Public –Private Partnership collaboration in environmental climate compatible agricultural growth. Preliminary observation

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Abstract

Following the success of PANTIL sub-project integrated dairy production systems in Njombe District villages an idea of piloting the Promising Agricultural Production Methods evolved among the University of Life Sciences (UMB) and SUA experts by the end of the programme in 2010. The idea was shared with the Private Companies namely YARA (International Fertilizer Company) and SYANGETA (an international Company dealing with agricultural inputs). In October 2010 a Public – Private Partnership (PPP) team composed of SUA, UMB, YARA and SANGETA researchers conducted a reconnaissance survey in Manyara, Morogoro and Iringa regions with an aim of establishing demonstration farms for piloting promising agricultural methods that are environmentally friendly and climate compatible. In order to establish a baseline data of soil physical and chemical properties of the farms and recommend the use of fertilizers accordingly before crop planting, soil samples were collected from 8 farms in Nov 2010; 1 in Manyara region (Malbadaw wheat farm), 4 in Morogoro region (Gairo and Mgeta maize farms and Dihombo and Lungo rice farms), and 3 from Iringa region (Ibumila, Lunyannywi, Kichiwa maize farms). At each farm, historical background was recorded before soil sampling. Then a free survey was done to know the boundary and size of the farm. Important feature of the farm such as landform, soil colour, soil texture were observed so as to draw sampling units. At each sampling unit 10 to 15 points were selected in zigzag fashion and at each point a pit of 60 x 60 cm was made and two soil samples were collected one each in two sampling depth 0-20 cm and 20-40 cm. Soils were air dried, sieved through 2mm sieve, packed and sent to the soil laboratory for analysis. The farms in Iringa region were planted with maize in mid Dec. 2010 while those in Morogoro were planted with rice in Feb 2011. A baseline survey involving 5 villages (i.e. 3 in Njombe district- Iringa and 2 in Mvomero district- Morogoro) where the demonstration farms were established was conducted in March 2011. Twenty farming households (HH) were involved (i.e. 4 HH per village; 2 in and 2 out of demonstration farms). The aim of the HH baseline survey was to collect information on HH characteristics, current land-use and agricultural practices, use of inputs such as seeds, pest and weed control, and the timing and nature of agricultural activities related to maize and rice cultivation. The crops were harvested in June and July 2011 in Morogoro and Iringa, respectively. Historically, it was noted that, except for the large wheat farm in Manyara region, most HH did not apply enough fertilizer to their farms. Use of nitrogen fertilizer ranged from 1.5 to 1.8 bags of urea per ha. Fertilizers use regardless of type ranged from 67 to 87 %. Use of pesticides was greatly pronounced in Njombe (90 % of the HH) as compared to Mvomero (50%of the HH). In both districts, 64 % of the HH just recycle the seeds they produce from their own farms. Except for the Malbadaw and Gairo farms which had high ph value (> 7) all other farms had pH values ranging from very low (< 4.3) to low (4.4 – 5.0). Soil Phosphorus, Potassium, Magnesium, Sulphur, Copper and Zinc values were very low in Iringa farms and low to medium for the Morogoro and Manyara region farms. Intervention with correct fertilizer application, weed management and pest management increased the yield of rice in Dihombo from 1438 kg/ha to 5400 kg/ha and maize yield in Kichiwa-Njombe increased from 2625 kg/ha to 4375 kg/ha. The increase in crop yield improved HH farming profitability substantially. Preliminarily it can be concluded that Public –Private Partnership collaboration can improve substantially the environmentally climate compatible agricultural growth. However, enough time is required in testing the model meanwhile its real economic and social impacts being assessed.

