smallholder basis. The smallholder farmers are also dispersed, and this makes provision of support services expensive and ineffective.

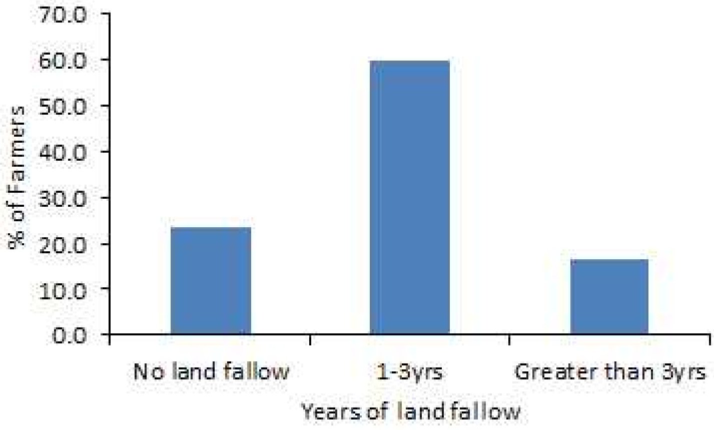


Figure 6 Duration of land fallowing

3.1.3.3 Current crop production system

The results of the interview revealed that crops produced in the district are Yam, Maize, Millet, Sorghum, Rice, Soybeans and Groundnuts, though Cowpea and Bambara beans are also grown but they are produce by few farmers. These crops are grown by almost every household on an average land size of about 2 ha, though average total amount of arable land available for cropping, including fallow lands may be more per household (Fig. 5). Production is largely rain-fed with limited mechanization and inadequate use of improved technologies such as high and stable yielding crop varieties, good agricultural practices, fertilizers, and other agro-inputs. These among many other things have contributed to low levels of productivity in the agricultural sector (Chamberlin, 2007).

The majority of farmers in the district are into mono-cropping but the farmers are practicing crop rotation whereas few once are into intercropping (Fig 7). The most commonly practiced rotation is Yam/Maize and Soybean or Groundnut/Maize or Sorghum. The major intercropping involves the mixture of cereals and legumes. The crop rotation system could be promising since it involves legumes after cereals for the maintenance of soil fertility.

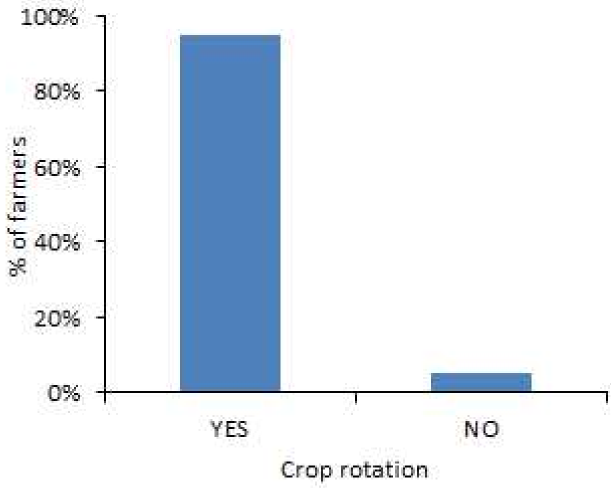


Figure 7 Number of household practising crop rotation

For the purpose of the N2Africa project, legume production and utilisation in the district was assessed into details. According to the survey, the major legumes produced in the district were Soybeans, Groundnuts, Cowpea and Bambara beans (Fig. 8). Fifty-six percent of farms in the district were Soybean farms whereas 40% were Groundnuts with only 5% as Cowpea and Bambara bean farms. The Soybean and Groundnut production is high in the district because the climatic conditions in the region favour the production of these crops. Secondly, the crops also have a good potential for market sales in the region.

