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Highlights

- Seedling Growth of Pea
- Extracts of Some Ornamental Plants
- Different Compound Fertilizers
- Bioinformatics in Crop Improvement

Discovering Thoughts, Inventing Future

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Comparative Study of Different Compound Fertilizers on Garlic (*Allium Sativum* L.) Productivity under Various Soils and Seasons

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Abstract- Production of good productivity of garlic for both consumption and economic value is the goal of most farmers/producers. However, soil fertility depletion and erratic rainfall are among the major constraints to sustain production of the crop due to limited fertilizer type/sources application and rainfall dependence. Thus, to elucidate this problem a field experiment was conducted to study the effect of different types of compound/blended fertilizers on growth, yields and economic benefits of garlic under both irrigation and rain-fed conditions at DebreZeit Agricultural Research Centre, Ethiopia, on both Andosols and Vertisols in 2013/14. The treatments consisted of control (unfertilized), Diammonium phosphate(NP), Azofertil(NS), Basic(NPKCaO) and D-coder(NPSZn) compound fertilizers each applied at 200kgha^{-1}. The experiment was laidout in randomized complete block design in three replications on both soils.

Keywords: *compound fertilizer, productivity, cropping season, economic benefits, garlic yield, soil type.*

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Keywords: compound fertilizer, productivity, cropping season, economic benefits, garlic yield, soil type.

I. Introduction

Garlic is one of the main *Allium* vegetable crops known worldwide with respect to its production and economic value. It is used as a seasoning in many foods worldwide and without garlic; many of our popular dishes would lack the flavor and character that make them favorites. Garlic's volatile oil has many sulphur containing compounds that are responsible for the strong odor, its distinctive flavor and pungency as well as for its healthful benefits (Salomon, 2002). Moreover, it contains considerable amounts of different nutrients and vitamins (Maly *et al*., 1998). Garlic has higher nutritive value than other bulb crops: 30–35% dry matter, 6–7% protein, and different minerals. Garlic also contains antibiotics *garlicin* and *allistatin*, a number of enzymes, amino acids, universal substances, including trace elements (Maly *et al*., 1998). However, these quality attributes are depend on production and management practices on both field and after harvested.

Despite its importance, garlic yield and quality are affected by various biotic and abiotic stresses, among which low/excess mineral nutrition, irrigation schedule/rainfall are among the major ones (Jaleel *et al*., 2007; Cheruth *et al*., 2008). Garlic crop has a shallow root system and needs optimum and regular application of water and nutrients. Cropping season and soil moisture affect the growth and yield of garlic; low moisture conditions in the soil are conducive to poor productivity (Shock *et al*., 1998), while excessive soil moisture results in wastage of irrigation water and nutrients leaching lead to rots and poor bulb quality. In dry cropping season, water is the most important limiting factor in agriculture and economic development issues. Water is an important factor in reducing yield and one way to increase crop yield is using irrigation water; thus, its application must be done efficiently to ensure profitability through maximizing yield, because as a natural resource it is either inadequate or irregular in most areas where onions production is prevalent (Muhammad *et al*., 2011). With the adoption of new technology in intensive cropping with high yielding varieties, there is a considerable demand on soil for supply of nutrients. Fertilizer types also affect the productivity and quality of crops; poor bulb formation, undesirable crop quality and low nutritional quality result from inadequate levels of nitrogen, phosphorus and potassium application (Liu *et al*., 2010).

Hence, considering garlic as one of the potential vegetable crop for consumption as well as for market, it is imperative to increase its productivity along with desirable quality and nutrients content through application of other sources of nutrients beyond Urea

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and Diammonium phosphate(DAP) that are most widely used in Ethiopia, in addition to other production and management practices like soil types and cropping seasons. The use of compound/blended fertilizers that contain various nutrients in one fertilizer product to obtain high yield and good quality garlic bulb is an important practice in today's garlic production on available land. Consequently, a study was undertaken with the objective of differentiating the suitable type and effect of comparing different compound fertilizers with various nutrients for garlic yield attributes and economic benefits under irrigation and rain-fed cropping conditions on both Andosols and Vertisols soil types.

II. Materials and Methods

a) *Experimental Sites and Materials*

The experimental areas were characterized by sub-humid tropical climate type with mean annual maximum and minimum temperatures of 28/26°C and 10.2/9.9°C, respectively; mean rainfall of 550/930mm and relative humidity of 52/62% during dry and rainy seasons, respectively. The experiment was conducted at the experimental farm of DebreZeit Agricultural Research Centre/DZARC/ (08^{0}44"N latitude, 38^{0}58"E longitude, altitude of 1860 m.a.s.l) in central Ethiopia during both dry season using irrigation and rainy season under rain in the year 2013/14. The experiment was conducted on two major soil types: light grey soil(Andosols) with well-drained and good soil physical property; and black soil(Vertisols) with high water holding capacity, swelling and shrinking properties. The experimental fields were under 'Tef'[*Eragrostis tef*(Zucc.)Trotter] cultivation for the two previous consecutive cropping seasons.

The physical and chemical properties of the experimental soils were analysed following the procedures of Jackson(1967). Thus, Vertisols experimental site showed surface soil texture of sandy-clay-loam which contained low organic matter (1.80 and 1.65%); low total N (0.058 and 0.071%), low available P (13.56 and 16.84ppm), medium available S (18.0 and 16.9mgkg^{-1}soil), medium K (1.15 and 1.23C.mol(+)/kg) and pH value of 7.17 and 7.08 during dry and rainy seasons, respectively. The Andosols experimental site with surface soil texture of sandy-loam was contained medium organic matter (2.56 and 2.34%), medium total N (0.127 and 0.113%), low available P (18.30 and 22.41ppm), low available S (15.8 and 19.7mgkg^{-1}soil), high K (2.22 and 2.04C.mol(+)/kg); and pH value of 7.66 and 7.38 during dry and rainy seasons, respectively when compared with that of Vertisols.

Tseday(G-493) garlic cultivar was used with similar diameter and weight for the experiment on both soils under the two cropping seasons. Different compound fertilizers containing different nutrients were applied for the experiment viz., Diammonium phosphate/DAP/(18%N+20%P),Azofertil(30%N+25%S), D-coder(14%N+9%P+21%S+0.1%Zn) and Basic (9%N+6%P+22%K+ 10%CaO) compound fertilizers per 100 kgha^{-1}. However, the fertilizers were applied at the rate of 200 kgha^{-1} on two soils under both irrigation and rain-fed seasons for the experiments. The nitrogen amount in DAP fertilizer was adjusted to 92 kgha^{-1} using Urea.

b) *Treatments and Experimental Design*

The treatments were consisted of five different compound fertilizers which containing various nutrients; viz. Control/without fertilizer/, DAP, Azofertil, Basic and D-coder. DAP fertilizer, which regularly used by farmers, was applied as a check for comparison with the new compound fertilizers introduced from abroad. Randomized Complete Block Design was used in three replications on both soil types. The experimental plot area was 3.6m^2 (1.8mX2m) with spacing of 10cm, 30cm and 60cm between plants, single rows, double rows, respectively; maintaining 1m and 1.5m between plots and blocks distances, respectively. The plot size consisted of six rows with 20 plants/row. Treatments were assigned to each plot randomly. All the fertilizer treatments were applied during planting and all other cultural, crop production and management practices were carriedout uniformly to the plots on both soils under the two seasons following the areas' recommendations (Getachew and Asfaw, 2000).

c) *Data Collected*

Ten sample plants on each plot were randomly selected from the middle four rows at 90 days of planting and growth parameters like plant height(cm), leaf number per plant, neck diameter(mm) and leaf area index from ten sample plants were recorded. After matured, bulb and yield attributes like fresh bulbs weight(g), bulb diameter and length(cm), mean clove weight(g) (the ratio of total clove weight to total clove number per sampled bulbs), biological yield(g) (the summation of above and below ground yields), total bulb yield(t/ha), harvest index (the ratio of bulb yield to biological yield) of garlic were recorded. The economic benefits of bulb yield of garlic was calculated from the cost incurred that vary with each treatment and economic yields obtained depending on the average prices prevailed at the time of production was considered to calculate the gross return. The benefit to cost/B:C/ was obtained from the ratio of gross return to total input variable cost of cultivation to compare the performance of different treatments.

d) *Data Analysis*

The obtained data were subjected to statistical analysis of variance/ANOVA/ using SAS statistical software version 9.0 and mean separation was done using the Fisher's least significant differences at $P<0.05$

level of probability using the method described by Snedecor and Cochran (1980).

III. Results and Discussion

a) *Effects of Fertilizers and Soils on Growth Attributes of Garlic*

Application of different compound fertilizers significantly influenced garlic plant height under both irrigation and rain-fed production systems; but neck diameter and leaf area index/LAI/ were significantly affected only under rain-fed production. However, application of different types of fertilizers did not significantly influence leaf number(Table1). Plant height of garlic treated by different types of compound fertilizers was not showed significant variation from each other, except from the untreated/control/ plot using irrigation. However, highest plant height was recorded from garlic plants treated with D-coder fertilizer (200 $kgha^{-1}$) followed by those fertilized with Azofertil under rain-fed season, and lowest height was recorded from garlic produced on the control plot(Table1). Garlic neck diameter was significantly increased by Azofertil and D-coder fertilizers application than the others under rain-fed, and highest LAI was produced by D-coder application under rain-fed(Table1). These might be due to the response of the plants to the cumulative effect of the applied nutrients as indicated by their mean values, which revealed that the cumulative role of the nutrients available in the compound fertilizers on the plant development and growth. These results are inline with the result of Faten *et al.* (2010) who reported highest onion plant height and neck diameter due application of Sulphate of potash than Muriate of potash, which revealed that the positive cumulative effects of more than two nutrients available in the compound fertilizers than the fertilizer containing single/two elements on the growth of the crop.

Soil types also significantly influenced the growth parameters of garlic plant during both dry and rainy seasons except LAI under dry season using irrigation(Table1). Plant heights under both dry and rainy seasons; and leaf number, neck diameter and LAI under rain-fed season were increased on Andosols grown garlic plants; but leaf number and neck diameter of garlic plant grown on Vertisols were higher than those grown on Andosols in dry season. These might be due to the soil characteristics to influence bulbs growth and nutrients mobility in addition to their availability as they influenced the growth of the whole plants. However, soils did not significantly influence the LAI produced during dry season using irrigation(Table1).

Table 1: Effects of different types of fertilizers and soils on growth indices of garlic under both dry season using irrigation and rainy cropping seasons of 2013/14

Treatments	Dry season(Irrigation)				Rainy season(Rain)			
	Plant height/cm/	Leaf number	Neck diameter/cm/	LAI	Plant height/cm/	Leaf number	Neck diameter/cm/	LAI
Fertilizer								
Control	50.22^{b}	12.00	7.02	0.970	47.65^{d}	11.75	9.12^{d}	1.945^{d}
DAP	53.98^{a}	11.67	7.03	1.063	51.33^{c}	11.78	10.48^{c}	2.107^{c}
Azofertil	54.47^{a}	11.67	7.22	0.993	55.65^{ab}	11.82	12.05^{a}	2.733^{b}
Basic	55.38^{a}	11.48	7.03	1.048	53.60^{bc}	11.35	11.12^{b}	2.237^{c}
D-coder	55.38^{a}	11.35	7.15	1.020	57.53^{a}	12.00	12.05^{a}	3.017^{a}
SE	1.46	0.41	0.211	0.07	0.58	0.187	0.259	0.051
LSD(0.05)	*	ns	ns	ns	*	ns	***	***
Soil								
Andosols	57.44^{a}	10.95^{b}	6.80^{b}	1.056	59.55^{a}	12.17^{a}	12.01^{a}	2.531^{a}
Vertisols	50.33^{b}	12.32^{a}	7.38^{a}	0.982	46.76^{b}	11.31^{b}	9.92^{b}	2.284^{b}
SE	0.93	0.26	0.134	0.044	0.37	0.119	0.164	0.032
LSD(0.05)	***	*	**	ns	***	**	***	**
CV(%)	4.34	9.94	7.33	16.80	3.29	3.93	5.80	5.21

SE-Standard error; LSD-Least Significant Differences; CV-Coefficient of Variation; DAP-Diammonium phosphate; LAI-Leaf Area Index; No–Number; ns-nonsignificant

b) *Effect of Fertilizers and Soils on Yield and Yield Attributes of Garlic*

The values of bulb attributes like fresh bulb weight, mean clove weight, bulb diameter and length were significantly($P \leq 0.01$) influenced by the fertilizer types applied during both dry- and rainy- seasons on both Andosols and Vertisols(Table2). Garlic cultivated without fertilizer application resulted in lowest bulb components under both seasons. Application of Azofertil (60kg N+50kg S ha^{-1}), Basic (18kg N+12kg P+44kg K+20kg CaO ha^{-1}) and D-coder (28kg N+18kg P+42kg S+0.2kg Zn ha^{-1}) compound fertilizers produced significantly higher bulbs as compared to DAP and control in both seasons. This indicated that availability of optimum nutrients with optimum moisture increased the growth of garlic height, number, length and width of leaves, in response to higher levels of fertilization(Diriba-Shiferaw *et al.*, 2013). All of which

Global Journal of Science Frontier Research (D) Volume XVII Issue I Version I Year 2017

might have increased dry matter production and allocation of assimilate to bulbs; resulting in an increased garlic weight of bulbs and cloves which are in agreement with the finding of Amin *et al.* (2007) who reported that application of 107kg N+72kg P+90kg K+33kg S ha^{-1} resulted in the highest growth and yield of onion over three consecutive cropping years. However, soil types significantly influenced bulb characteristics only during dry season production using irrigation; higher fresh bulb weight, mean clove weight, bulb diameter and length were produced on Andosols as compared to those produced on Vertisols(Table2). This might be due to moisture managements and better nutrients availability in Andosols before planting crop in addition to the externally applied as compared to Vertisols.

Table 2: Effects of different types of fertilizers and soils on bulb components of garlic under both dry and rainy cropping seasons of 2013/14

Treatments	Dry season(Irrigation)				Rainy season(Rain)			
	Fresh bulb weight(g)	Bulb diameter (cm)	Bulb length(cm)	Mean clove weight(g)	Fresh bulb weight(g)	Bulb diameter (cm)	Bulb length(cm)	Mean clove weight(g)
Fertilizer								
Control	23.30^{c}	3.34^{d}	2.44^{d}	1.54^{b}	19.05^{b}	14.51^{c}	2.37^{b}	0.94^{c}
DAP	32.32^{a}	4.29^{a}	3.60^{a}	1.70^{a}	25.46^{a}	19.32^{b}	2.61^{a}	1.14^{b}
Azofertil	31.85^{a}	4.10^{ab}	3.32^{b}	1.63^{ab}	28.20^{a}	21.99^{ab}	2.62^{a}	1.28^{a}
Basic	25.73^{b}	3.70^{c}	3.01^{c}	1.36^{c}	29.94^{a}	19.80^{b}	2.66^{a}	1.29^{a}
D-coder	31.39^{a}	4.04^{b}	3.20^{bc}	1.69^{a}	29.23^{a}	24.87^{a}	2.63^{a}	1.40^{a}
SE	0.64	0.075	0.084	0.042	1.58	0.086	0.065	0.043
LSD(0.05)	***	***	***	**	**	**	*	**
Soil								
Andosols	33.16^{a}	4.19^{a}	3.26^{a}	1.79^{a}	26.33	3.37	2.60	1.24
Vertisols	24.67^{b}	3.59^{b}	2.96^{b}	1.38^{b}	26.42	3.47	2.56	1.18
SE	0.40	0.048	0.053	0.026	1.00	0.054	0.041	0.027
LSD(0.05)	***	***	**	***	ns	ns	ns	ns
CV(%)	4.65	4.74	6.57	5.07	15.42	6.57	5.27	8.08

SE-Standard error; LSD-Least Significant Differences; CV-Coefficient of Variation; DAP-Diammonium phosphate; LAI-Leaf Area Index; ns-nonsignificant

Yield components and total bulb yield of garlic were also significantly($P \leq 0.01$) influenced by the applied fertilizers under the cropping seasons except harvest index/HI/ under rainy season (Table3). The highest biological yields were produced by application of DAP and D-coder fertilizer types at 200 $kgha^{-1}$ during dry-season using irrigation. However, under the rainy-season the highest biological yield was produced from garlic plants treated with D-coder without significant differences from those fertilized with Azofertil and Basic fertilizers. Lowest biological yields of garlic were obtained from those produced on the control plots in both seasons and from those fertilized with Basic and DAP fertilizers during dry and rainy seasons, respectively(Table3). Highest HI was produced in dry-season by D-coder application and lowest HI from garlic produced without fertilizer application(Table3); which was increased by 50% as compared to the lowest HI from control, and by 27% as compared to those produced with DAP application(standard check).