1.0 Introduction

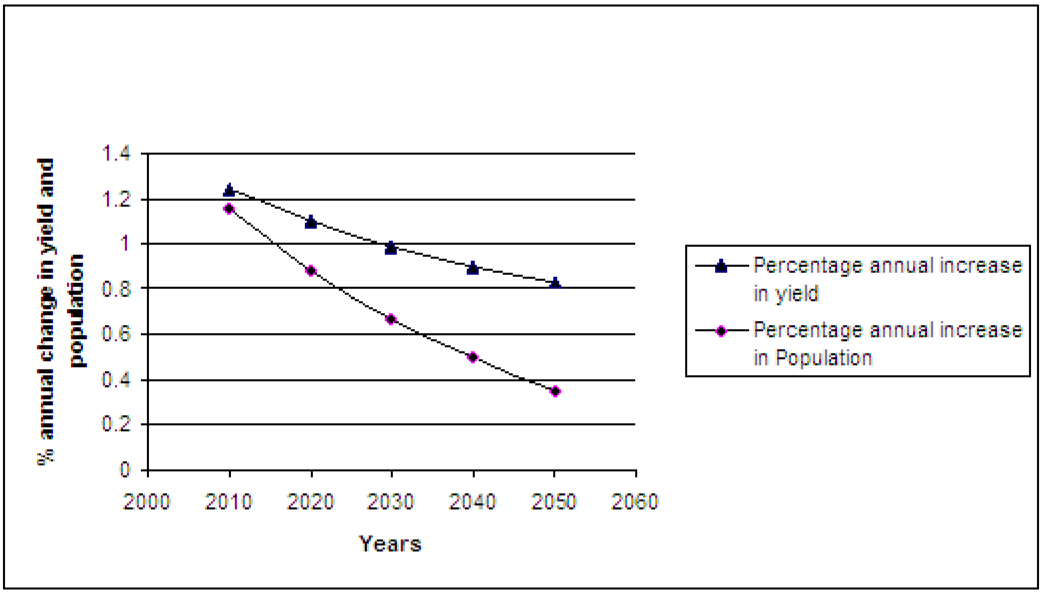
1.1 Global food demand versus population growth under climate change

In developing countries half of the population is involved in agriculture compared to 5.5 % of the developed world (Reynolds et al., 2005). Indeed nearly 80 % of the population in Tanzania is involved in agriculture. Smallholder farmers produce most of the developing world's food but are much poorer than the rest of the population (Dixon et al., 2001). The United Nations Millennium Development Goal (UN, 2000) includes eradication of extreme poverty and hunger (Goal 1. Eradicate extreme poverty and hunger with two targets, between 1990 and 2015, of halving the proportion of people whose income is less than US $ 1 a day and halving the proportion of people who suffer from hunger). There is no sustainable way of reducing poverty and hunger without improving livelihoods (a means to a living) in rural areas (FAO 2003). According to Dixon et al. (2001) there are five main strategies smallholder farmers may follow in their daily struggle for livelihood security: (i) income diversification; (ii) expansion of land area; (iii) intensification of land use; (iv)increased non-farm income; and (v) leaving farming altogether. Dixon et al. (2001) also propose elements for reducing hunger and poverty as: refocusing of institutions, policies and public goods; trade liberalization and market development; enhancing agricultural infrastructure and human capital, and improving techniques and management of natural resources.

The world's population is expected to reach eight billion by 2025 (Reynolds, et al. 2005) and projected to be 9.15 billion and growing at around 35 m (0.4 %) per annum (United nations 2010). The projected growth rate of population has been shown to be similar or lower than the rate of increase of cereal yields (Figure 1). As incomes increase, however, there is a change in dietary preferences from cereals towards meat consumption. This change results in an increased demand for cereals as feed grains. The use of grains for biofuels is also rising and it is projected that by the year 2020 industrial countries could consume 150 kg maize/capita/year for ethanol production (Rosegrant et al., 2008) that is similar rates of cereal food consumption in developing countries. All these changes will result in an increased demand for grains at a grater rate than that of the population. Real demand of major cereals such as maize and rice will therefore continue to be higher than the production in the years to come because of water, land and energy shortages, climate change, and increased demand for food, fuel and feed.

1.2 Possibility of improving production of major cereal food crops

The three major cereal crops in the world are maize, rice and wheat. In Sub-Saharan Africa maize and rice are the major cereal crops are the major staple food and also cash crop in some regions. The crucial agricultural dilemma is how to satisfy the demand of cereal for food and all other uses and at the same time sustain the natural resources base. Unsustainable and environmentally unsound policies and practices have caused widespread degradation of the environment and increased people's vulnerability to food shortages. Since the expansion of cropped areas is ultimately limited and increasingly undesirable then efficient agronomic practices to adopt will include: soil and water management, weed and pest management, increased soil fertility exploitation and improved crop variety. These will increase productivity and close the gap between high cereal demands against low production.