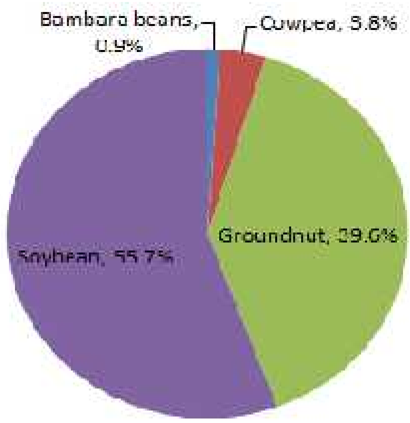


Figure 8 Legumes distribution in the Yendi district

Production of legumes in the district is on small scale with an average farm size of 1.5 ha which comprises 1.6 ha for soybean, 1.3 ha for Groundnuts, 2.3 ha for Cowpea and only 0.4 ha for Bambara beans. This could be attributed to the high cost of production such as land preparation, input cost and inaccessibility to input and output market and credit. These farmers are not able to invest more into the production of legumes because there is little investment in especially inputs application, for instance fertilizer or manure. In this case the absence of input application may have affected productivity drastically as average grain yield was found to be less than 1 t/ha for the entire legume crops which is far below the potential yields as depicted in Fig 9. This can also be attributed to the poor and declining nature of soil fertility in the region which calls for a major nutrient management strategies. The main variety for soybean cultivation is “Janguma” whiles “Chinese” is used for groundnut production. These varieties were released by Savannah Agricultural Research Institute (SARI) which is helping farmers to boost productivity. The farmers however, did not have any idea on the varieties used for the other crops such a cowpea, Bambara beans etc.

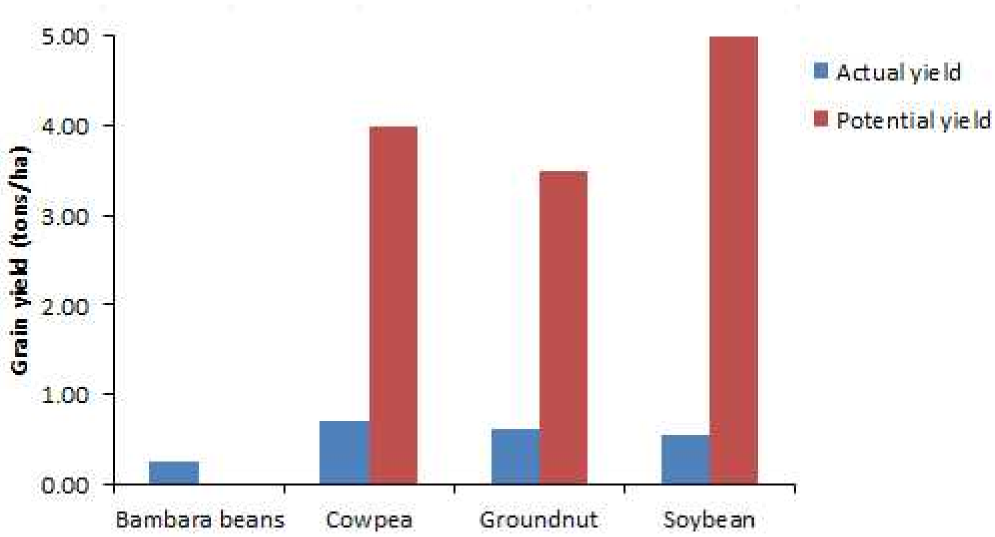


Figure 9 Actual grain yields of legumes in the Yendi district as compared to their potential yields (Potential yield was obtained from PROTA, 2006)

3.1.3.4 Legume consumption and Nutrition

From the total production of legumes, farmers were selling part of the total yield for income whereas the remaining parts were kept in the household for food and planting material (seed). Grain legumes form part of almost the daily meal of the people in the district. Groundnuts, Cowpea and Bambara beans are used for soups, stews and dawadawa (a locally prepared spice for soups and stews). Soybeans are used for Porridge, and other side dishes such as Soybean cakes (Keebabs as shown in the photo below). From the survey, it was realised that grain legumes were consumed almost every day mostly as side dish especially during the production or harvesting season whereas a large proportion of farmers consume legumes once a week in the low season, though others may possess legume grains for consumption at any time (Fig. 10).

Photo: Pieces of Keebab (Soybean cakes) prepared from Soybeans. Photo by Gregory Mensah.