The highest bulb yield was produced in response to D-coder application in both dry and rainy seasons as compared to other fertilizer types, and lowest yield was produced from control plot in both seasons(Table3). The highest economic bulb yield produced by D-coder was increased by 47% and 61% over those produced on the control plot during dry and rainy seasons, respectively. Application of D-coder also increased bulb yield by 15% and 32% as compared to those fertilized by DAP during dry and rainy seasons, respectively(Table3). These results emphasized that the adequate soil moisture content along the growing period and applied nutrients encouraged vegetative growth of the plant, which cumulatively enhanced the development of large bulbs and yields. The results of this study are in agreement with the finding of AL-Abdulsalam and Hamaiel(2004) who reported significantly higher onion bulb weight with application of compound fertilizer containing 14%N:38%P:10%K nutrients. Morsy *et al.* (2012) also reported greatest values of onion bulb weight with 120 kgN+30 kgP+48 kgK ha^{-1} fertilization over two seasons. Halim and Ener (2001), Kumar *et al.* (2007) and Enciso *et al.* (2009) also found that irrigation highly affected the total bulb yield and yield components of onion. Similarly, Pejic *et al.* (2011) revealed that the highest yield and yield components of onion were produced by irrigation as compared to rain-fed cultivation.

Application of D-coder fertilizer improved bulb yields of garlic more than other fertilizer types. The increment in vegetative growth and dry weight of plant organs by combined N,P,S,Zn application may be

Global Journal of Science Frontier Research (D) Volume XVII Issue I Version I Year 2017

attributed to the direct effect of nutrients in improving plant metabolism, increasing photosynthetic rate and free amino acids, which led to an increase in yield and quality characters (El-Kader *et al.*, 2007). The interaction of N with P and K application also increased production of large dry matter and bulb weights of the crop that increased the total bulb yield. Similarly, Morsy *et al.* (2012) obtained higher yield and quality attributes of onion by applying 120kg N+24kg P+48kg K ha^{-1} combination in two seasons; and Coolong and Randle (2008) revealed that, application of Ammonium sulphate improved bulb yield and mineral uptake of onion than other fertilizer types.

Soil types also showed significant variation on economic bulb yield during both dry and rainy seasons; however, biological yield and HI was showed significant variations only during dry season due to soil type(Table3). Both biological yield and HI was higher on Andosols as compared to those produced on Vertisols during dry season using irrigation; improving by 36.6% and 20%, respectively. The economic bulb yield was significantly increased on Andosols compared to on Vertisols during both dry and rainy seasons. Bulb yield produced on Andosols was improved by 31.75% during dry season and by 9.52% in rain-fed as compared to yield produced on Vertisols(Table3). These might have been due to the controlled watering of the crop through irrigation which improved the economic bulb yield through improving uptake of nutrients from the Andosols. This revealed that application of optimum amounts of nutrients along with the nutrients available in the soils increased the production of dry matter as well as the total bulb yield of garlic which increased crop nutrients uptake in both seasons on the soils (Diriba-Shiferaw *et al.*, 2013).

Table 3: Effects of different types of fertilizers and soils on yield and yield indices of garlic under dry and rainy cropping seasons of 2013/14

Treatments	Dry season(Irrigation)			Rainy season(Rain)		
	Biological yield(g)	HI	Bulb yield(t/ha)	Biological yield(g)	HI	Bulb yield(t/ha)
Fertilizer						
Control	32.68[c]	0.56[d]	8.16[d]	22.10[c]	0.88	5.33[d]
DAP	50.06[a]	0.66[c]	10.45[bc]	28.76[b]	0.91	6.48[c]
Azofertil	41.88[b]	0.77[b]	10.89[b]	33.40[ab]	0.86	7.40[b]
Basic	34.62[c]	0.74[b]	9.61[c]	32.12[ab]	0.95	7.42[b]
D-coder	49.26[a]	0.84[a]	12.00[a]	34.53[a]	0.85	8.59[a]
SE	1.15	0.021	0.298	1.620	0.051	0.301
LSD(0.05)	**	***	**	**	ns	**
Soil						
Andosols	48.15[a]	0.78[a]	11.62[a]	31.17	0.85	7.36[a]
Vertisols	35.25[b]	0.65[b]	8.82[b]	29.20	0.93	6.72[b]
SE	0.72	0.013	0.189	1.025	0.033	0.191
LSD(0.05)	**	***	***	ns	ns	*
CV(%)	8.10	6.64	7.55	14.82	15.28	10.50

SE-Standard error; LSD-Least Significant Differences; CV-Coefficient of Variation; DAP-Diammonium phosphate; HI-Harvest Index; ns-nonsignificant

c) Economic Benefits of Compound Fertilizers

The different types of fertilizers applied on different soils both during dry and rainy seasons were found significant with respect to gross and net returns. The higher gross and net returns were found with application of D-coder, Azofertil and Basic fertilizers respectively on Andosols during dry season using irrigation and on Vertisols under rainy season than DAP and control. However, the significantly highest gross and net returns were obtained from Andosols treated with D-coder, Basic and Azofertil fertilizers respectively during the rainy season; but highest gross and net returns were due to DAP which followed by D-coder and Azofertil fertilizers on Vertisols during dry season. The highest net return was found in plot fertilized with D-coder on Andosols during dry season and lowest from control plot on Vertisols during rainy season(Figure 1). Fertilizers, seasons and soils showed significant differences with respect to benefit to cost (B:C) ratio. D-coder fertilizer applied on Andosols in both seasons and on Vertisols during rainy season showed significant benefit than other fertilizers types on both soils because of its higher yield produced in terms of cost incurred during production. Whereas, among the fertilizer types applied on Vertisols during dry season, highest B:C ratio was recorded with application of DAP followed by D-coder and Azofertil, and lowest B:C due to Basic fertilizer. Lowest B:C ratio was observed when garlic was grown without any fertilizer on both soils during the two seasons except on Vertisols during dry season, because of Basic treated produced low yield interms of higher cost incurred during the production season(Figure2). This might be also due to the higher yield as a result of nutrients uptake and dry matter production using elements available in compound fertilizers plus the nutrients in Andosols soil and availability of optimum moisture during rainy season. However, application of fertilizers to Vertisols did not produce significant benefit to cost ratio during both seasons, which might be due to lower amount of nutrients available in the soil before the external fertilizers applied. Kale (2010) also found higher gross and net returns with higher yields of onion with the application of Sulphate of potash and Ammonium sulphate but lower B:C than the other N and K fertilizer sources, single nutrient containing fertilizer type.

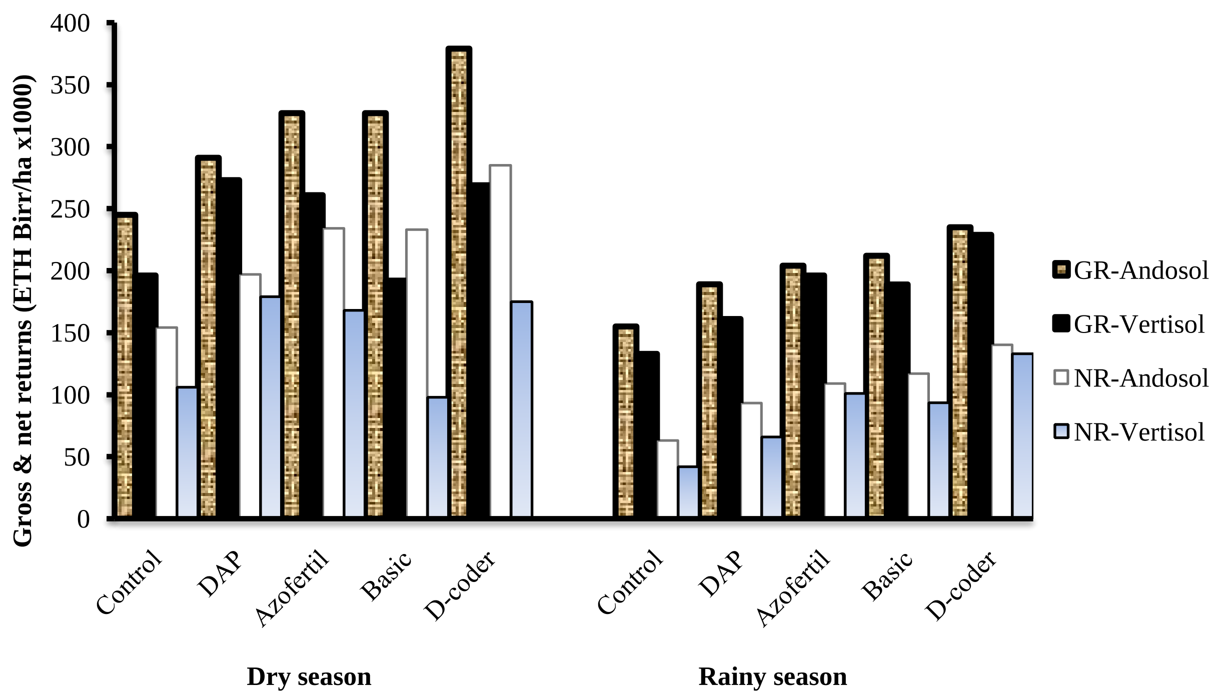

Figure 1: Gross return(GR) and Net return(NR) of garlic as influenced by fertilizer types on Andosols and Vertisols during dry and rainy cropping seasons of 2013/14

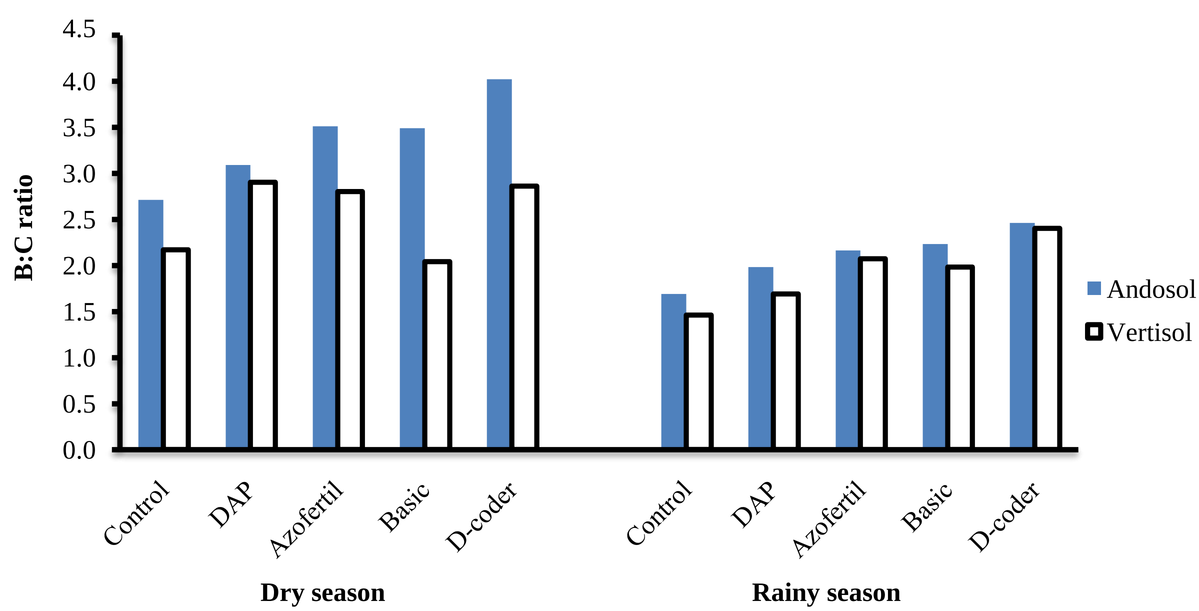

Figure 2: Effect of fertilizer types on B:C of garlic on Andosols and Vertisols during dry and rainy cropping seasons of 2013/14

Note: At the time of dispatch 1kg of garlic costs Birr 25-35 and average taken was 30Birr/kg during both seasons; consequently, production yields were adjusted by 10% reduction to compensate with those produced by farmers.

IV. Conclusions and Recommendations

Garlic plant showed differential responses to the different types of compound fertilizers on both Andosols and Vertisols under both dry and rainy seasons. The morphological characters like plant height, neck diameter and leaf area index were significantly influenced by the application of different compound fertilizers and soil types under different production seasons. Yield and yield components and economic returns of the crop were also significantly increased by the application of different compound fertilizers in dry-season cultivation using irrigation than under rainy season on both soils. But, significantly superior response of garlic, as observed by vegetative growth, yields and economic benefits of the crop, was obtained when garlic was planted in the dry-season using irrigation on Andosols with the fertilization of D-coder fertilizer at 200 $kgha^{-1}$ which supplied 28kg N+18kg P+42kg S+0.2kg Zn ha^{-1} followed by Azofertil fertilizer at 200 $kgha^{-1}$ which supplied 60kg N+50kg S ha^{-1}. Thus, it could be concluded that application of D-coder fertilizer containing 28kg N+18kg P+42kg S+0.2kg Zn ha^{-1} nutrients and Azofertil fertilizer containing 60kg N+50kg S ha^{-1} nutrients are better to substitute the locally recommended DAP fertilizer (92kg N+40kg P ha^{-1}) for better productivity of garlic over the other fertilizer types under both dry season using irrigation and rainy season on both Andosols and Vertisols soil types of the area and the like.

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From Ecobiological Heritage to Local Ecodevelopment

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Introduction- Access right and profit sharing issues regarding plant genetic resources rely on the farmers' and other users' rights particularly for species used for food, medicinal and common usage purposes such as wood for energy, for timber or for art work. However the exercise of access rights as much for farmers as for other users is strongly linked to land constraints. Indeed, the terms of management transfer and that of land ownership transfer may be articulated with those related to certain procedures enacted by the estate law respectively by concession, long term lease, operating license, or land Endowment to local communities with transfer fees or for free to the operators.

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From Ecobiological Heritage to Local Ecodevelopment

Jules Razafiarijaona

I. Introduction

Access right and profit sharing issues regarding plant genetic resources rely on the farmers' and other users' rights particularly for species used for food, medicinal and common usage purposes such as wood for energy, for timber or for art work. However the exercise of access rights as much for farmers as for other users is strongly linked to land constraints. Indeed, the terms of management transfer and that of land ownership transfer may be articulated with those related to certain procedures enacted by the estate law respectively by concession, long term lease, operating license, or land Endowment to local communities with transfer fees or for free to the operators.