Source: Edmeades, 2010

Figure 1. Projected annual change in global population and cereal yield

The impact of climate change however, poses serious challenges to sustainable livelihoods and economic development of smallholder farmer production systems in Tanzania. The adverse impacts of climate change are already noticeable in the country, with frequent drought, floods, and occasionally excessive high temperatures and dwindling supply of water. Therefore sustainable use of natural resources and reduced emission of GHG gasses can only take place if farmers' trade-offs are smaller i.e. if the conservation initiatives have higher benefit to small-scale farmers. The question is therefore, how to intensify agriculture to enable farmers to provide more food for a growing population while at the same time conserve dwindling forests, wild-life and water. Climate change mitigation and adapting communities to its impacts represents an opportunity for new and more sustainable investments and management choices that can also contribute to improved livelihoods and fighting poverty among rural communities. There is therefore a need for the right partnership to enable efficient food crop agronomic practices and for small farmers to receive technological assistance in adapting to and mitigating the effects of climate change. A strong partnership between public technical advisory and agro-industries (both agro- input providers and agro-product processors) will enhance agricultural productivity especially of the food production and thus reduce vulnerability of rural communities to the effects of climate change. Such partnerships especially the Public –Private – Partnership model are currently being encouraged by Tanzanian government under its "Kilimo Kwanza" strategy, and within the recently launched Southern Agricultural Growth Corridor of Tanzania (SAGCOT).

1.3 Synthesis of PPP model on environmentally climatic compatible Agriculture at SUA

During the implementation of PANTIL, SUA researchers in collaboration with extension officers in Njombe district managed to raise maize crop yield in home gardens from about 0.5 t/ha to about 3.5 t/ha through the proper utilization of dairy cattle manure. Previously, the farmers were spreading the small quantities of available dairy cattle manure to the whole home garden. On average, each household in the Njombe villages in which PANTIL operated owns one dairy cow and a home garden of about 0.5 to 1ha. During the implementation of PANTIL, SUA researchers successfully tried in collaboration with farmers to apply about 0.6 kg of manure per hole planted with maize seed. The maize seed selected for the trials was the variety known locally as 'Lomba'. Following this achievement in farmers' maize yield increase, other partners, particularly YARA (a private, international fertilizer company) proposed that yields could be raised further through the use of industrial fertilizer. A private seed company SYNGENTA, which deals with plant protection, also joined the team in its efforts to further increase farmers' maize crop yields through chemical pest and weed control. Based on the interests of the project partners as well as previous successes under PANTIL, the pilot project was further expanded to include rice producing farmers in Mvomero district.

This paper therefore highlights a preliminary observation of the implementation of the public – private partnership model constituted by SUA, UMB, YARA and SYNGETA under smallholder maize and rice farmers in Njombe and Mvomero districts respectively. The partnership was initiated with an aim of establishing demonstration farms among the smallholder farmers for piloting promising agricultural methods that are environmentally friendly and climate compatible in various parts of the country.

1.0 Material and Methods

2.1 Reconnaissance survey and soil sampling

In October 2010 a Public –Private Partnership (PPP) team composed of SUA, UMB, YARA and SANGETA researchers conducted a reconnaissance survey in Manyara, Morogoro and Iringa regions with an aim of establishing demonstration farms for piloting promising agricultural methods that are environmentally friendly and climate compatible. In order to establish a baseline data of soil physical and chemical properties of the farms and recommend the use of fertilizers accordingly before crop planting, soil samples were collected from 8 farms in Nov 2010; 1 in Manyara region (Malbadaw wheat farm), 4 in Morogoro region (Gairo and Mgeta maize farms and Dihombo and Lungo rice farms), and 3 from Iringa region (Ibumila, Lunyannywi, Kichiwa maize farms). At each farm, historical background was recorded before soil sampling. Then a free survey was done to know the boundary and size of the farm. Important feature of the farm such as landform, soil colour, soil texture were observed so as to draw sampling units. At each sampling unit 10 to 15 points were selected in zigzag fashion and at each point a pit of 60 x 60 cm was made and two soil samples were collected one each in two sampling depth 0-20 cm and 20-40 cm. Soils were air dried, sieved through 2mm sieve, packed and sent to the soil laboratory for analysis.

2.2 Planting of demonstration farms

The farms in Njombe district, Iringa region were planted in mid December 2010 while those in Mvomero district were planted in Feb 2011. It was unfortunate that some of the farms whose soil samples were taken in November 2010 were not planted because their soil results were not ready during the planting season in December 2010 and January 2011. Unfortunately due to the delay of soil chemical analysis only 3 farms whose soil results were ready were planted in 2010/2011 season. These were 2 maize smallholder farms in Iringa region (i.e. in Tegamenda and Ibumila villages). Only one smallholder rice farm was planted in Morogoro region at Dihombo village. The agronomic management of the crops is indicated in Appendix 2 & 3. Farmers were involved during planting and other necessary agronomic practices so as to upscale the knowledge.