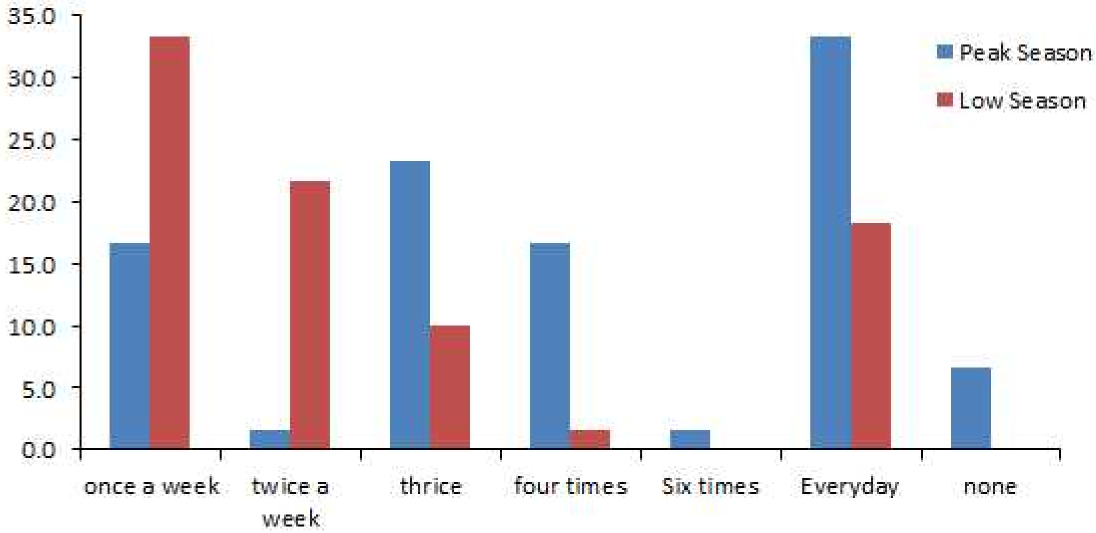


Figure 10 Legume consumption in the Yendi district

Nutritionally, most farmers were found to struggle to find sufficient food to feed their families especially within the month of June and July during the year. This is attributed to the fact that the cropping season in the district usually starts from May through to the end of July where farmers may had run short of food and the only grains or tubers left are used as planting seeds. It was again found out that, in the normal year, farmers begin to get food to feed their families from August until April. Harvesting of crops, particularly yams and early planted maize starts from August and reaches its peak in October and November where food becomes abundant.

3.1.3.5 Input Management

Farmers were asked about the use of inputs such as mineral fertilizers, organic inputs and the use of inoculants on their farms. The response on the use of mineral fertilizer was positive as 85% of the farmers were applying different types of nitrogen (N) mineral fertilizers to their farms whereas 15% of the farmers applying nothing (Fig. 11). However, the fertilizer is only applied to maize farms because maize is increasingly becoming a major food and a cash crop and farmers have realised that maize yields are very poor without the application of fertilizers. Again through capacity building trainings from some organizations, farmers had become aware that maize production requires N fertilizers in the various physiological growth stages of the crop, especially when farming on poor soils. The main types of N fertilizers identified were NPK fertilizers and Sulphate of Ammonia (Fig. 10). The 15% of farmers who were not applying any mineral fertilizer to their fields could be due to the high cost of mineral fertilizers for these farmers, inefficiencies in fertilizer distribution networks which limit access, adding to the high cost of fertilizers in the communities. Also the agro-input marketing looks rudimentary and the Farmer-Based Organizations are also finding it difficult to acquire credit, fertilizer and other inputs in bulk to reduce cost (FAO, 2005).

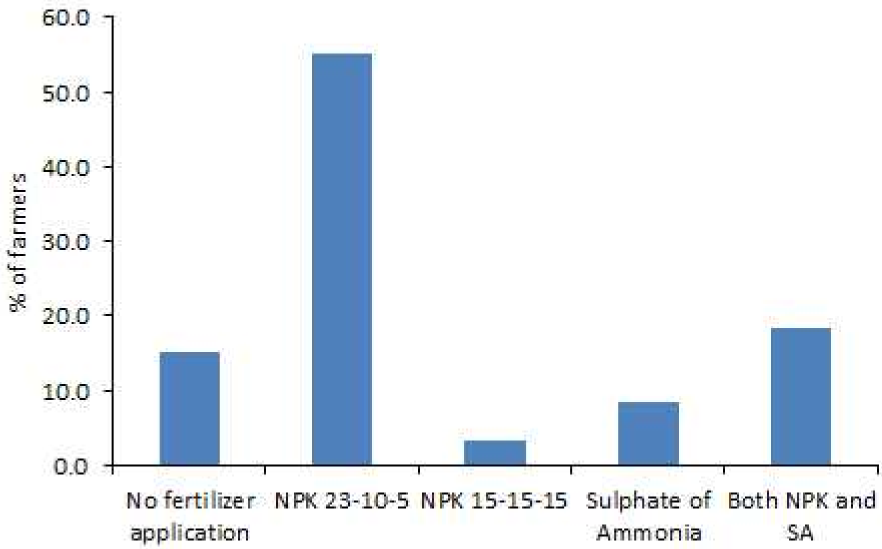


Figure 11 Application of mineral fertilizers

On the use of organic inputs, 65% of farmers were applying organic inputs directly or indirectly to their fields (Fig 12). The majority of the organic inputs were found to be the incorporation or the spread of crop residues especially the legume haulms on the field after harvesting. Although most of the farmers were into livestock production, the use of animal manure was not well practiced because all the animals were under extensive production where animal manures are scattered around the environment making it difficult for proper manure management and application. In addition, most of the animal manure is also used for other purposes such as building material as depicted in the photo below.