II. Problematic

The legal framework for these aspects suffers from a lack of regulations on the use of the various genetic resources either fish, livestock or wild plants related to cultivated plants; the latter are subjected to intense exploitation within various rural areas highly devoted to forest, as forest plant genetic resources (CANAL-FORGUES E et al, 2004-2005) covered by statutory texts. These issues may take into account the private sector involvement in plant genetic resource economic valorization process for agriculture and nutrition by implementing seed technology.[1]

III. Methodology

By adopting the articulating and combining approach to these legal matters, issues related to access rights and profit sharing could be put in place in the sense of creating opportunities for economic and financial returnsfor basic local communities, incomes for operators, and local taxes for decentralized territorial communities. The conditions of access, use and trade of forest plant genetic resources (RAZAFIARIJAONA J, 2011) in general and access to plant genetic resources for food and agriculture in particular involve a legal framework regulatingecosystem biological representa - tiveness prospection, collection and valorizat - iondepending on their ecological characteristics.

IV. Results

Spontaneous or wild species, due to their agricultural and production potential, offer economic, financial and social opportunities; generally, legal inconsistencies or gaps limit the implementation of the strategy on conservation and enhancement of plant genetic and biological resources (CANAL-FORGUES E et al, 2004-2005). Issue on the matter of wild species related to grown plants has to be solved by the development of a legal framework for their protection, their characterization, their use and their enhancement as genetic materials usedin order to obtain variety and plant material multiplication for agriculture and food security (CANAL-FORGUES E et al, 2004-2005). For these reasons, plant genetic resources related to cultivated plants have to be accounted for in national programmes; these resources are characterized by their potential to produce more competitive items and to meet the domestic demand for food products and value-added creatoragricultural products that would justify benefit equitable sharing (CANAL-FORGUES E et al, 2004-2005). The State role is to be maintained in its rightful status, to guarantee the general interest, and to implement structuring investments related to land, agricultural credit and agricultural and ecological taxation in order to fit and secure productive investments in rural areas. Essentially, it is about taking into consideration the institutional, technical and financial capacities of the Communeson the matter of decision-making processes, of project and program planning, investment planning, development management planning, control exercise and follow-up actions; in order to avoid a structural and institutional deadlock due to routine and contextual phenomena.

V. Discussions

a) Conservation And Valorization Macroeconomic Framing Elements

Givenpublic financesdeficit state at the national level, decentralized territorial communities are characterized by their inabilities to cover induced local expenses; public investment contribution to support production structuring remains low relative to demand

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[1] Obtainingvariety, plant genetic material multiplying, conditioning, storage and exchange are the seed sector constituents (RAZAFIARIJAONA, j., 2004, 2005).

thus, exposing ecosystems to degrading phenomena. The situation macroeconomic expression framing is expressed by the following equation, such as:

- At the national level $Y < C + I + X - M$[2](see Appendices V &VI).
- At the level of the conservation site neighboring communes, it is expressed as

$$Y < C + I \text{ and } Y < C + S.$$

These relations express national income and local revenue formations which respectively, show a chronic double deficit both internal and external. A situation which forces the Central Government to resort to oversea borrowing in order to finance input needs for both agricultural production and environment protection and management. These two relationships that form an equation system of economic actor behaviors, i.e. the state and the municipalities, as well as the basic local communities, help to better understand the necessary measures in terms of conservation and environmental quality. A negative income Y[3] means that the sum of variables penalizes its formation because of the existence of high environment opportunity costs; However, a positive Y[4] means that the opportunity costs are falling due to the existence of alternatives leading to productive asset creations that are likely to promote value formation; in other words, it is not about producing or operating less [3]in order to preserve ecosystems versus local development; valorization should be effected otherwise. This approach transposition to local economies due to local deficits refers to the equations as local income formation (LABONNE M, 1991) translates as follows:

$$Y = Q.P;\ Y = C + S;\ Y = C + I;\ Y = M.V = C + S$$

However, because of environment opportunity costs and of the economy self-sustaining characters at the neighboring commune site levels, revenue is written as follows: $Y < C$, where $C > I$. From these relationships, it is inferred that household income within the various conservation site neighboring communes, despite the existence of abuse in the operations of plant genetic resources, are engulfed in by consumption because of the sector archaic or artisanal situation accentuated by hard difficulties to access inputs and lack of structuring investment; for savings (S) when it is close to nil, the direct consequence is manifested by the hard time given on natural ecosystems.

Taking Keynes hypothesis (KEYNES, J M, 1936) when investment (I) is greater than savings (S), i.e. that there is a domestic deficit, an external deficit is inferred by forcing the State into contracting further debts and systematically, bridge the internal gap, to finance capital investment needs. The differences between income and domestic consumption (FONTAINE J M, 1994) $Y – A$, and common transactions related to exports and imports, $X - M$, allow to see a country macro-economic situation. For Madagascar, these two criteria are materialized by a double internal and external deficit.

b) Forest Plant Genetic Resource Conservation Economico-Legal Framing Elements

Conservation site wild flora species evolve within a degradation context linked to rural poverty socio-economic dimensions. This situation implies that the integrated legal framework is necessary for plant genetic and biological resource protection, for the access terms and conditions to necessary natural resources for agricultural production, and for the exploitation and management modes of these resources. It is about printing the conditions that contribute to the assurance of an *in situ* conservation and allow a valorization guaranteeing a sustainable food security and a sustainable income generation. As such, the framing process implies the consideration of relationships involving an interrelation and interaction between space, natural resources and the neighboring communities of the Corridor basiclocal population. That consists in proceeding by a conceptualization of the institutions working for coordination mechanisms and able to concern themselves with the required

[2] Within theeconomic analysis language, domestic absorption is defined as the sum of expenditures made in a given country. They are made up of three elements: consumption privatespending, noted as C, investment spending, I, and Government spending, noted as G. Be $A = C + I + G$, where A represents the domestic absorption. From the thenational income Ypoint of view, any expense made on the territory is perceived by a resident, and the income will include the three constituents of absorption, C, I and G. But relationships with the rest of the world create also an income: exports X add to national income, and imports M are deducted from. National income Y, therefore,is made up of five elements:

$$Y = C + I + G + X – M$$

Net income from foreign trade is expressed as X - M, i.e. the balance of income transfers with the outside world, represented by the current account balance that will be noted as B. Then, the equation of revenue could be written as:

$$Y = A + B$$

and the correspondence between internal and external deficits could be shown. If A is greater than Y, i.e. if total domestic spending: absorption A, are higher than income Y; the balance of current payments B will be negative. However, among the variables that can result in excess of absorption A over income Y, there would be the amount of government spending G, which will play a major role.

Mathematically, the correspondence between the excess of absorption over the income and the external deficit can be read in two directions: acurrent balance initial deficit ($B < 0$) could lead to an excess of absorption over income ($A > Y$), or on the other side, an excess of absorption can determine an external deficit.

[3] With $Y < 0$, to waive offecosystem development could lead to positive opportunity costs, i.e. that the losson local income is much higher while preserving natural resources over the neighboring population interests. The reason is that there is no alternative to conservation measures.

[4] With $Y > 0$, to waive offecosystem enhancement could lead to negative opportunity costs when comparative advantages are much higher both for the environment and the local populations. The reason is that there are alternatives to conservation measures.

mechanism creation or development. Therefore, such structures would likely either exercise regulative institutional powers of planned or spontaneous institutions, or exercise constitutive institutional powers of also planned or spontaneous institutions (TURNER J., 1993).

i. *Space-resource relationships and common ecobio - logical heritage*

From one site to another, space changes in the sense that there are forest areas, pastures, lake areas. Given that each space is characterized by linked typical resources, these resources accession or exploitation systems are intrinsically tied to the proper occupation systems specific to each area. Natural resource management is community and property based; It takes into account resource and space uniqueness which serve as their physical support. This concept of space is designed to take into account the exploitation right exercise as being foreign to them; it is designed based on a local approach to grasp the importance of the area a biotic and biotic characteristics. For all these reasons, biodiversity and biological representativeness ecosystems constitute an ecobiological community heritage. Access right and benefit-sharing issues regarding forest plant genetic resources (CANAL-FORGUES E et al, 2004-2005), including wild species related to grown plants in particular, rely on the farmers' and other users' rights especially for the species for food, medicinal purposes and common use such as wood for energy, timber, woodwork, etc…

As for the question regarding these resources, the development of a legislative framework for their protection, their characterization, their use and their enhancement as genetic materials should be used to promote variety acquisition and plant material multiplication (RAZAFIARIJAONA J, 2005) for agriculture and food security. In particular, regarding the spontaneous species, their usage due to their agricultural potential, would offer economic, financial and social opportunities to the extent that legally, the strategy would be to make a series of legislative provisions related to plant genetic and biological resources. The idea is to take into consideration the various international convention texts toward which Madagascar is committed including the Convention on biological diversity, the Treaty on plant genetic resources for food and agriculture, the Cartagena Protocol, the Convention on the fight against drought and diversification, the Convention on climate change.

Viable and [4]sustainable natural resource management requires an institutional structure and a scale relationship among the various powers and regulations; otherwise it remains within a routine situation or in a contextual rationality such as that occurring at rural area levels. Structuring consists in achieving a mode or system of land occupation and access to resource stratification.

The scale relationship is concerned with superposition, interference and systemic links of various types of use, enjoyment and disposition. The structuring of land occupation and access to natural resource modes and the derived scale relationship that form the whole land and environment controls[5], reflect on the accession to social contract and programmed rationality. This justifies the need to implement regulatory texts of general importance taking into account natural resource ecosystem relationships and agriculture system relationships of the populations with the ecosystems.

Natural resource community management, through these environmental land controls, must incorporate the negotiated and passed as agreement management principles and mechanisms according to a heritage approach in order to instill a conventional or contractual reflex among actors. In short, environmental land controls are summarized by:

- Exploitation rights legal recognition, depending on the needs and local specificities, either on time or on space levels,
- Integration agreement between the ecosystem conservatory measures and resource economic development imperatives.

ii. *Land and environment terms of occupation*

Viable and sustainable natural resource management requires structuring and scale relationships. Structuring consists in a land occupation and access to resource mode stratification (MINTZBERG H, 1982), depending on whether the concerns are based on logics of environmental property controls [6] (BARRIERE O et al, 1997) about resource use and exploitation. Production social relations reflect both space management and natural resource accesses. Scale relationsare about superposition, interference and

---

4[5] Minimum, priority, specialized and exclusive controlsconsist in defining alocalized and specific temporary or seasonal management system, while intentional control relies on the need to orient and reframe the human impact shares in an integrative process of viable, feasible, reliable and sustainable environment management.

[6] Environmental land controlsare minimum, priority, specialized, exclusive and intentional.

[7] Vegetation cover modification by secondary forest extension is an actual threatof changes over the hydrological regime and soil physical morphology by increasing runoff water, floods and erosion. That means that primary foresttransformation intosecondarized forestswould mean actual extinction threats to several plant genetic and biologic species.

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systemic links of these types of use, enjoyment and space and resource disposition.

The environmental management issue is therefore inextricably linked to that of land. In other words, land, i.e. space relates to natural resources of which it is the support. However, this concept which tries to redefine land as related to environment faces a fundamental issue regarding land occupation and access modes and modalities summarizing land relations in their multiple interference. This observation justifies the approach based on systemic relationships [7] (EASTON D, 1956) among natural ecosystems.

The space and natural resource governance issue with their biophysical characteristics require an ecosystem approach adoption, preventing soil degradation process, deforestation physical impacts and agricultural nonperformance. Outside spaces givenindividualizedtitles bestowed on private individuals, known as private property, space and resources come within the environmental domain. The land-environment concept would find its foundations in the sense that it expresses the relationship between human and nature, communities and spaces-resources and by the social relationship set between men and community groups for these natural resource and these space appropriation or exploitation on the other hand.

VI. Conclusion

With this state of facts related to anthropo-legal analysis it would be an imperative that there be a coviability among ecosystems and operating systems. Natural resource community management, through land environment controls, must integrate management principles and mechanisms set by contract and according to a heritage approach. In other words, natural resource management is linked to land security (RAZAFIARIJAONA J, 2005) in order to translate the land ecology-based approach.

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Role of Bioinformatics in Crop Improvement

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Abstract- Bioinformatics plays a significant role in the development of the agricultural sector, agro-based industries, agricultural by-products utilization and better management of the environment. With the increase of sequencing projects, bioinformatics continues to make considerable progress in biology by providing scientists with access to the genomic information. It is believed that we will take on another giant leap in bioinformatics field in next decade, where computational models of systems wide properties could serve as the basis for experimentation and discovery. Agricultural bioinform -atics areas that need focus would be are data curation and need for the use of restricted vocabularies. Being an interface between modern biology and informatics it involves discovery, development and implementation of computational algorithms and software tools that facilitate an understanding of the biological processes with the goal to serve primarily agriculture and healthcare sectors with several spinoffs.

Keywords: agricultural bioinformatics, crop improve ment, bioinformatics, biology, information-technology.

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Role of Bioinformatics in Crop Improvement

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Abstract- Bioinformatics plays a significant role in the development of the agricultural sector, agro-based industries, agricultural by-products utilization and better management of the environment. With the increase of sequencing projects, bioinformatics continues to make considerable progress in biology by providing scientists with access to the genomic information. It is believed that we will take on another giant leap in bioinformatics field in next decade, where computational models of systems wide properties could serve as the basis for experimentation and discovery. Agricultural bioinform -atics areas that need focus would be are data curation and need for the use of restricted vocabularies. Being an interface between modern biology and informatics it involves discovery, development and implementation of computational algorithms and software tools that facilitate an understanding of the biological processes with the goal to serve primarily agriculture and healthcare sectors with several spinoffs. Bioinformatics is more often a tool than a discipline, the tools for analysis of biological data. The ability to represent high resolution physical and genetic maps of plants has been one of the great applications of bioinformatics tools.

Keywords: agricultural bioinformatics, crop improve ment, bioinformatics, biology, information-technology.

I. Introduction

Bioinformatics is a new and emerging science that combines the power of computers, mathematical algorithms, and statistics with concepts in the life sciences to solve biological problems. It is an emerging interdisciplinary area of science and technology encompassing a systematic development and application of information technology solutions to handle biological information by addressing biological data collection and warehousing, data mining, database searches, analyses and interpretation, modeling and product design (Degrave et al., 2002; Xiong, 2009; Jayaram and Dhingra, 2010). Thus bioinformatics is the interdisciplinary science of interpreting biological data using information technology and computer science. Bioinformatics was invented by Paulien Hogeweg and Ben Hesper in 1970 as "the study of informatic processes in biotic systems". Paulien Hogeweg is a Dutch theoretical biologist and complex systems researcher studying biological systems as dynamic information processing systems at many interconnected levels.

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Over the past few decades, major advances in the field of molecular biology, coupled with advances in genomic technologies, have led to an explosive growth in the biological information generated by the scientific community (Vassilev et al., 2006).

In recent years, rapid developments in genomics and proteomics have generated a large amount of biological data. These data requires sophisticated computational analyses for drawing conclusions. The importance of this new field of inquiry will grow as we continue to generate and integrate large quantities of genomic, proteomic, and other data. As the amount of data grows exponentially, there is a parallel growth in the demand for tools and methods in data management, visualization, integration, analysis, modeling and prediction. Bioinformatics plays an essential role in today's plant breeding with regards to the development of new plant diagnostic tools.

Bioinformatics have huge applications in various fields. Bioinformatics helps scientists to apply different tools and technology to facilitate and analyse the research work. Some major fields where bioinformatics is widely used are as follows.