2.2 Household baseline survey

The baseline survey covered villages that were involved in the implementation of the Programme for Agricultural and Natural Resources Transformation for Improved Livelihoods (PANTIL), based on the successes achieved under this programme. Purposive sampling was used whereby five villages in which PANTIL was implemented in Njombe district (3 villages) and in Mvomero district (2 villages) were involved in the baseline. A sample size of 20 households was covered in the household survey; that is, for each village, four households were surveyed. While purposive sampling was used whereby beneficiary villages of PANTIL were a target, within each village a district agricultural extension officer together with the village PANTIL farmer group selected the four households for an in-depth survey. Households were selected according to the criteria given by project partners, which in turn were related to the needs for implementing the maize and rice trials. The requirements were that selected households i) possess at least 1.5 acre of land (for maize) and 1 acre of land (for rice) on which to potentially conduct trials, and ii) keep livestock (dairy cattle). The aim was rather to describe in detail the agricultural, livelihood and natural resource management activities of the selected farmers. Group discussions with farmers in the selected villages, about maize and rice production constraints and agricultural labour calendars for maize and rice, provide some more contextual understanding of agricultural practices in the villages as a whole. The questionnaire included the following questions: on household characteristics, household assets, crops cultivated at different seasons, harvest obtained from agricultural and livestock production, source of labour for agricultural production, the use of natural resources, organization and participation in farmers' groups, and source of markets as well as prices and costs for the produce and inputs. Information about maize and rice production constraints and agricultural labour calendars were collected during group discussions with men and women farmers in the villages in which data were collected.

2.3 Crop harvest

Harvesting season in 2011 started at rice farm in Dihombo village in Mvomero District in June 2011 and thereafter the maize farms at Ibumila and Tegamenda villages, respectively in Njombe district in July 2011. During harvesting period the demonstration crop field was demarcated into 3 plots. Two sampling units were then fitted in each of the three plots making a total of 6 sampling units per demonstration field. Rice sampling units were a I m^2 quadrat while maize field was a line on 4 m. The sampling units were placed at the middle of each sampling plot. A maize field adjacent to the maize demonstration filed was request and sampled during harvest to compare in situ the PPP practice and farmers practice as presented in Tables 3 and 4. After sampling the farmer continued to harvest his/her crop but total crop yield was recorded for calculating profitability of the crop production and thus compare the PPP practice with that of the small farmers as indicated in Appendix 2 and 3. Farmers' days was conducted one week before crop harvest in each site. The aim being to appreciate the crop performance.

3.0 Results and Discussion

3.1 Characteristics of the household agricultural inputs use

a) Fertilizer use

In Maize production in Njombe district, DAP is used for base dressing (42% of households) at the rate of 0.73 bags per acre. The most common fertilizers used for top dressing are urea, sulphate of ammonia and Calcium ammonium nitrate, normally at the rate of 0.93 bags per acre. In rice production in Mvomero district, fertilizer is not used for base dressing but for top dressing wherein urea of varying application rate from 16 to 50 kg per acre is used for this case.

b) Use of pesticides and herbicides

In Njombe district most (about 90%) households use pesticides whereas but fewer (≤ 50%) households in Mvomero use pesticides. Herbicides used for controlling weeds in rice production in Mvomero district are 2, 4 D and round up whereas herbicides are not used in maize production in Njombe district. Some farmers also use medicinal plants for treating seed that is stored for next planting season.

c) Seeds

Most seeds are produced by farmers themselves as 63.6%, 53.8% and 87.5% of the interviewed households responded for maize, potatoes and beans respectively in Njombe district, and 50%, and 100% for maize and rice respectively in Mvomero (Figure2). However, although in most cases farmers produce seeds on their own, other mechanisms of obtaining seeds exist. These are social seed networks, subsidy (in rare cases), purchase, and being provided seeds by companies (Figure 2). Maize and rice varieties (i.e. the main crops cultivated in the study area) are indicated in Table 1 for both Njombe and Turiani. Maize is the main crop in Njombe district whereas rice is the main crop in Turiani, Mvomero district