Photo: Cattle manure being prepared with some amount of soil as building materials. Photo by Gregory Mensah.

Again on the legume haulms, some of the farmers were also using them to feed their animals, while others were selling them to other people, burning them on the field or burning them and using the ashes to produce local soaps as depicted in Fig. 13. The 35% of farmers who were not applying any organic inputs was due to ignorance on how to use organic materials such as legume haulms for soil fertility amendments apart from burning them or feeding them to their animals.

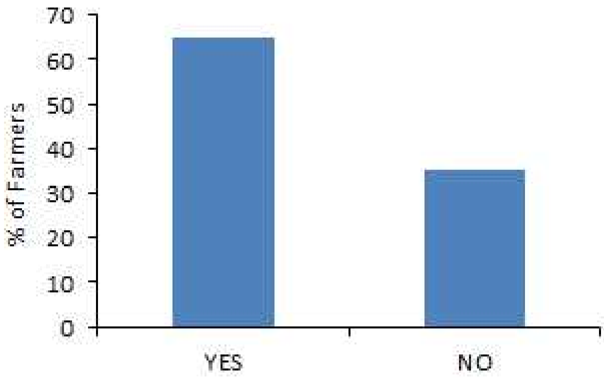


Figure 12 Application of organic inputs

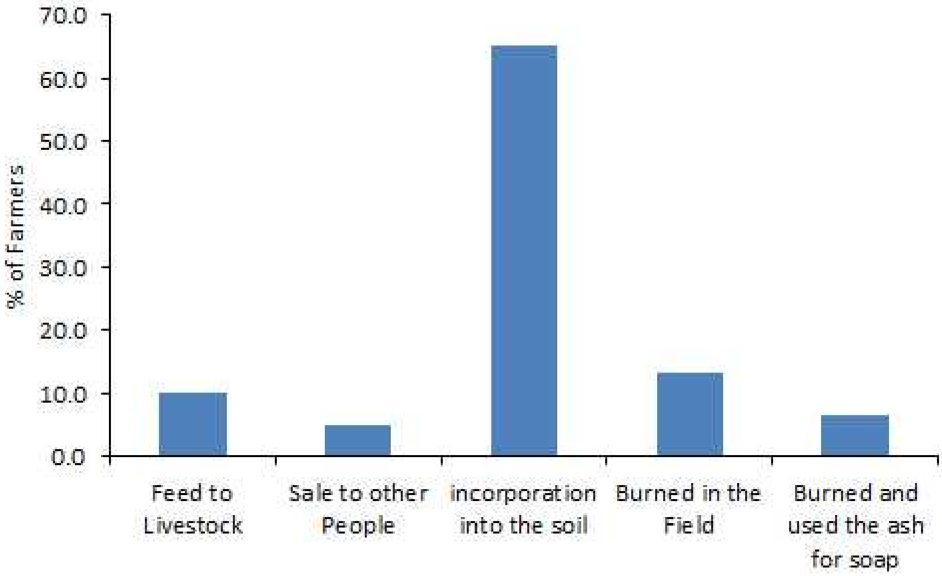


Figure 13 Use of legume haulms

On the use of inoculants, all the farmers in the district did not have any idea about the use of inoculants for legume production. The use of inoculant for legumes therefore became news to them because the district under study did not participate in the first phase of the N2Africa project. This makes it very necessary and vital for the phase 2 of the project to include farmers in the district.

3.2 On-farm trials on the Soybean

3.2.1 Crop establishment

Figure 14 shows the results of crop establishment which depicts that plots inoculated with Rhizobium compared to the control recorded basically the same percentage of crop establishment with a slightly higher plant establishment in the un-inoculated plots. Crop establishment indicates the germination ability and seedling survival of the treatments. Un-inoculated plants were a little more established than those in inoculated plots and this could have been due to a non-establishment of the bacteria strains activities after Rhizobium inoculations at this early stage of plant growth. In addition, genetic and environmental factors such as amount of soil moisture and fertility gradient which are believed to be responsible for differences in plant stands could be better in the un-inoculated plots than the inoculated plots.