II. Fields of Bioinformatics

- Microbial genome applications
- Molecular medicine
- Personalised medicine
- Preventative medicine
- Gene therapy
- Drug development
- Antibiotic resistance
- Evolutionary studies
- Waste cleanup
- Biotechnology
- Climate change Studies
- Alternative energy sources
- Crop improvement
- Forensic analysis
- Bio-weapon creation
- Insect resistance
- Improve nutritional quality
- Development of drought resistant varieties
- Veterinary Science

a) Microbial genome applications

- Genome assembly
- Re-sequencing
- Comparative analysis

- Evolutionary studies
- Antibiotic resistance
- Waste cleanup
- Biotechnology

III. Scopes of Bioinformatics

Bioinformatics is an important discipline of biological sciences that allows scientists to decipher and manage the vast quantities of data available to them (Ojo and Maxwell, 2010). It consists of two subfields: the development of computational tools and databases, and the application of these tools and databases in generating biological knowledge to better understand living systems (Xiong, 2009). These two subfields are complementary to each other. The tool development includes writing software for sequence, structural, and functional analysis, as well as the construction and crating of biological databases. These tools are used in three areas of genomic and molecular biological research, including molecular sequence analysis, molecular structural analysis and molecular functional analysis (Tramontano, 2009; Xiong, 2009). The areas of sequence analysis includes sequence alignment, sequence database searching, motif and pattern discovery, gene and promoter finding, reconstruction of evolutionary relationships and genome assembly and comparison. Structural analyses include protein and nucleic acid structure analysis, comparison, classification and prediction. The functional analysis includes gene expression profiling, protein–protein interaction prediction, protein sub cellular localization prediction, metabolic pathway reconstruction and simulation (Rao et al., 2008; Xiong, 2009). The three aspects of bioinformatics analysis are not isolated, but often interact to produce integrated results. For example, protein structure prediction depends on sequence alignment data; clustering of gene expression profiles requires the use of phylogenetic tree construction methods derived in sequence analysis. Sequence based promoter prediction is related to functional analysis of co-expressed genes.

IV. Importances of Bioinformatics

Bioinformatics apply the principles of information sciences and technologies to complex life science data (Ojo and Maxwell, 2010). Therefore, the field of bioinformatics has evolved such that the most pressing task now involves the analysis and interpretation of various types of data, including nucleotide and amino acid sequences, protein domains, and protein structures (Wales, 2009).

Table1: Classification of databases in the 2004 edition of the Molecular Biology Database Collection (11)

Category	Number of Databases
Genomic	164
Protein sequences	87
Human/vertebrate genomes	77
Human genes and diseases	77
Structures	64
Nucleotide sequences	59
Microarray/gene expression	39
Metabolic and signaling pathways	33
RNA sequences	32
Proteomics	6
Other	6

(Source: D. Vassilev, J. Leunissen, A. Atanassov, A. Nenov & G. Dimov (2005) Application of Bioinformatics in Plant Breeding, Biotechnology & Biotechnological Equipment, 19:sup3, 139-152).

The analysis of genetic and DNA sequences such as nucleic acid sequences, protein structure/function relationships, genome organization, regulation of gene expression, interaction of proteins and mechanisms of physiological functions, can all benefit from a bioinformatics approach. Nucleic acid and protein sequence data from many different species and from population samplings provides a foundation for studies leading to new understandings of evolution and the natural history of life (Tramontano, 2009). The main tasks of Bioinformatics involve the analysis of sequence information that involves identification of genes in the DNA sequences from various organisms, identification of families of related sequences and the development of models, aligning similar sequences and generating phylogenetic trees to examine evolutionary relationships. Finding all the genes and proteins of a genome from a given sequence of amino acids and predicting active sites in the protein structures to attach drug molecules (Rao et al., 2008).

There are three important sub-disciplines within bioinformatics (Kumor 2009 and Asthana 2009), the development of new algorithms and statistics with which to assess relationships among members of large data sets; the analysis and interpretation of various types of data including nucleotide and amino acid sequences, protein domains, and protein structures; and the development and implementation of tools that enable efficient access and management of different types of information (Rao et al., 2008).

Table 2: List of plant species in which partial or whole genomes have been sequenced. (Data extracted from the following internet sites: http://www.ncbi.nlm.nih.gov/genomes/PLANTS/PlantList.html; http://www.arabidopsis.org/portals/genAnnotation/other_genomes/index.jsp; http://www.ildis.org/)

Division	Class	Species
Non Vascular	Algae	Chlamydomonas reinhardtii, Chlorella variabilis, Cocco-myxa sp., Cyanidioschyzon merolae, Ectocarpus siliculosus, Micromonas pusilla, Micromonas sp., Ostreococcus, Lucimarinus, Ostreococcus tauri, Volvox carteri, Zostera marina
Vascular	Bryophytes	Physcomitrella patens, Selaginella moellendorffii
	Dicotyledons	Amborella trichopoda, Aquilegia sp., Arabidopsis lyrata, Arabidopsis thaliana, Arachis hypogaea, Asclepias syriaca, Beta vulgaris, Boechera holboellii, Brassica napus, Brassica napa, Brassica rapa, Caffea caneophora, Cajanus Cajan, Cannabis sativa, Capsella rubella, Carica papaya, Castanea mollissima, Citrullus lanatus, Citrus Clementine, Corchorus olitorius, Cucumis sativus, Eucalyptus grandis, Fragaria vesca, Glycine max, Gossypium hirsutum, Gossypium raimonddi, Hordeum vulgare, Jatropha curcas, Lactuca sativa, Linum usitatissinun, Lotus japonicas, Malus domestica, Manihot esculenta, Medicago truncatula, Mimulus guttatus, Phaseolus vulgaris, Pinus taeda, Populus tremula, Ricinus communis, Theobroma cacao, Populus nigra, Populus trichocarpa, Prunus avium, Prunus persica, Pyrus bretschneideri, Rubus idaeus, Salix purpure, Solanum lycopersicum, Solanum pimpinellifolium, Solanum tuberosum, Spirodella polyrhiza, Thellungiella Parvula, Vitis vinifera
	Monocotyledons	Brachypodium distachyon, Elaeis guineensis, Miscanthus Giganteus, Musa acuminate malaccensis, Oryza sativa, Oryza glaberrima, Panicum hallii, Panicum virgatum, Phoenix dactylifera, Seratia italic, Sorghum bicolor, Triticum aestivum, Zea mays

V. Bioinformatics Tool

a) Biological databases

Biological databases are archives of consistent data that are stored in a uniform and efficient manner. These databases contain data from a broad spectrum of molecular biology areas. A simple database might be a single file containing many records, each of which includes the same set of information (Xiong, 2009). Databases are composed of computer hardware and software for data management. The chief objective of the development of a database is to organize data in a set of structured records to enable easy retrieval of information. Each record, also called an entry, should contain a number of fields that hold the actual data items. To retrieve a particular record from the database, a user can specify a particular piece of information, called value, to be found in a particular field and expect the computer to retrieve the whole data record. This process is called making a query.

There are two kinds of database; the primary and secondary database. Primary or archived databases contain information and annotation of DNA and protein sequences, DNA and protein structures and DNA and protein expression profiles. Secondary or derived databases are so called because they contain the results of analysis on the primary resources including information on sequence patterns or motifs, variants and mutations and evolutionary relationships (Rao et al., 2008).

Although data retrieval is the main purpose of all databases, biological have a higher level of requirement, known as knowledge discovery, which refers to the identification of connections between pieces of information that were not known when the information was first entered (Xiong, 2009).

b) Software and Tools

Bioinformatics uses different software that range from simple command line tools to more complex graphical programs and stand alone web-services available from various bioinformatics companies or public institutions. BLAST (Basic Local Alignment Sequence Tool) is the one that is used for doing sequence alignment. It remains the fastest means by which to identify specific sequences in large datasets and enables the rapid annotation of novel sequences. Although BLAST is the standard tool for identifying sequence similarities in large datasets, there are several options for assembling sequence datasets, the choice

Global Journal of Science Frontier Research (D) Volume XVII Issue I Version I Year 2017

of which depends on hardware availability, dataset size, data format, structure and the genetic structure of the organism (Edwards and Batley, 2004).

VI. Dealing Data With Bioinformatics

Dealing data is an important aspect of Bioinformatics. Bioinformatics deals with the following important biological data:

a) DNA, RNA and Protein Sequences

The sequence of nucleotides in DNA or RNA, and the sequence of amino acids in a protein, can be obtained through laboratory sequencing methods.

b) Molecular Structures

Higher molecular structure can be obtained by combining thermodynamic data and computer modeling with measurements from laboratory techniques, such as x-ray diffraction and nuclear magnetic resonance imaging.

c) Expression Data

Scientists use microarrays in the laboratory to determine when and where genes are expressed. Such microarrays can also measure overall gene expressions in certain cell types, or in specific environmental conditions.

d) Bibliographic Data

The number of scientific articles has increased dramatically in the last few decades, due to the increasing number of research projects and genome sequencing programs.

VII. Uses of Data in Bioinformatics

The first step to making sense of all the biological sequences and structures is to formulate a method to manage the data, as well as how to process and maintain it. Data management is the first and most fundamental task of bioinformatics, and bioinform - aticians do this by assembling information into databases. A database is a collection of information stored in a systematic way. Bioinformatics database may consist of DNA sequences, RNA sequences, or even protein sequences. These sequences may be organized according to their function, or according to the species from which they came, or the journal articles which reported them first. A database may also contain journal articles and abstracts. With the data assembled, bioinformaticians can find means by which to mine, retrieve, and use the data. This is usually done through computer programs, which can search databases and retrieve information, depending on a scientist's needs.

Table 3: List of some published plant genome

Species Name	Size (~Mb)*	#of Chr**
Arabidopsis thaliana (mouse ear cress)	115	5
Bracypodium distachyon	355	5
Brassica rapa (Chinese cabbage)	284	10
Cajanus cajan(pigeonpea)	883	11
Carica papaya (papaya)	372	9
Cucumis sativus (cucumber)	203	-
Fragaria vesca(woodland strawberry)	240	7
Glycine max (soybean)	975	20
Medicago truncatula (barrel medic)	241	8
Malus × domestica(apple)	881.3	-
Oryza sativa (rice, japonica)	372	12
Panicum virgatum (switchgrass)	1,230	-
Populus trichocarpa (poplar)	422.9	19
Ricinus communis (castor bean)	400	-
Pinus taeda(loblolly pine)	22,180	27
Solanum tuberosum(potato)	800	12
Sorghum bicolor (sorghum)	730	10
Theobroma cacao(cacao)	346	-
Vitis vinifera (grapevine)	487	19

(Source: Agarwal R, Narayan J (2015) Unraveling the Impact of Bioinformatics and Omics in Agriculture. Int J Plant Biol Res 3(2): 1039)

VIII. Applications of Bioinformatics in Agriculture

Bioinformatics is widely applied in agricultural research. Since agricultural data are of different types and huge in collection, its interpretation is difficult; thus Bioinformatics play big role to analyze the data properly. Collection and storage of plant genetic resource and wisely application of bioinformatics help to produce stronger, more drought, disease and insect resistant crops and improve the quality of livestock making them healthier, more disease resistant and more productive.

a) Crops

Comparative genetics consists of the model and non-model plant. Species can reveal an organization of their genes with respect to each other which further use for transferring information from the model crop systems to other food crops. *Arabidopsis thaliana* (water cress) and *Oryza sativa* (rice) are examples of available complete plant genomes (Proost et al 2009).

b) Renewable Energy

Plant based biomass is one of the best resource for obtaining energy by converting it into biofuels such as ethanol which could be used to drive the vehicles and fly the planes. Biomass based crop species such as maize (corn), switch grass and lignocellulosic species like bagasse, and straw are widely used for biofuel production. We could detect sequence variants in biomass-based crop species to maximize biomass production and recalcitrance. Recently, genome of *eucalyptus grandis* has been released which is also one of major resource of biomass components and all the genes take part in conversion of sugars into biomass components have already been deciphered, therefore bioinformatics provides great insight into mechanisms and pathways responsible for this conversion so that in future we can enhance production of biomass components in eucalyptus and other relevant plants (Bisby et al 1993). Thus, the use of genomics and bioinformatics in combination with breeding would likely increase the capability of breeding crop species to be being used as biofuel feedstock and consequently keep increasing the use of renewable energy in modern society (Boyle et al 2004, Betz et al 2000).

c) Insect resistance

Bacillus thuringiensis genes control a number of serious pests that have been successfully transferred to cotton, maize and potatoes. These crops are known as Bt crops. This new ability of the plants to resist insect outbreak may reduce the amount of insecticides being used.

d) Improve Nutritional Quality

Scientists have recently succeeded in transferring genes into rice to increase levels of Vitamin A, iron and other micronutrients. Bioinformatic tool helped to produce such golden rice that can fight against vitamin A deficiencies. This work could have a profound impact in reducing occurrences of blindness and anemia caused by deficiencies in Vitamin A and iron respectively (Paine et al 2005). Scientists have inserted a gene from yeast into the tomato, and the result is a plant whose fruit stays longer on the vine (Fraser et al 2009).

e) Grow in Poorer Soils and Drought Resistant

Progress has been made in developing cereal varieties that have a greater tolerance for soil alkalinity, free aluminium and iron toxicities. These varieties allow agriculture to succeed in poorer soil areas, thus adding more land to the global production base. Research is in progress to produce crop varieties capable of tolerating reduced water conditions (Wang et al 2004). Data obtained from such intensive research are huge which are difficult to analyse by a single scientist. Bioinformatics help in a greater amount to solve such problems.

f) Plant Breeding

The goal of plant genomics is to understand the genetic and molecular basis of all biological processes in plants. This understanding is fundamental to allow efficient exploitation of plants as biological resources in the development of new cultivars with improved quality and reduced economic and environmental costs.

An omics data can now be envisioned as a highly important tool for plant improvement. The ability to examine gene expression allows us to understand how plants respond to and interact with the internal and external stimuli. These data may become crucial tool of future breeding decision management systems (Langridge 2011).

g) Agriculturally Important Microorganism

Bioinformatics helps to understand the genetic architecture of microorganism and pathogens to check how these microbes affect the host plant by using meta genomics and transcriptomics approach, so that we could generate pathogen resistant crop and would identify those microbes which are beneficial for host (Berg 2009, Schenk 2012).

h) Accelerate Crop Improvement in a Changing Climate

The change in climate and increase in population will increase pressure on our ability to produce sufficient food. The breeding of novel crops and the adaptation of current crops to the new environment are required to ensure continued food production. Advances in genomics offer the potential to accelerate the genomics based breeding of crop plants. However, relating genomic data to climate related agronomic traits for use in breeding remains a huge challenge, and one which will require coordination of diverse skills and expertise. Bioinformatics, when combined with genomics has the potential to help maintain food security in the face of climate change through the accelerated production of climate ready crops (Batley and Edwards 2016).

i) Bioinformatics in Plant Disease Management

Pathogen trait is considered as a primary interest of plant bioinformatics. The contribution of

Global Journal of Science Frontier Research (D) Volume XVII Issue I Version I Year 2017

bioinformatics advances made possible the mapping of the entire genomes of many organisms in just over a decade. The current efforts to determine gene and protein functions, have improved the ability to understand the root causes of plant diseases and find new cures. Furthermore, many future bioinformatics innovations will likely be spurred by the data and analysis demands of the life sciences. Bioinformatics have many practical applications in current plant disease management with respect to the study of host-pathogen interactions, understanding the disease genetics and pathogencity factor of a pathogen which ultimately help in designing best management options.