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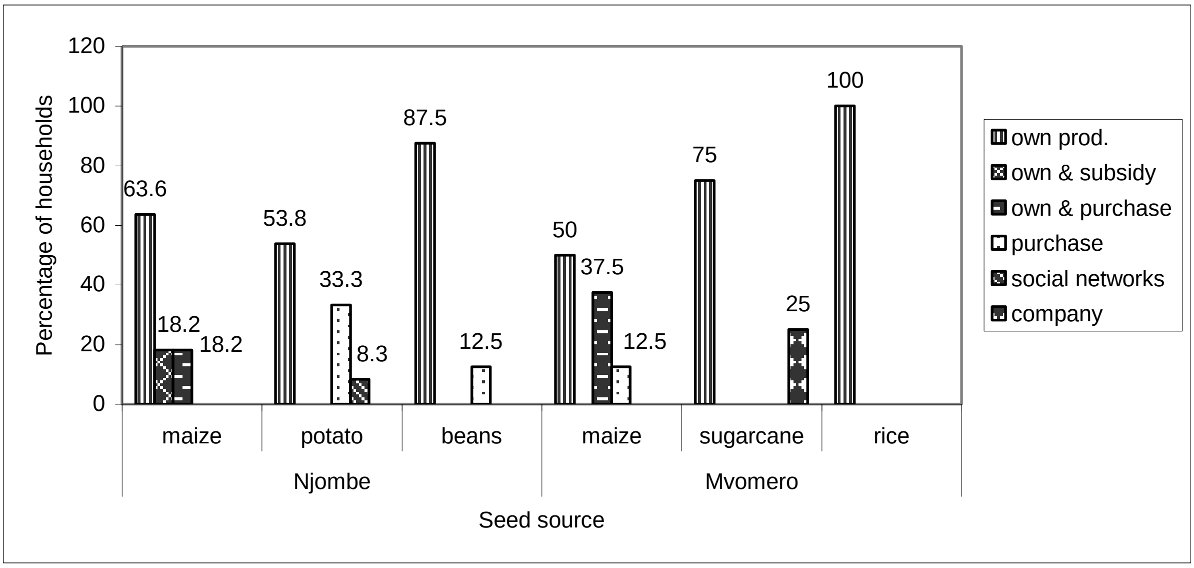

Figure 2: Seed source for various crops grown in Njombe and Mvomero districts

Table 1: Maize and rice varieties cultivated in Njombe and Mvomero districts

Maize – Njombe	**Rice – Mvomero**
Hybrid varieties: 1. Uyole 6303 2. Kenya 625 3. Uyole 614 4. Kenya 628 5. Kenya 6302 6. Hybrid 615* Local varieties 1. Lomba* 2. Mbirikimo 3. Semdelevendo	1. Mbawambili* 2. Shingo ya mwali 3. Super Mbeya 4. Super kawaida 5. Saro* 6. Super pamba 7. Moshi wa taa 8. Super Shinyanga*
* The most used crop **v**arieties in Njombe and Mvomero districts	

3.2 Soil characteristics from different sites

To reduce bulkiness of this paper only soils characteristics from the established farms in 2010/2012 season are described in this section.

a) Ibumila, Tegamenda and Lunyanywi villages in Njombe district

In Ibumila site soil pH ranged from 4.1 to 4.27 i.e. very strong acid (Appendix 1A). Soils from this site had very low organic carbon, exchangeable potassium and exchangeable magnesium. Plant available nitrogen NO_3-N and NH_4-N and mineral N were also very low. Levels of sulphur were low and response to S fertilizer application is likely. Micronutrient boron and zinc were within adequate rang while copper is at low level. These soils are rated as low fertile soil and fertilizers NPK and micronutrients are necessary for good yield.

At Tegamenda site soil pH ranges 4.2 to 4.69 i.e. very strong acid. Levels of Bray 1 P were at deficient level. Exchangeable potassium were at low level, magnesium levels ranged from 3.45 mg/100g to 10.9 mg/100g which is low to high level. Plant available nitrogen NO_3-N and NH_4-N and Mineral N are very low. Sulphur level are low, micronutrients boron, copper and zinc ranged 0.15 to 0.36, 0.1 to 0.33 and 0.16 to 0.74, respectively ranging from low to adequate levels.