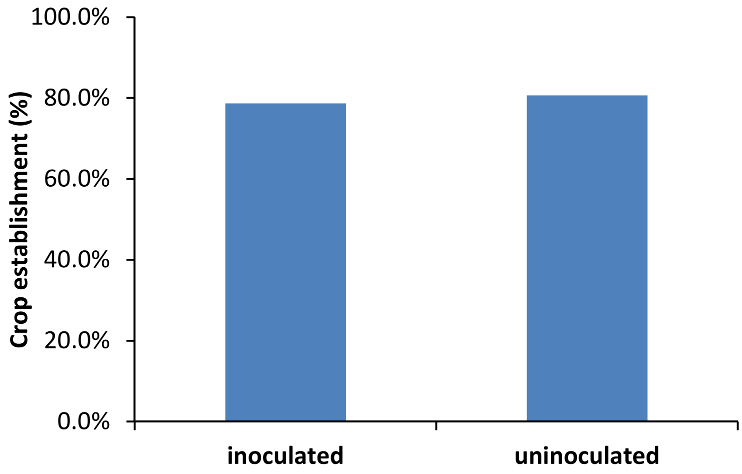


Figure 14. Effect of inoculation regime on crop establishment of soybean at 2 WAP.

3.2.2 Plant height

Inoculation with Rhizobium did not have any effect on soybean plant height throughout the sampling period but inoculation with Rhizobium produced a slightly taller plants with the effect (13.5 cm) being experienced at 3 WAP compared to the heights (13.2 cm) of un-inoculated plants at the same stage (Figure 15).

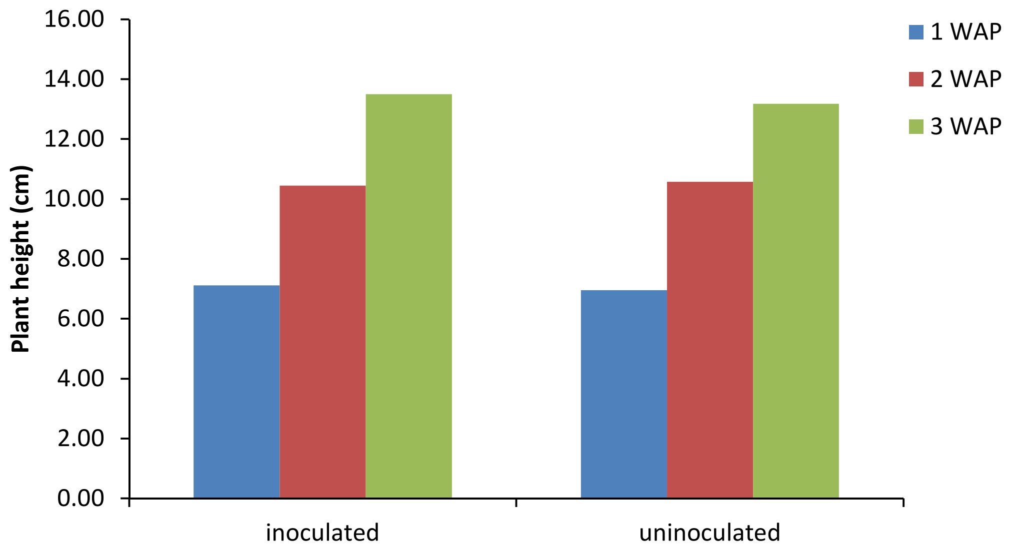


Figure 15. Effect of inoculation regime on plant height of soybean.

Plant height is usually influenced with genetic or environmental factors or both. Plants compete with other plants and weeds for light and other growth resources such as soil nutrients. To out-compete weeds, plants need to outgrow and shade weeds rapidly to increase biomass production. Plant height therefore is an important plant genetic attribute. There was a slight influence among the treatment for plant height especially at 3 WAP. This is in agreement with Lamptey et al. (2014) where they experienced slightly taller plants at 3 WAP but with the greatest effect being experienced at 9 WAP when soybeans were inoculated compared to un-inoculated plants. Their results were not surprising as Hernandez and Cuevas (2003) stated that inoculation increased plant height. However, there was no difference in plant height at the earliest stage of the plant growth (1 and 2 WAP).

4.0 CONCLUSIONS AND RECOMMENDATIONS

The survey revealed that the municipal is dominated by small holder farmers who are confronted with the issues of poor soil fertility management, low yields and at times erratic rainfall as mentioned by these farmers during the survey.
At the early stage (2 WAP) of the plant growth from the on-farm soybean demos, virtually no differences in plant height and establishment were observed between the inoculated and un-inoculated plots at the early growth stages of soybeans in the district. However, inoculation increased plant height slightly at 3 WAP.

From the results of the baseline survey, I will therefore recommend that agricultural development programmes should continue to target smallholder farmers and support them with technical training to enhance their technology uptake in terms of ISFM and climate change to improve on the huge yield gap for the farmers in the municipal. Secondly, government should adopt policies and develop institutions that will increase farmers' purchasing power while also increasing access to farm inputs.

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