IX. Bioinformatics Impacts on Plant Science

Bioinformatics help to deal with the vast amount of data being generated by the genome sequencing projects. Powerful bioinformatics tools are needed to organize the data and to extend our ability to analyze these complex biological systems. Universally the development of bioinformatics is tightly linked with international collaboration in genome sequencing projects and the pharmaceutical industry in its drive for drug discovery and development. Although in infancy, bioinformatics is already well established. For example, for study of genome regulation and structure, bioinformatics covers many topics including: databases on regulatory sequences; the regulation of gene expression; analysis and recognition of genomic sequences; gene structure prediction; modeling of transcriptional and translational control; and large scale genome analysis. The integration of bioinformatics will influence plant science and lead to crop improvements in the following areas:

- The identification of important genes through genomics, expression analysis and functional genomics. In conjunction with the design and construction of transgenic plants this will allow new target genes to be identified that will improve quantitative and qualitative traits of commercially important crops.
- The design of agrochemicals based on an analysis of the components of signal perception and transduction pathways to select targets, and with cheminformatics, to identify potential compounds that can be used as herbicides, pesticides, or insecticides.
- The utilization of plant genetic resources to preserve genetic diversity in agricultural species. The need for taxonomic data goes far beyond the field of classical taxonomy, and a catalogue of all species, with phenotypic and genotypic attributes is required. The core taxonomic effort gives stability to the work of regulatory, management and conservation bodies. Efficient utilization of biological repositories of clones, cell lines, organisms and seeds. Typically, existing repositories are not linked to each other databases. The commercial databases and repositories are also part of the bioinformatics infrastructure but operate largely outside of the present day cooperative activities.

Table 4: List of small RNA databases and tools in plants

Database and Tools	URL	Purpose
Arabidopsis small RNA Project	http://asrp.danforthcenter.org/	Provide entry to small RNA data and resources from the Carrington laboratory
Arabidopsis small RNA database	http://mpss.udel.edu/at_sRNA/	Provide sequencing by synthesis based small RNA data
Cereal Small RNAs Database	http://sundarlab.ucdavis.edu/smrnas/	Platform for providing cereals small RNA data and tools for finding small RNAs and their targets
Plant Small RNA Target Analysis Server	http://plantgrn.noble .org/psRNATarget/	It will perform high throughput analysis of next generation data to give a putative list of miRNA and their target pairs
Plant mRNA database (PMRD)	http://bioinformatics.cau.edu.cn/PMRD/	PMRD integrates the available large information of plant mRNA data consisting of mrNA sequence and their target genes, secondary dimension structure, expression profiling, genome browser etc.
UEA snRNA Toolkit	http://srna.tools.cmp.uea.ac.uk/plant/cgi-bin/srna-tools.cgi	This site provide links to tools for the analysis of high through put small RNA data
miRNA Precusor candidates for Arabidopsis thaliana	http://sundarlab.ucdavis.edu/mirna/	It is collection of predicted miRNA and precursor candidates for the Arabidopsis genome predicted by “find MiRNA” method
PsRobot:Plant Small RNA Analysis Toolbox	http://omicslab.genetics.ac.cn/psRobot/	It can identify stem loop shaped smRNAs and their targets

PLncDB: Plant Long noncoding RNA Database	http://chualab.rockefeller.edu/gbrowse2/homepage	Repository of Arabidopsis long non coding RNA
MiSolRNA	http://misolrna.org/about	Provide tomato miRNA data
Phytophthora small RNA Database	http://phytophthora-smallrna-db.cgrb.oregonstste.edu/	Provide access to small RNA data of Phytophthora infestans and P. sojae
miRNA Tools2.0	http://sites.google.com/sites/mirnatools2.0	Provide list of tools to investigate miRNA and their regulatory action

(Source: Agarwal R, Narayan J (2015) Unraveling the Impact of Bioinformatics and Omics in Agriculture. Int J Plant Biol Res 3(2): 1039).

X. Recent Activities in Bioinformatics to Improve Plant Biotechnology

Knowing the complete sequence of a plant's genome can pave the way for all future studies of that organism. For instance, scientists at the United States Department of Agriculture's Agricultural Research Service (USDA-ARS) are now analyzing gene expression patterns in crops such as soybean and barley, in order to determine the function of genes involved in the resistance of plants to environmental stress (www.usda.com/ars). The International Rice Research Institute, Philippines, is working on the complete genome of rice. Brazilian scientists have already completed the gene sequence of *Xylella fastidiosa*, a plant pathogen that infects citrus plants.

Table 5: Examples of genomic databases related to crop improvement

Database Name	Web Link
autoSNPdb	http://autosnpdb.appliedbioinformatics.com.au/
Brachypodiumdatabase	http://www.brachypodium.org/
Brassica rapagenome database	http://brassicadb.org/
DNA Data Bank of Japan (DDBJ)	http://ddbj.sakura.ne.jp/
European bioinformatics institute, EnsEMBL plants	http://plants.ensembl.org/
European Molecular Biology Laboratory (EMBL) nucleotide sequence database	http://www.ebi.ac.uk/embl/
GenBank	http://www.ncbi.nlm.nih.gov/genbank/
Graingenes	http://wheat.pw.usda.gov/
Gramene	http://www.gramene.org/
International Crop Information System (ICIS)	http://www.icis.cgiar.org
International Nucleotide Sequence Database Collaboration (INSDC)	http://www.insdc.org/
Legume Information System (LIS)	http://www.comparative-legumes.org/
MaizeGDB	http://www.maizegdb.org/
Maize sequence database	http://www.maizesequence.org/
Oryzabase	http://www.shigen.nig.ac.jp/rice/oryzabase/
Panzea	http://www.panzea.org/
Phytozome	http://www.phytozome.net/
PlantsDB	http://mips.helmholtz muenchen.de/plant/genomes.jsp
PlantGDB	http://www.plantgdb.org/
The Plant Ontology	http://www.plantontology.org/
Plaza	http://bioinformatics.psb.ugent.be/plaza/
Rice Genome Annotation Project	http://rice.plantbiology.msu.edu/
SSR Primer	http://flora.acpfg.com.au/ssrprimer2/
SSR taxonomy tree	http://appliedbioinformatics.com.au/projects/ssrtaxonomy/php/
SOL Genomics Network (SGN)	http://solgenomics.net/

SoyBase	http://soybase.org/
TAGdb	http://flora.acpfg.com.au/tagdb/
The Crop Expressed Sequence Tag database, CR-EST	http://pgrc.ipk-gatersleben.de/cr-est/
The Triticeae Repeat Sequence Database (TREP)	http://wheat.pw.usda.gov/ITMI/Repeats/
Wheat genome information	http://www.wheatgenome.info

(Source: Lai Kaitao, MichałT. Lorenc and David Edwards (2012) Genomic Databases for Crop Improvement, Agronomy 2012, 2, 62-73; doi:10.3390/agronomy2010062)

The worldwide Potato Genome Sequencing Consortium, led by the Netherlands Genomics Initiative and the Wageningen University and Research Center is another example. Teams from countries such as Brazil, Chile, Russia, India, China, Peru, and New Zealand are working together to sequence all 840 million base pairs of DNA on potato's 12 chromosomes. All this data may be used by scientists to improve potato, which is the world's fourth most important crop. It can be used to design better plants. Once the genes responsible for certain plant traits are known, scientists can identify the basis for disease resistance and stress tolerance, and thus design methods by which plants can be made hardier and more resilient. Scientists also use bioinformatics to help them design plants with higher quality fruit, or with the ability to survive in extreme environmental conditions.

Australia's Queensland Agricultural Biotechnology Center is studying papaya, an important food crop in the tropics, where it is also used in the cosmetics and pharmaceutical industries. To identify the genes involved in papaya ripening, researchers looked at expressed sequence tags (EST) of the fruit's genome. ESTs are short DNA sequences of expressed genes which have been used as a tool for rapid gene discovery. Researchers were able to pinpoint genes that were highly expressed during the ripening process; once these genes are localized, scientists can produce better papayas which may ripen later, or taste better.

- It can be used to harness genetic diversity

By knowing which plants are closely related, scientists can figure out which sexually compatible species have desirable characteristics (such as longer stalks for rice plants, or larger grains for barley, corn, or wheat). The wild relatives of today's plants may be sources of crop improvement genes. Scientists at the University of Wisconsin, are seeking to improve potatoes by studying the genomes of wild potato species. Researchers at the Weizmann Institute in Israel, on the other hand, are working on understanding the process of gene exchange between crop plants and their wild ancestors, in order to use these processes to incorporate desirable genes from wild relatives into important crop plants.

- It can be used to design new tools to study gene function

Scientists first discovered micro-RNAs (mRNAs), a family of gene sequences in plants. These small RNA molecules control various aspects of plant growth and development. They target traits, DNA sequences, keep certain genes from being active. Mutations in miRNAs can cause faulty floral development, or even plant death. miRNA molecules can be designed to silence whole gene families. As a result, scientists are turning to miRNA technology to develop the next generation of plants. Several projects are now underway in the University of California, Riverside and the Whitehead Institute to predict and identify miRNA families in important crops such as rice.

- It can be used to test, analyze, and identify plants

With more and more microarray profiles online, scientists can learn about and exchange information concerning differences in gene expression. They can also test plants for differences in gene expression or protein profiles under different stress conditions, such as drought, disease, or insect infestation. If certain genes are expressed in high amounts during these stress conditions, then they may hold the key to a plant's survival under stress and they may be used to improve other plants that may not have the same gene. To test if GM plants are comparable to their conventional counterparts, scientists carry out protein or RNA profiling. In a recent research, scientists compared GM potato to conventional potato by analyzing the crops proteome, and found that there were no new proteins unique to individual GM lines. Scientists from the Danish Institute of Agricultural Sciences used microarrays, as well as analysis software, to compare gene expression profiles of transgenic and wild type wheat. They found that there were no significant differences in gene expression in the two wheat types.

XI. Selected Internet Resources for Plant Bioinformatics

1. Arabidopsis Genome Initiative (AGI) http://ge no me- www.stanford.edu/Arabidopsis/AGI
2. Arabidopsis Genome Data Analysis, Cold Spring Harbor Laboratory http://nucleus.cshl.org/protarab
3. Plant Genome and Information Center, USDA http://www.nal.usda.gov/pgdic
4. UK Crop Plant Bioinformatics Network http:// synteny.nott.ac.uk/agr/agr.html
5. The Institute for Genomic Research (TIGR) Database http://www.tigr.org

Global Journal of Science Frontier Research (D) Volume XVII Issue I Version I 20 Year 2017

6. Arabidopsis Genome Center at the University of Pennsylvania http://genome.bio.upenn.edu/ATGCUP.html
7. The Genome Sequencing Center of Washington University in St Louis http://genome.wustl.edu/gsc
8. Grain Genes Database http://wheat.pw.usda.gov Maize Genome Database http://www.agron.missouri.edu
9. ArabidopsisInternal Coding Exon Finder http://clio.cshl.org/genefinder/ARAB/arab.htm
10. NetPlantGene V2.0 Web Prediction Server http://www.cbs.dtu.dk/NetPlantGene.html

XII. Future Perspectives

With the increase of sequencing projects, bioinformatics continues to make considerable progress in biology by providing scientists with access to the genomic information. With cloud based service on internet, scientists are now able to freely access volumes of such biological information, which enables the advancement of scientific discoveries in agriculture. The field of biology has undergone several rounds of transformation in the approaches taken, ranging from theoretical to experimental perturbation to discovering molecular components. In the next decades to come, it is believed that we will take on another giant leap in bioinformatics field, where computational models of systems wide properties could serve as the basis for experimentation and discovery. The ramifications of this will be not only the precise understanding of how plant specified traits, to discover the causality of diseases, and to predict their responses to changes in the environment. This could lead to prevention and targeted treatment of diseases, improved food production, and preservation of the environment.

Some of the areas in agricultural bioinformatics that need focus would be are data curation and need for the use of restricted vocabularies. Editing scientific data is important for dissemination of information and therefore highly curated datasets need to be continuously developed through analysis by expert in the field and the results be provided for public use. There is a need for research communities to collaborate and share controlled vocabularies. The efforts of the plant ontology (PO) and gene ontology (GO) consortia would help in a uniform implementation of restricted vocabulary databases. Efforts are being carried out internationally to link existing related databases around the whole world (Kilian et al 1995). This will enable instantaneous transfer of knowledge and information on agriculturally related matters and practices. The linking of agricultural information resources would be helpful.

Being an interface between modern biology and informatics it involves discovery, development and implementation of computational algorithms and software tools that facilitate an understanding of the biological processes with the goal to serve primarily agriculture and healthcare sectors with several spinoffs (Jayaram and Dhingra, 2010). Bioinformatics is more of a tool than a discipline, the tools for analysis of biological data (Kumor, 2009).

XIII. Summaries

Bioinformatics is now playing a significant role in the development of the agricultural sector, agro-based industries, agricultural by-products utilization and better management of the environment. Genomics including sequencing of the model plant and plant pathogen genome has progressed rapidly and opened several opportunities for genetic improvement of crop plants. The high degree of synteny among diverse plant species, commonality in traits, the availability of expression and function information of sequences has enabled the discovery of many useful traits for crop improvement. Genome sequencing of several important plants species has enabled researchers to identify 'chromosome' and 'difference' factor in sequences. This in turn has been used to identify value traits for crop improvement. For instance, the barley stem rust resistance gene has been identified from rice-barley comparisons and the sugarcane rust resistance gene based on maize-sorghum comparisons. Comparative genomics along with bioinformatics could help in achieving improvement of yields in rice, maize, and other related grass crops such as barley, rye, sugarcane and wheat. The ability to represent high resolution physical and genetic maps of plants has been one of the great applications of bioinformatics tools.

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Adaptability Evaluation and Selection of Improved tef Varieties in Growing Areas of Southern Ethiopia

By Yasin Goa Chondie & Agedew Bekele
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Abstract- Eight tef varieties including local checks were evaluated with the objective of selecting adaptable, best performing varieties and to assess farmers' criteria for tef variety selection during 2008 and 2009 cropping season at Areka and Hossana stations of Areka Agricultural Research center in the Southern region of Ethiopia. In the study the Tef varieties namely Koye, Gimbichu, Quncho, Dega tef, Keytena, Amarach and Ajora-1 were collected from the Federal and regional Research center along with local checks, Ethiopia and Regional Agricultural Research Institute. These materials were put into trial at Areka Agricultural Research center station farms at Areka and Hossana of Wolayta and Hadiya Zones. The trial was laid out in a randomized complete block design with three replications. Each plot measured 3m x 3m with 1m between plots and 1.5m between blocks. Sowing was done within the last week of July to 1st week of August 2008 and 2009.

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Abstract- Eight tef varieties including local checks were evaluated with the objective of selecting adaptable, best performing varieties and to assess farmers' criteria for tef variety selection during 2008 and 2009 cropping season at Areka and Hossana stations of Areka Agricultural Research center in the Southern region of Ethiopia. In the study the Tef varieties namely Koye, Gimbichu, Quncho, Dega tef, Keytena, Amarach and Ajora-1 were collected from the Federal and regional Research center along with local checks, Ethiopia and Regional Agricultural Research Institute. These materials were put into trial at Areka Agricultural Research center station farms at Areka and Hossana of Wolayta and Hadiya Zones. The trial was laid out in a randomized complete block design with three replications. Each plot measured 3m x 3m with 1m between plots and 1.5m between blocks. Sowing was done within the last week of July to 1st week of August 2008 and 2009. Data on various characters, such as plant height, panicle length, days to heading, and days to maturity and grain yield. Data was subjected to analysis of variance and there was highly significant difference ($p<0.01$) among the varieties for grain yield and some of agronomic traits. The results for the trials indicated that there were significant yield differences between the local check and the released varieties at two stations. At Areka, the combined analysis of variance over years indicated that varieties Koye, Amarch and Quncho gave the highest grain yield viz., 988.7, 984.3 and 958.7 kg/ha respectively. Similarly at Hosanna, varieties Gimbichu, Quncho and koye out yielded other varieties and had yield advantage of 31.9, 25.14 and 15.14 % over local variety, respectively. Both combined across locations over year's analysis and farmers' assessments identified two varieties Quncho and Koye as potential varieties for wider production. This result also indicated that farmers were as capable as Researchers in varietal choice. Therefore, based on objectively measured traits (grain yield, days to maturity, plant height, panicle length, days to heading and farmers' preference, Koye and Quncho are recommended for wider cultivation in Areka and Hossana areas of south Ethiopia while varieties (Amarach and Gimbichu) showed specific adaptability for Areka and Hossana areas respectively.