At Lunyanywi site soils pH were in strong acid level and ranged from 4.1 to 4.89. The soils had very low levels of Bray 1 P, exchangeable potassium and magnesium. Plant available nitrogen NO_3-N and NH_4-N and Mineral N values at top soils were medium levels reached up to 66 kg N /ha ranged from 20 to 66 kg N/ha while at sub soil were at low levels with lowest value of 7 kg N /ha. Sulphur levels were low to marginal of critical level. Micronutrients boron and zinc were at adequate level while levels of copper were low, below critical level of 1 mg/kg. Levels of Mn and Fe are high to very high 18 to 325 mg / kg and 90 to 396 mg / kg. These data are suggesting that under water logging condition manganese toxicity is likely to happen.

b) Dihombo

Dihombo site soil pH was slightly alkaline in top soil to acid in sub soil, with low levels of organic carbon, Bray 1 P and very low exchangeable potassium and available nitrogen (Appendix 1B). Exchangeable magnesium is high and sulphur is at marginal level of the lower side. Plant available nitrogen is at low level. Micronutrients boron copper and zinc were at adequate levels. Manganese and iron are very high. Recommended fertilizers are those with N, P, K and S elements.

3.3 Crop harvest

a) Crop performance

Mean rice plant population in Dihombo site was $35/m^2$ and was less than the required population of about 45 to $50/m^2$ (Table 1). The moisture content of grain during harvest was about 5 units higher than ideal moisture content of the grain for storage which is 14 %. The yield (0.672 kg fresh wt) seems to be nearly double than that reported by the farmers for the same variety (Semi-Aromatic i.e. SARO) in the same area (i.e. 0.294 kg/m^2). This could be due to well fertilized field, better weed control, proper soil moisture that improved plant healthy in terms of increased tillering, stem thickness and high percentage of fertile tillers.

In Tegamenda, the plant row spacing in both PPP and farmers practice were nearly the same and close to normal (75cm between plant rows x 30 cm between plants within the row) (Table 3). In Ibumila site (Table 2) the number of plants per 4 m was lower than normal (i.e. 13 plants/4m). In Tegamenda site (Table 3) however, the PPP and farmers practices fields had more les the same plants per 4m. Maize grain yield in Ibumila site was nearly 4 times higher in PPP field (i.e. 1.13 kg/4m) as compared to the farmers practice field (i.e. 0.27 kg/4m). In Tegamenda site PPP field produced nearly twice as much maize grain than the farmers practice field. PPP practice proved to be better than farmers practice possibly due to proper plant population, weed control and appropriate fertilizer application that improved plant vigour, cob size and grain weight.

b) Crop yield and profitability

The intervention with PPP agricultural practice improved both rice and maize crop yield and thus the profit of crop production (Table 5). The profitability of rice was quite huge because the farmer did not apply fertilizer in the previous year (Appendix 2A). Maize profitability could have been much higher if the right seed variety whose grain does not rot (Table 4) under Tegamendas climate

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Table 2. Rice crop yield characteristics from Dihombo village, Mvomero district June 2011

S/No	Parameter	Range	Mean
1	Number plants per m^2	31- 45	35.83
2	Number of tillers per m^2	243 - 339	283.5
3	Tiller height (cm)	79.3 – 90.0	70.93
4	Thickness of tillers (20cm above the ground) mm	5.03 – 5.71	5.31
5	Number of panicles per m^2	159 - 284	214.33
6	Grain fresh weight (kg)	0.560 – 0.818	0.672
7	Grain moisture content (% of fresh wt)	17.50 – 20.76	18.93
8	Straw fresh weight (kg)	1.180 – 2.342	1.856
9	Plant moisture content (% of fresh wt)	60.19 – 66.61	63.59
10	Grain specific weight (1000 grain wt) gm	26.54 -32.52	29.83

Table 3 Maize crop yield characteristics from Ibumila site, Njombe district July 2011