I. Introduction

Tef [*Eragrostis tef* (Zucc.) Trotter] is an annual grass crop and important cereal harvested for grain in Ethiopia. Ethiopia is not only the origin of tef but it is also the center of diversity (Vavilov, 1951). Tef is adaptable to a wide range of ecological conditions in altitudes ranging from near sea level to 3000msl and even it can be grown in an environment unfavourable for most cereal, while the best performance occurs between 1100 and 2950 masl in Ethiopia (Hailu and Seyfu, 2000). In the country, cereals, pulses, oil crops, vegetables and root crops are grown annually on the average, 10 million hectares. Of these 7.6 million is allocated for cereals. Tef, the single dominant, occupies 2,404,674 hectares and the production is about 24,377,495 quintals annually (CSA, 2003).Tef flour is preferred in the production of enjera, a major food staple in Ethiopia. Tef is also grown on a limited basis for livestock forage in other parts of Africa, India, Australia and South America. In the U.S. small acreages of tef are grown for grain production and sold to Ethiopian restaurants (Carlson, Idaho) or utilized as a late planted livestock forage (Larson, Minnesota). According to Asrat and Frew (2001) Tef is primarily grown to prepare enjera, porridge and some native alcohols drinks. The straw is used for animal feed. In the 2001/2002 cropping season about 133 882.2 ha was covered by tef. The nutritional value of Tef grain is similar to the traditional cereals. Tef is considered to have an excellent amino acid composition, lysine levels higher than wheat or barley, and slightly less than rice or oats. Tef contains very little gluten. Tef is also higher in several minerals, particularly iron.

In Southern Nations, Nationalities and Peoples Regional State (SNNPR), the main tef producing zones in SNNPR are North Omo, Gurage, Hadiya, Kembata-Tembaro Alaba and kefico Shekicho (CSA, 2003). It is greatly valued by farmers and consumers. This crop is important crop for human consumption, source of cash and straw for animal feed and plastering compounds for construction purposes. Tef the most preferred crop because its straw quality for livestock feed, best 'enjera' quality, long seed storability, and drought resistance. The importance of Tef is based primarily on consumer preference for enjera (Ethiopian bread).Its agronomic versatility and reliability even under adverse conditions which suit it well to a country of contrasting and unpredictable environments where water logging, drought ,pest and disease are all too common and bring repeated famine also makes this crop very important. The regional average yield of tef is about 7.39q/ha in 200 1/2002(CSA, 2003) cropping season.

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The yields of tef are low in Ethiopia as well as in southern region due to different production problems including: lack of improved varieties, non adoption of improved technologies, disease and pests are some of the most serious production constraints in tef production in Ethiopia. Some varieties of tef were released by the different regional and federal research centers in Ethiopia; however, most of them were not evaluated around areas of southern Ethiopia and farmers were not participated in varietal improvement and testing process. Participation of farmers' in varietal choice has considerable value in technology evaluation and dissemination. Participatory varietal evaluation and selection is being conducted in some crops like common bean (Kornegay *et al.,* 1996) and barley (Fufa *et al*., 2010). According to Courtois *et al.* (2001) evaluated the effect of participation of farmers by comparing only the rankings of varieties by farmers and researchers at the same locations and reported a strong concordance between farmers and breeders in environments that have been producing contrasting plant phenotypic performance in rice. Two way feedbacks between farmers and researchers is indeed vital component of highly client-oriented breeding programs in locally important and traditionally cultivated crop (Getachew *et al*., 2008). Daniel *et al.* (2007) stated that farmers' selection criteria vary with environmental conditions, traits of interest, ease of cultural practice, processing, use and marketability of the product, ceremonial and religious values. Therefore, the objectives of this study were to evaluate and select improved tef varieties which are adaptable, high yielding and to assess farmers' criteria for variety selection with the participation of farmers in southern Ethiopia.

II. Materials and Methods

a) *Study Area*

The experiment was conducted at Areka Agricultural Research Farm of the Hosanna and Areka stations between end of July and August, 2008 and 2009. Hosanna is located at an altitude of 2290 masl ,latitude 07°5' N, longitude 37°5' E, temperature: 17.02°c , rainfall: 1500– 1800mm, soil type: Profondic Luvisols (Areka Meteorological Station, 2008). Similarly, Areka is located at an altitude of 1830masl, latitude 07°4'24'' N, longitude 37°41'30'' E, temperature: 20.3°c, rainfall: 1200– 1700mm, soil type: Haplic alisol (Areka Meteorological Station, 2008).

Eight tef varieties namely Koye, Gimbichu, Quncho, Dega tef, Keytena, Amarach and Ajora-1 varieties were collected from the Federal and regional Research center along with local checks, Ethiopia and Regional Agricultural Research Institute. These materials were put into trial at Areka Agricultural Research center station farms at Areka and Hossana of Wolayta and Hadiya Zones during Meher season of 2008-'09. The trial was laid out in a randomized complete block design with three replications. Unit plot size was 9 m^2 (3 m x 3 m) with spacing of 1 m between plots and 1.5m between blocks. Planting was done by broadcasting at seed rate of 30 kg/ ha. Sowing was done within the last week of July to 1st week of August 2008 and 2009. All other recommended agronomic practices were kept normal and uniform to ensure normal plant growth and development. Seed yield of each plot was recorded and then converted into kg/ha. Data on plant height, panicle length, days to heading, days to maturity and grain yield were collected and subject to statistical analysis using SAS statistical software (SAS,2002). The farmers used matrix ranking to assess the most suitable varieties for their areas. The characters scored included; plant height, straw yield, thresh ability, days to maturity, seed colour, lodging, shattering, biomass yield and grain yield.

III. Results and Discussions

The analysis of variance revealed that there were highly significant ($p<0.01$) difference among varieties for days to maturity, plant height and panicle length, days to heading and grain yield at Areka (Table 2). These results are further supported by Fentie *etal* (2012) who reported considerable variation in the days to maturity, plant height and panicle length, days to heading and grain yield of different tef varieties when planted over years .Koye gave the highest grain yield (988.7 kg/ha) followed by Amarach (984.7 kg/ha) and Quncho (958.7kg/ha) at Areka station (Table 2). Varieties koye, Amarach and Quncho had yield advantage of 15.9%, 15.4% and 12.4% over the local check respectively (Table 2).

At Hosanna station, the analysis of variance indicated that there were significant ($P<0.01$) difference among varieties for grain yield. This also agrees with the findings of Mathewos (2012) who evaluated 22 tef genotypes at four locations and reported that significant variations in grain yield of tef at all test locations. Similarly in this study there were significant ($P<0.01$) difference among varieties for days to maturity, plant height and panicle length, days to heading. These results are in contrast with the earlier findings Fentie etal 2012 who noted that the effect of the different varieties used over years didn't show significant difference for plant height and panicle length. Variety Gimbichu gave the highest grain yield (1656.1kg/ha) followed by Quncho (1571.3 kg/ha). Gimbichu and Quncho had yield advantage of 31.9% and 25.14% over the local check respectively. Gimbichu variety was found to be the earliest in maturity which was (99.5 days) at Hossana (Table 1). Grain yield was generally higher at Hossana than Areka, (1656.1kg/ha) and (988.7) respectively (Table 1&2).

The combined analysis of variance across locations over years among varieties revealed that there were significant difference for 50% days to heading and maturity, plant height, panicle length and grain yield. Varieties by year interaction indicated that there was highly significant ($p<0.01$) difference for panicle length and days to heading. However, significant difference was not observed in plant height, days to maturity and grain yield. Varieties Gimbichu and Quncho gave the highest grain yield (1343.4kg/ha) and (1318 kg/ha) respectively. Gimbichu gave the highest grain yield in both years and performed consistently over years at Hossana. In the combined analysis across locations over years, all farmers were consistently selected varieties koye and Quncho higher yielding and very white seed color whereas variety Amarach and Gimbichu gave higher yields than local checks are recommended for Areka and Hossnana areas specifically respectively. They also further argued that the high grain yielding potential of Quncho may be due its tallest plant height and bigger stem resisting relatively lodging compared to other improved varieties. Gimbichu and Quncho gave yield advantage of 21.9% and 19.6 % over the local check respectively. Gimbichu, keytena and Amarach varieties took (91.3), (95) and (95.3) days to mature respectively (Table 3).

Farmers group around the stations visited and evaluated the research demonstration field twice at stage of maturity and harvesting for varietal choice. Accordingly, farmers set selection criteria of grain yield, maturity period and seed color. Based on their selection criteria, farmers selected Gimbichu for grain yield and for its short maturity period and ease of thresh ability and Quncho for its high yield, very white seed color and tolerance to long rainfall. Therefore, based on quantitatively measured agronomic traits (grain yield, seed color, and lodging, threshability and maturity date) and farmers' visual observation at field, koye and Quncho are recommended for production in Areka and Hossana areas of south Ethiopia and similar agro ecologies. Whereas varieties Amarach and Gimbichu showed specific adaptation for Areka and Hossana areas; respectively are recommended with their full production packages.

IV. Conclusions and Recommendation

The combined analysis of variance revealed that varieties are significant for days to heading, maturity, panicle length, plant height and grain yield. Varieties Gimbichu, koye, Quncho and Amarach had a grain yield advantage of 21.9%, 15.4%,19.6% and 6.8% over the local check respectively (Table 3). Gimbichu was found to be the earliest maturing variety with higher grain yield. Farmers' main selection criteria were grain yield, biomass yield, straw yield, panicle length, lodging tolerance, thresh ability, maturity date and seed color. Based on their selection criteria, farmers selected Quncho for grain yield; biomass yield; straw yield, shattering resistance, tolerance to long rainfall and very white seed color, koye for grain yield and ease of thresh ability and white seed color. Gimbichu for its short maturity period and its higher grain yield for Hosanna areas and Amarach for its high yield, simplicity of threshability and very white seed color particularly to Areka areas. Therefore, based on researchers and farmers' preference, it was concluded that varieties Koye and Quncho are recommended for wider cultivation whereas varieties Gimbichu and Amarach are specifically recommended for Hosanna, Areka areas; respectively.

Table 1: Mean grain yield and agronomic data of tef varieties tested combined over years (2008 &2009) at Hossana

Varieties	PH	PL	DH	DM	GY(kg/ha)	% YA/L	Rank
Koye	74.5cd	30.2cd	46.5ab	104.8a	1445.7b	15.14	3
Gimbichu	72.6d	26.9d	41.8d	99.5c	1656.1a	31.9	1
Quncho	90.9a	38.7a	46.2ab	104.3a	1571.3ab	25.14	2
Degatef	78.9bcd	35.3ab	47.3a	104.8a	1258.7c		5
Keytena	71.1d	31bcd	45.2bc	102.5b	1240.6c		7
Amarach	85.3abc	33.2bc	43.2cd	102.8b	1259.3c		4
Ajora-1	87.03ab	34.9ab	46.2ab	105a	1045d		8
Local	81.4abcd	33.8bc	45.2bc	104.7a	1255.6c		6
Mean	80.24	32.99	45.2	103.4	1341.5		
CV (%)	11.75	11.98	3.96	1.1	9.83		
LSD (5%)	11.12	4.7	2.11	1.33	155.6		

Key: - GY=Grain yield (kg/ha, PH=plant height (cm), PL=Panicle length (cm), HD=Days to Heading, MD=Days to maturity & YA/L=-% yield advantage over local variety.

Table 2: Mean grain yield and agronomic data of tef varieties tested combined over years (2008 & 2009) at Areka

Varieties	PH	PL	DH	DM	GY(kg/ha)	% YA/L	Rank
Koye	78.1bc	29.8d	41.5a	89.8a	988.7a	15.9%	1
Gimbichu	79.3bc	27.6d	36.8e	83.2d	927.7ab		4
Quncho	95.2a	40.6a	38.5cd	87.8c	958.7a	12.4%	3
Degatef	85.7ab	37.8ab	39.8bc	89.5ab	790.7c		7
Keytena	73c	31.2cd	41.2ab	87.5c	781c		8
Amarach	92a	33.3cd	38.2de	87.8c	984.3a	15.4%	2
Ajora-1	96.5a	36.2abc	39.5cd	89.8a	795.7c		6
Local	79.5bc	30.03cd	39.98bc	88.5bc	853.3c		5
Mean	84.9	33.32	39.4	88	983.3		
CV (%)	11.75	15.92	3.57	1.2	7.49		
LSD (5%)	11.76	6.3	1.7	1.24	78.2		

Table 3: Mean grain yield and agronomic data of tef varieties tested across Areka & Hosanna combined over years (2008 & 2009)

Varieties	PH	PL	DH	DM	GY(kg/ha)	% YA/L	Rank
Koye	76.3cd	30d	44a	97.3a	1272.1a	15.4%	3rd
Gimbichu	75.95cd	27.3e	39.3e	91.3d	1343.4a	21.9%	1st
Quncho	93.1a	39.6a	42.3c	95.6c	1318.2a	19.6%	2nd
Degatef	82.4b	36.5b	43.6ab	97.2ab	1068.6c		6th
Keytena	72.05d	31.1d	43.2abc	95c	1054.2c		7th
Amarach	88.7a	32.3c	40.7d	95.3c	1176.5b	6.8%	4th
Ajora-1	91.8a	35.6b	42.8bc	97.4a	964.5d		8th
Local	80.4bc	31.9cd	42.5c	96.6b	1101.9bc		5th
Mean	82.6	33.2	42.3	95.7	1162.4		
CV (%)	8.8	7.9	2.4	0.93	9.24		
LSD (5%)	6.03	2.2	0.84	0.74	89.29		

Key: - GY=Grain yield (kg/ha,, PH=plant height (cm), PL=Panicle length (cm),HD=Days to heading ,MD=Days to maturity & YA/L=-% yield advantage over local variety

Table 4: Matrix ranking of tef varieties at Areka and Hossana stations over years (2008 and 2009)

Tef varieties in 2008 & 2009		Selection Criteria's									
Areka	GY	MD	BY	SY	SC	TS	LG	SH	PH	Total	Over all Rank
Koye	3	2	2	2	2	3	1	2	2	19	**3rd**
Gimbichu	3	3	2	2	2	3	1	2	2	20	**4th**
Quncho	3	2	3	2	3	2	2	2	2	21	**2nd**
Degatef	1	2	2	2	2	2	2	2	2	17	**6th**
Keytena	1	2	1	2	1	3	2	2	1	15	**8th**
Amarach	3	2	2	3	2	3	3	3	3	24	**1st**
Ajora-1	1	2	1	2	2	3	2	2	3	18	**5th**
Local	1	2	1	2	2	3	2	1	2	16	**7th**
Hossana											
Koye	3	2	2	3	2	3	1	2	2	20	3rd
Gimbichu	3	3	2	3	2	3	1	2	3	22	2nd
Quncho	3	2	3	3	3	2	3	2	1	23	1st
Degatef	2	2	1	2	2	2	3	2	2	18	5th
Keytena	1	2	2	2	1	3	2	2	2	17	6th
Amarach	3	2	2	2	2	3	2	2	1	19	4th
Ajora-1	2	2	1	2	2	2	2	2	1	16	7th
Local	1	2	2	2	1	3	2	1	1	15	8th

Key: Key: GY=Grain yield, BY=Biomass yield, SY=Straw yield, SC=seed color, TS=Thresh ability MD=Days to maturity, SH=Shattering tolerance & LG= Lodging tolerance, Preference scale 0-3, 0= Poor 1 = fair 2 = Good 3 = Very good

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Problematics of Land Ownership and Rural Development in Madagascar: Anthropo-Legal Dimensions to Land-Environment Relationships

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Introduction- Due to its insularity, Madagascar possesses a wealth in heritage and in natural resources that explained themselves by a high rate of endemic biodiversity. Such an observation, related by several works on Madagascar, translates indeed the disposal of a large biologic diversity (RAZAFIARIJAONA, 2007). Wild species related to cultivated plants make up a genetic potential that can be used to develop and diversify the production of staple foods and that of other industrial plantations, and as such insure regional and national food security. In fact, for Madagascar, food plant species such as wild rices, sorghum, grapevine, tubers, fruit plants, spices, or commercial plants (vanilla and coffee) have been identified.Besides, other species such as fiber plants, tropical noble woods, medicinal plants, or aromatic plants of which plant genetic resource preservation would allow opportunities of high value-added transactions by agribusiness operations.

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PROBLEMATICSOFLANDOWNERSHIPANDRURALDEVELOPMENTINMADAGASCARANTHROPOLEGALDIMENSIONSTOLANDENVIRONMENTRELATIONSHIPS

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Jules Razafiarijaona

I. Introduction

Due to its insularity, Madagascar possesses a wealth in heritage and in natural resources that explained themselves by a high rate of endemic biodiversity. Such an observation, related by several works on Madagascar, translates indeed the disposal of a large biologic diversity (RAZAFIARIJAONA, 2007). Wild species related to cultivated plants make up a genetic potential that can be used to develop and diversify the production of staple foods and that of other industrial plantations, and as such insure regional and national food security. In fact, for Madagascar, food plant species such as wild rices, sorghum, grapevine, tubers, fruit plants, spices, or commercial plants (vanilla and coffee) have been identified.Besides, other species such as fiber plants, tropical noble woods, medicinal plants, or aromatic plants of which plant genetic resource preservation would allow opportunities of high value-added transactions by agribusiness operations.

The main part of this biological diversity is associated with the mountainous ecosystems and also with the spontaneous swampy state of the Eastern, the Western, the Northern and the Southernregions of Madagascar (0NE, 2000). Moreover, due to the imperious necessity to promote andensure food security to local population, the creation ofeconomical and financial value chains must constituteone of the rural development policy's main axes of orientations.

A justification of integrated public policies on an institutional level is thus necessary to establish the natural resource conservation measures, including that of plant genetic resources for the purpose of economic rationality in their use and their enhancement.

The current general policy orientation on the matter of decentralization is required to assess and characterize the plant genetic resources, in phase and in tight relation with Madagascar agro ecological zones, in order to establish an efficient operational natural resource governance necessary to agricultural production activities. The objective of the present article can only take notably into account the integrational aspect and size of environment conservation programs and of agricultural biodiversity valorization programs especially that of food plant species conservation and valorization.

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II. Problematic

The fundamental issue that deserves to be addressed is the question of how to proceed to transform the right to possess into ausufructuary rightconcerning natural resources management. Therefore, since the natural resource management must take place by a transfer of contractualized management, the approach will have to comply with the principles of the rights of use and exploitation based upon the control of the ecological and technical aspects of environmental management. This assumes consistency between the anthropo-legal principles specific to each region or locality and the socio-organizational principles specific to management, space and resources.

It is self explanatory whenmoreover local varieties of wild or spontaneous plants related to the cultivated plants could open up new opportunities for the revival of regional production of staple foods and agro-industrial plants. Plant genetic resource exploitationis bound intimately with the way of accessing to space and to natural resources in the sense that free access may only constitute a way to their deterioration by irrational and abusive agricultural practices for the purpose of a survival economy and/or illicit low value added commerce.

Paradoxically to this situation, the current export policy based upon a system tributary to the world trade and its product standards imposed by the international market, could contribute to the accentuation of the depreciation of the non inventoried, non collected and non protected local wild varieties. The legalization of this situation must consist in legalizing the ecosystem elements of biologicalrepresentativeness threatenedby disappearance, for the purpose of ex situ and in situ conservation, and to integrate them intoseed technology process in order to transform them into strain materials of effective varieties. However, accompanying measures must be put in place to identify comparative advantages and, especiallythe tangible economic and financial returns expected for various users.

A number of gaps or even legal contradictions characterize the use of the plant genetic resources in Madagascar insofar as the rural development policy instituted by decree doesnot take into consideration the identified spontaneous species for the benefit of agricultural revival, opposite to the decree about plant genetic resource management strategy; used species are based solely on introduced varieties, acclimated and collected in order to encourage farming diversification oriented towardexport whereas, spontaneous species presenting strong agricultural potential exist but they are subject to devastating human pressures.

III. Overall Objective

It is understood that the wild species related to cultivated plants represent a plant genetic heritage that requires a protection either on the matter of biological ecosystem representativeness or in term of service ecosystems due to their economical and social potential; the main objective consists in the development of a public policy framework appropriate for this imperative need for resource and genetic material protection while privileging integration aspects of conservation with the valorization.

IV. Approach Methodology

Natural resource governance requires consistency within the texts pertaining to the principles and mechanisms of decentralization as for the implementation of their local governance in relation to their access, conservation, use and exchange; implementing this decentralized governance is imperative and constitute an ultimate opportunity to be able to coordinate and to articulate initiated programs decided by the central authorities and their decentralized services with those of the decentralized collectivities especially at region levels that became henceforth the hinges in terms of local development structures.

In other words, it is in this sense to implement an integrated approach for the management of the access, conservation, use and exchange of plantgenetic resources as well as to implement that of prospection, collection, characterization to promote the obtaining of a local variety from these spontaneous species and their seed multiplication while conforming to the agro ecological, anthropo-nutritional and anthropo-cultural specificities.

This approach would likely insure food security and agribusiness supply. However, the role of the state must be maintained in the perspective that it would be the latter's duty to set in structuring investments related to land ownership, agricultural credit and taxation system in order to be both inciting and deterrent in rural areas so as to encourage and secure private sector productive investments on the matter either of conservation or valorization of the spontaneous species as real economical constituting elements of biodiversity.

This integrated approach would contribute, to this effect, to the setting of relationship between the various parametric aspects that characterize natural resource management, meaning legally, institutionally, socio-organizationally, economically, financially, technically, socially and anthropologically its strengths and weaknesses. The natural resource management, considered to bea local and ruralsustainable development basis mustbe conceived considering following aspects:

- thespace-resource relationships,
- the land-environment relationships,
- thecontrol of land-environment relations,
- the economical value scale,
- thetechnical expertise transfer.

V. Results and Discussions

a) Onnatural ecosystem multifunctionality

The polysectorial sizing of natural resource management explains the ecosystem multiplefunc - tionality, main object of natural resource governance. Besides, it facilitates the articulation, the setting in synergy and in consistency of the different development programs: natural resource management can only be local because of ecological diversity and resourcesc - arcity; its sustainability can only be perpetuated by its ability to coexist with the various economic actions, interventions and operations. The ecobiological value management of a region has to be bound to the economic valorization of local agricultural sectors. The natural ecosystem diversity, including soil, water, fauna and flora, that constitute the basis of an agro-ecology, allowsthe undertaking ofan inventory of activities that are most likely to motivate the local population and make them accountable for the natural resource management actions and exploitation.

It is about considering it within the frame of a set of conceptual elements, such as the space-resource concept and the land-environment concept (BARRIERE, 1997),in order to streamline the land-environment control performed by local population. These different concepts must set up the basic principles of a local natural resource management. They are used to proceed to the legalization of humane cultural characters toward the institutional characterizations that the local development requires.

i. *The space-resource relationships*

Since every space is characterized by linked typical resources, the accession or exploitation systems of these particular resources are intrinsicallylinked with the proper way of space occupation, specific to every region.

Therefore, the management of natural resources that are owned in community and heritage must take into account not only these resources but also of the space that support them.

Otherwise, this notion of space is conceived by taking into account the fact that the practice of the exploitation rights are legally foreign to it, that means that it has to be conceived on the basis of a territorial approach in order to apprehend the region or the localityspecific biotic and abiotic elements.

ii. *The land-environment relationships*

The land-environment concept invokes the matter of relationships between local communities and the space, and those between manned space and natural ecosystems and biodiversity.

Consideration of the land aspect resizes the environmental aspect in a sense of technical, economical and anthropo-legal streamlining of the space andnatural resources multiple functionality, while allowing the reduction or the attenuation of the latter scarcity.

However, the rural area predominating system of occupation and exploitation is the one based on the practice of the ownership right and not on the usufructuaryright.

It requires a clarification between the customary and the modern land right: the first is based on the consideration of the space-resource as a common heritage of the local community, the second as the state or local public authority heritage.

iii. *The land-environment controls*

The natural resource management transfer cannot then be separated from the land management transfer due to their intrinsic character in this sense that access to space-resource translates the way land is occupied, and requires a zoning mechanism that distinguishes areas of high biodiversity from developable and recoverable areas. In short, the land-environment controlssum up to:

- the exploitation right legal recognition, depending on the nature of the needs and on local specificities, as much on the temporal level as on the spatial,
- the sense of integration between the ecosystem conservatory measures and the imperatives of economic development.

Therefore, natural resource management must prevail on a spatial management based on constraints and threats as well as on opportunities, and not only on demand, to assure a viable and sustainable management transfer.

b) The economic valuation scale

Viable and sustainable natural resource management requires structuring and scale relationship. The structuring consists in a stratification of the ways or systems of land occupation and access to resources.

The scale relationship focuses on the overlay, interference and the systemic links among these types of space and resource usage, enjoyment and disposition as mentioned above. The economic valuation scale results from the environment-land control concept. The local communities neighboring the spaces and resources must find their account in the process of management transfer. It is about starting from a non conventional approach taking into account the local and endogenous particular elements and articulate them with the exogenous variables capable to bringing internal comparative advantages for the contracting communities. In other words, the management process must be set based on:

- an analysis of the minimum, acceptable thresholdeither on legal, economic, social or cultural levels,
- an effect of scales in order to combine and to put in consistency conservation with development.

c) The integrated approach

For long term viable natural resource management, it is a process about ensuring a rational and optimal exploitation for the benefit of the basic local communities according to an environmental heritage approach. The basic local communities have to take advantage of these resources development exclusive rights within the frame of a negotiated and contractualized operating mode. The operation and management negotiating and contracting require:

- a zoning delimiting the conservation spaces in relation to those intended to productive activities,
- and an inventory of some species of resources likely to be exclusively for their use, enjoyment and disposal.

Such an approach is presumed to define in an integrated manner the biological representativeness ecosystems and the service or valuation ecosystems. This implies the necessity to reframe the management transfer within a development planning that takes into account land security processes such as very long term lease, concession, and administrative authorization by license, land endowment to local communities, and the development of high value-added sectors.

i. *The environmental approach*

The heritage theory is the biodiversity sustainable management conceptual foundation. It constitutes the environmental approach explanatory concept that focuses on the question of knowing the opportunities of coviabilization between biodiversity conservation and channel valorization through the triangular relationship between environment, land and local population. The patrimonial right allows the knowledge of land ecology set up parameters and, compared to the right to property, it is a set made up on one hand of goods, holdings and rights, and on the other hand, of liabilities, duties and debts. The latter might be acquired, transferred, dismembered or remodeled. This concept of property right introduces another concept related to an ecological taxation system that deserves a particular approach as for the space - resource legal status.

[1]The approach is explained by the value formation process[1] taking into consideration the integration among the various economic values in order to recover conservation measureinduced comparative advantages. It reflects the economic values of the ecosystem ecological functions within the setting of the transformation process of representativeness ecosystemsintoservice ecosystems. The analysis approach focuses on the correlation between the ecosystemeconomic values basedupon their ecological multiple functionality and the income they provide the local populations.

ii. *The social approach*

The social approach consists in identifying the social relationship between the various social formation representative components and the site public and private entities subject to conservation measures. It is about identifying, and later on, analyzing the human cultural and socio-organizational dimensions with strong customary legal characterization connected to situations of land occupation, of access to natural resources, of production processes, and of governance mode of local businesses. Since the individual is a social being with a social conscience, he calculates hisprofits and his possible losses while adopting a maximizing strategic rationality (BILLAUDOT, 2004) in relation to space and natural resource utility according to hislogic; he aims at the same time to get socioeconomic returns and uses to this end a procedural rationality (SIMON, 1997) in order to be able to coordinate his actions. However, he endeavors to insert them within a contextual or social rationality relative to identity and cultural values for the purpose of implementing power relationships and behaviorstandards.

iii. *The economic approach*

The economic approach is essentially about the survey of the cost and local comparative advantageparameters of the various speculations and about the analysis of the component variables of ecosystem and agricultural product total economic values. The promotion of agricultural sectors in relation to ecosystem conservation requires the sustainability of their economic values; it imposes a social regulation (REYNAUD, 1987) between the exploitation regime, the accumulation regime and the working regime. This requires a regulation between the institutional forms of production, accumulation and exchanges, according to a structural-functional process of the various local actors. Keynes theory recommends an approach on the relationship between investment and savings, and its meaningful expression states that the environment quality[2]depends on the impact of the use of the investment allowance to agricultural and environmental programs in such a way that there is an integrated approach.

At the level of the environment quality, opportunity costs are enormous, and translateinto a transformation process ofoption values, bequest and existence in direct and indirect usage value. Consumption propensity is high compared to the drive to invest or to save; usage value formation is achieved through strong attacks onto ecological values such as:

$$VET - (VO+VL+Ve) = VUD + VUI$$

Whereas due to local savings and local investment weaknesses (RAMANANARIVO R, 2004), meaning that savings (S) and investments (I) of the households are lower thantheir income, the needs in investments increase; because of lackof structuring meansproviding them with some capabilities, the protected areas or community management site resident populations cannot help cutting into the ability margin of the ecosystem exploitation. Moreover, Central and regional administration weaknessesin investment ability are noted in spite of the local need in various input constant increase of as it is explained by need roll up calculations. Economic and financial value formation[3] can only be done by anthropic actions that create new positive opportunity costs as much for the ecoregionenvironment as for the agricultural productivity. Opportunity cost increases, due to ecosystem deteriorations and to lack of agricultural infrastructures, generate negative externalities because of resourcescarcity; this explains why the ecosystem

[1] The total economic value of the ecosystems or VET (MEYERS D, 2003) is the sum of direct, indirect usage, option, bequest and existence values

[2] With $Y<0$, the renunciation to valorize the ecosystems can only generate positive opportunity costs, that means that the cut on local income is a lot stronger while preserving natural resources to the detriment of resident population. The reason is that there are no alternativestoconservation measures.
With $Y>0$, the renunciation to valorize the ecosystems may entail to some negative opportunity costs insofar as some comparative advantages are a lot much cleaner for the environment and for the local population. The reason is some that some alternatives exist in relation to conservation measures.

[3] The CHENERY and STROUT model (FONTAINE, J. M., 1994)adoption finds its justificationin sustaining the biodiversity conservation and valorization policies by structuring investments to the level of the Corridor. The double unbalancedmacroeconomic result has for consequence, on the matter of agricultural, environmental and a failurein their interrelationships and interactions, and leadingto low productivity and thuslow income for the rural populations.

natural production is lower than human consumption[4]. It would be imperative to orient the agricultural production system toward the market in order to allow local population accumulation, savings and productive investment.

VI. Conclusion

[2]The natural resource management transfer cannot be separated from land management transfer. It requires a zoning mechanism distinguishing betweenhigh biodiversity areas from developable and recoverable areas. The land-environment relationship must be distributed and managed according to the rights of use, of exploitation, of exclusivity, and of protection.