s/no	Parameters	Yara/Syngeta		Farmers field		Teprozin plots	
		Range	Mean	Range	mean	Range	Mean
	Plant spacing and stover characteristics						
1	Intra plant mean space (cm)	28 - 40	34	36-63	40	29-67	41
2	Intra row mean space (cm)	76-80	78	77-85	82	71-80	75
3	Number of plants per 4m row	8-21	13	7-12	9	6-10	9
4	Fresh stover wt kg per 4m row	1.3-8.0	3.5	0.7-1.7	1.1	1.6-2.5	2
5	Stover oven wt kg per 4 m row	1.1-5.6	2.9	0.6-1.5	0.9	1.4-2.3	1.8
6	Height of stovers (m)	1.3-2.2	1.64	1.1-1.4	1.3	1.8-2.1	2.0
	Cob and grain characteristics						
1	Number of cobs per 4m row	8-21	15	5-10	7	9-11	10
2	Cob filling (%)	80 - 95	86	64-91	81	83-94	88
3	Length of cobs (cm)	12-18	15	12-15	13	12-16	13
4	Wt of cobs +grain per 4m row (kg)	0.7-4.5	2.0	0.4-1.0	0.6	0.9-1.6	1.2
5	Grain fresh wt (kg) per 4m row	0.3-2.4	1.3	0.1-0.5	0.3	0.7-1.1	0.9
6	Rotten grain wt (kg) per 4m row	0.1-1.3	0.35	0.1-0.4	0.18	0.01-0.17	0.08
8	Grain wt at 12.5% moisture content	0.3-2.0	1.13	0.1-0.4	0.27	0.7-1.1	0.82
9	Grain specific wt (1000 grain wt)gm	191-365	277	77-270	142	234-333	264

Table 4. Maize crop yield characteristics from Tegamenda site, Njombe district July 2011

s/no	Parameters	Yara/Syngeta		Farmers field	
		Range	**Mean**	**Range**	**mean**
	Plant spacing and stover characteristics				
1	Intra plant mean space (cm)	33-53	41	29 - 45	35.5
2	Intra row mean space (cm)	62-78	71	62 - 73	70
3	Number of plants per 4m row	9-13	11	8 - 12	10
4	Fresh stover wt kg per 4m row	2.0 – 4.0	2.67	2.2 – 4.3	3.2
5	Stover oven wt kg per 4 m row	1.2 – 3.1	1.98	1.5 – 2.6	2.0
6	Height of stovers (m)	2.1 – 2.6	2.34	2.6 – 3.1	2.82
	Cob and grain characteristics				
1	Number of cobs per 4m row	9 - 14	12	8 - 13	10
2	Cob filling (%)	89 - 100	96	87 - 96	94
3	Length of cobs (cm)	16 - 19	17	14 - 19	17
4	Wt of cobs +grain per 4m row (kg)	2.2 – 3.7	3.2	1.0 – 4.3	2.36
5	Grain fresh wt (kg) per 4m row	1.8 – 3.0	2.3	0.7 – 2.2	1.54
6	Rotten grain wt (kg) per 4m row	0.07 – 0.59	0.33	0 – 0.31	0.08
8	Grain wt at 12.5% moisture content	1.5 – 2.4	1.94	0.5 – 1.6	1.11
	Grain specific wt (1000 grain wt)gm	180 -362	225	216 - 480	311

Table 5. Crop yield and profitability

Season	Yield in kg	Price per kg	Total revenue (Tshs)	Cost of production (Tshs)	Profit (Tshs)	Profitability difference between PPP and farmers practice
Rice crop (0.8acres) from Dihombo village						
2009/2010	1152 kg	400/=	460,800/=	441,200/=	19,600/=	
2010/2012	2160	400/=	864,000/=	541,760/=	322,240/=	302,640/=
Maize crop (1.6 acres) from Tegamenda village						
2009/2010	2100	500/=	1,050,000/=	403,600/=	646,400/=	
2010/2011	3,500	450/=	1,575,000/=	624,900/=	950,100/=	303,700/=

4.0 Conclusion

Preliminarily it can be concluded that Public – Private Partnership agricultural collaboration can improve substantially the environmentally climate compatible agricultural growth but rather longer observation under multiple locations is required.

5.0 Way forward

The preliminary phase used farmers recalled data to compare the PPP practice. The method is unreliable therefore PPP agricultural practice should be compared side by side with farmers practice without difference of planting as incidences of rain may affect the yield and yet the farmers recalled data is usually unauthentic. For this reason, in 2011/2012 season PPP agricultural practice has been established side by side with farmers practice in the same date. Further, the demonstration sites for each crop have been increased from 2 to 5 for maize and from 1 to 5 for rice. In addition an on station demonstration farm has been prepared at SUA which will be planted with three treatments: Farmers practice in Morogoro surrounding SUA, PPP agricultural practice and SUA recommended practice. It is envisaged that the SUA site if run for 3-4 seasons under scientific control and produce a reliable data for the modelling group to calculate the trade offs from expanding the farm and protecting nature.

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