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[4] While considering the ecosystem natural growth function (DUVIGNEAU, 1980), through the behavioral equation expressing the relation between the ecosystem natural production and the resource human consumption: $F = | P-C |$; P represents the natural production and C the human consumption. Interpretation of this relationship in the forest Corridorcase shows that it results in some environmental opportunity costs if $P < C$, and on the contrary, conservation would be sustained if $P > C$. In order to support the double deficit features, International aid should be taken intoconsideration as investment leverage for the rural sector in order to sustain environment protection and productive infrastructure financing; these facts underlie biodiversity conservation measures.

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Participatory Approaches for Varietal Improvement, It's Significances and Challenges in Ethiopia and Some other Countries: A Review

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Abstract- Participatory approaches such as participatory plant breeding (PPB) and participatory varietal selection (PVS) have become a motivating force for agricultural research and rural development. These approaches have been developed over the past decades as an alternative to centralised breeding methods designed to better incorporate the perspective of end users into the varietal development process to efficiently address the desires of the farmers for increasing food security and improving livelihoods of farmers, especially in resource poor areas. In search of this concept, this review paper discusses the concepts, advantages, experiences, impact and challenges in these participatory approaches stressing the existing evidence of success by various authorities from different countries. In PPB, farmers are actively involved in the breeding process, from setting goals to selecting variable, early generation material. In PVS, farmers are given a wide range of new cultivars to test for themselves in their own fields.

Keywords: *participatory, PVS, PPB, farmers, improved varieties.*

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PARTICIPATORYAPPROACHESFORVARIETALIMPROVEMENTITSSIGNIFICANCESANDCHALLENGESINETHIOPIAANDSOMEOTHERCOUNTRIESAREVIEW

Strictly as per the compliance and regulations of :

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Yasin Goa [α] & Mathewos Ashamo [σ]

Abstract- Participatory approaches such as participatory plant breeding (PPB) and participatory varietal selection (PVS) have become a motivating force for agricultural research and rural development. These approaches have been developed over the past decades as an alternative to centralised breeding methods designed to better incorporate the perspective of end users into the varietal development process to efficiently address the desires of the farmers for increasing food security and improving livelihoods of farmers, especially in resource poor areas. In search of this concept, this review paper discusses the concepts, advantages, experiences, impact and challenges in these participatory approaches stressing the existing evidence of success by various authorities from different countries. In PPB, farmers are actively involved in the breeding process, from setting goals to selecting variable, early generation material. In PVS, farmers are given a wide range of new cultivars to test for themselves in their own fields. In some of the crops the genotypes selected by the breeder and farmers were almost similar but some differences existed. Since participatory approaches include research and extension methods to deploy genetic materials at on farm experiment so that the variety developed through PPB and PVS remarkably increased varietal diversity that can meet demand of different stakeholders. It could be concluded that, the benefits of participatory research approach includes development of farmers' ownership of new technologies being tested and transferred; increasing degree of farmers' awareness, increase varietal diversity and mobilization of farmers' indigenous knowledge available within local communities for research and development planning and empowerment. Various authors' indicated that participatory approach is a dominant way to involve farmers for selecting and testing new cultivars that are adapted to their needs, systems and environments. Therefore, for sustainable development and benefit specific to the needs and conditions of farmers, proper implementation of participatory approach in research and development programs is decisive particularly for small scale and resource poor farmers.

Keywords: participatory, PVS, PPB, farmers, improved varieties.

I. Introduction

Development of a sustainable production system suitable for diverse ecological, social and economic environments has been one of the biggest challenges facing agricultural research, especially in developing countries. The increase in population and subsequent rise in the demand for agricultural products are expected to be greater in regions where the production is already insufficient, particularly in developing country. Agricultural technologies improvement plays an important role in the development and strengthening of local agricultural systems. Growth in agriculture is fundamental or backbone to the overall economic growth because of the large share of agriculture in the Ethiopian economy.(Yazie Chanie, 2015). Currently, to achieve the planned goal for agricultural growth programme phase-2 (AGP-II) the government of Ethiopia designed an approach; community level participatory planning (CLPP) to make the Research and development activities demand driven and problem solving. The Ethiopian government also devotes considerable resources to research and extension in view of encouraging small-scale farmers to increase their productivity and to enable them achieves food self-sufficiency. In this regard, several improved crop technologies (improved crop varieties, agronomic practices, pre and post-harvest technologies) have been introduced, evaluated and made ready for users through the agricultural research system but some of them have failed to find their way into the smallholder farming systems probably because they were not adapted to the smallholder farmer's needs and production environment. Moreover, not all the released and high yielding varieties were equally accepted by farmers due to differences in farmers' preference for the varieties in different localities. This was because the varieties were developed through conventional breeding that didn't consider farmers' criteria. As stated by Gemechu *et al.* (2004), the rate of adoption of most of the varieties developed by the conventional breeding approach is believed to be far below expectations. Most breeding experiments suffer from the disadvantage that the major stakeholders are not involved in the selection and development of the varieties. This scenario leads to poor adoption and diffusion of the resulting technologies (Osiru et al., 2010). Hence there is need to involve farmers who are the beneficiaries of improved agricultural technology.

Today involvement of farmers' in research and development activities are fundamental. Participatory

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processes such as PVS and PPB grew out of what is seen as inappropriate varieties, practices or extension that did not fit local environmental conditions and specific social needs (Cromwell et al., 2003). So as an alternative to centralized breeding, farmer participatory approaches using participatory varietal selection and participatory plant breeding can be used. PPB is an extension of PVS. In PPB, farmers are actively involved in the breeding process, from setting goals to selecting variable, early generation material. In PPB programs, the results of PVS were exploited by using identified cultivars as parents of crosses. PVS is meant to involve farmers in the planning, execution, monitoring, assessment and promotion of new and old crop varieties (Ortiz-Ferrara et al., 2007). In PVS, farmers are given a wide range of new cultivars to test for themselves in their own fields leading to enhance on-farm varietal diversity (Joshi et al., 1997; Sangay and Mahesh, 2010), and improve seed diffusion (Dorward et al., 2007). More critically, PVS and other participatory approaches especially those that are community- driven should be tools for learning and empowerment (CIAT, 2006; FAO, 2008).

Participatory variety selection is broadly defined as a range of approaches that involve a mix of actors (including scientists, breeders, farmers and other stakeholders) in plant breeding stages (Fekadu,2013). Because the objective is to produce varieties, which are adapted not only to the physical but also to the socio-economic environment in which they are utilized. According to Ashby (2009), the outcome of PVS is that more farmers adopt PVS varieties over wider areas, leading to increased food and income benefits. Witcombe et al. 1996 suggested that participatory Varietal Selection (PVS) can be used to identify acceptable new varieties and thereby overcoming the constraints that cause farmers to grow landraces or obsolete cultivars. Farmers' participation in the variety selection in their production environments ensures acceptance and eventual adoption of common bean varieties (Fekadu, 2013), maize (Daniel etal.2014, De Groote et al. 2002), bread wheat (Asaye et al., 2014), soybean (Adissu etal.2016), rice (Joshi and Witcombe, 1996) and Faba bean (Tafere etal.2012). Participatory varietal selection in Research and development project in Ethiopia and other countries showed that the maize, common bean, soybean, bread wheat, faba bean, rice varieties were highly preferred by farmers. Hence, the participatory variety selection has also been used successfully in various countries to identify different varieties and these varieties are also spreading within and outside the PVS study areas. PVS has been reported as an efficient approach for disseminating new improved varieties (Joshi and Witcombe 1996; Ortiz-Ferrara et al., 2007; Thapa et al. 2009; Witcombe et al. 2003). It is capable of better addressing farmers' needs of new varieties that very often are not recognized using conventional non-participatory varietal development approach.

Depending on who controls the breeding process (researchers or farmers) and the scale on which the work is undertaken (community-centred or research to extrapolate results) two broad categories are usually differentiated: 'farmer-led' and 'formal-led' PPB. The success of this, and other, PVS programmes in identifying preferred varieties is not reviewed and well documented. It is less well understood how improved varieties selected through participatory variety selection. Therefore, this work would give emphasis for overview of participatory agricultural research experience and its concepts, impacts, significance as well as key challenges. It would help to inform main actors i.e. agricultural research institutes, ministry of agriculture, agricultural universities and non-governmental organizations (NGOs) working in the area to see and revise their method of acting towards farmers interests and incorporate farmers' needs at the grass-root level in to their development plans.

Therefore the general objective of this seminar work is to review participatory agricultural research experiences, findings of participatory selection (PVS) research data emphasizing Ethiopia, PPB approach and its importance as well as key challenges

II. Some Definitions of Participation and Participatory Approaches

Participation: may be hard to give a single definition of participation as the practice and assumption or theories differ considerably (Lilja and Ashby, 1999 cited in Yazie Chanie, 2015). World Bank (2007) defined participation as the process through which stakeholders' influence and share control over priority setting, policy-making, resource allocations and access to public goods and services. It implies "empowering people to mobilize their own capacities, be social actors, rather than passive subjects, manage the resources, make decisions, and control the activities that affect their lives."(Cernia, 1985). Participation can be any 'voluntary or other forms of contributions by rural people to pre-determined programs or project' like participation in a survey, serving as key informant, or participation in an experiment which is researcher-managed trials. The organized efforts to increase control over resources and regulative institutions in given social situations on the part of groups and movements hitherto excluded from such control. (Pearse and Stiefel, 1979). Hence, participation for this deskwork purpose is "any voluntary cooperation or collaboration and contributions of farm households to any research and development programs or projects".

Participatory: The term participatory development has been defined as involving users and communities in all stages of the development process (Narayan, 1993).

Degrees of participation: degree of participation may vary according to nature of research topic, level of researchers' facilitation skills, experience of farmers in on-farm trial and level of mutual trust between researchers and farmers. The level of participation is often described by a scale as researcher managed, consultative, collaborative and farmer managed.

Participatory plant breeding: is the process by which farmers are routinely involved in a plant breeding programme with opportunities to make decisions throughout. Farmers' involvement in PPB can take many forms : defining breeding goals and priorities; selecting or providing sources of germplasm; hosting trials on their land; selecting lines for further crossing; discussing results with the scientists; planning for the following year's activities; suggesting methodological changes; and multiplying and commercializing the seed of the selected lines(Halewood et al. 2007).

Participatory variety selection (PVS): refers to processes whereby farmers are involved in selecting lines that they judge to be most appropriate for their own uses from among a range of fixed (stable) lines that are being field tested. PPB generally involves a higher and more complex degree of involvement of farmers, as they are engaged in decision-making in earlier and more fundamental stages of the variety development chain; PPB therefore has a higher empowerment effect than PVS (Witcombe 2005).

III. Types of Participatory Plant Breeding

Participatory plant breeding can be consultative and collaborative. The approach used will depend on the crop and the availability of resources.

Consultative: Farmers are consulted at every stage for example, in setting the breeding objectives, choosing the appropriate parent, and by making joint selections with breeders from material grown by breeders. Hence, until there is a finished product from the breeding programme for farmers to test in PVS trials, farmers are not involved in growing material in their fields.

Collaborative: Farmers grow the variable participatory plant breeding material in their own fields and select the best plants from it. Scientists can then obtain seed from farmers to test their selections in research station and participatory trials. It was used when no existing cultivars are identified that are suitable for testing in a PVS programme and when PVS has been tried but has failed to identify any varieties that farmers prefer. In addition to make crosses the participatory variety selection can be efficiently followed by participatory plant breeding since farmer preferred cultivars are the ideal parents for Participatory plant breeding programmes. Examples are PVS cultivar x high-yielding variety, local landrace x PVS cultivar and local landrace x high-yielding variety.

IV. Benefits of Participatory Approaches

a) *Participatory plant breeding*

Participatory plant breeding methods offer a number of potential reward compared to the traditional global approach to plant breeding.

Cost-efficiencies and effectiveness: fewer research dead-ends, more opportunities for cost sharing in research and less expensive means of diffusing varieties.

Effective meeting of user needs higher degree of farmer satisfaction, broader range of users reached, including marginal farmers and promotion of group learning through farm walks.

There is often a trade off between yield and early maturity. An early variety escapes common end of season droughts, and produces a harvest at the hungriest time of the year, before other crops mature. It also reaches the market first, so its grain fetches a higher price (Witcombe, J.R. 1998)

Biodiversity enhancement: communities have wider access to germplasm, wider access to related knowledge and increased inter- and intra varietal diversity.

Production gains: yield and stability increases, faster uptake, wider diffusion and higher market value of products.

b) *Participatory variety selection*

In conventional breeding and testing programs, on-farm trials are conducted as the final step (variety verification) in a long selection process that may involve many replicated trials conducted on research stations. Researchers usually manage conventional on-farm trials. These trials are good for measuring agronomic traits, but they often do not include a step where farmers are asked their opinion about the varieties in the test.

PVS trials are managed by farmers or use the same management techniques used by farmers, and they always include a step in which farmers' opinions are collected in a way that allows the information to be summarized as numbers or ratings, as well as in lists of farmers' comments about the varieties. In this step, the opinions of women farmers, poor farmers, and farmers from minority ethnic and social groups are specifically sought. Thus benefiting disadvantaged beneficiary groups, such as women, by promoting gender equity in access to resources and agricultural knowledge through participatory research should be social goals of participatory research (Thelma et al., 2007). PVS provide an opportunity to the farmers a large number of varietal choices on their own Resources, Enhance farmer's access to crop varieties and increase in diversity, increase production and ensure food security, help to disseminate the adoption of pre and released varieties in larger areas, allow to varietal selection in targeted areas at cost-effectiveness and also in less time and it also help seed production at community based seed. This approach needs to be more widely tested in the heterogeneous rain fed environments of Africa, where involving farmers, especially women farmers, in selecting varieties has shown early successes for beans, maize, and rice (World Bank, 2007). In Syria scientists working in the Barley Program at ICARDA carried out a groundbreaking piece of participatory research with the involvement of women in the determination of best varieties adapted to their unique environments were considered an important achievement in an agricultural practice that has been dominated by male farmers (Patricia, 2011).

PVS approach comprises three steps to identify preferred variety; situation analysis and identify farmers' needs; search for genetic materials to test in farmer's condition; Experimentation of on-farm research and dissemination of preferred varieties. The situation analysis identifying farmer's needs requires community meetings to identify, prioritize and document specific varietal traits preferred by farmers.

PVS is a simple way for breeders and agronomists to learn which varieties perform well on-farm and are preferred by farmers. Introducing PVS into a variety development program can increase the chances that its products will be adopted. Various authors' recommends that PVS procedures be included as a standard part of crop breeding programs. There are two main steps in the recommended PVS system: -

The *mother trial* is an on-farm trial in which a set of new lines or introduced varieties is compared with local checks using farmers' crop management practices. In this step, agronomists measure yield and other important traits. Groups of farmers are invited to visit the trial and rate the varieties using a simple technique called preference analysis (PS). If the "mother" trial already conducts researcher-managed on-farm trials, demonstration trials in which data are collected, or even advanced on-station multi-location trials at several research centers, farmers can be invited to visit the trial site.

The "baby" trial: Varieties that perform well and are preferred by farmers in the mother trial are evaluated by farmers on their own farms in *baby* trials. Baby trials are small trials of 2 to 5 varieties that are given directly to farmers. Researchers do not lay out these trials. They are planted and harvested by farmers. Researchers may take crop cuts to measure yield if resources permit, but farmer ratings, comments, and yield reports have been shown to be highly reliable and are the main output of the baby trial. Farmers rate the varieties in comparison to their own (local check).

V. Main Barriers to Adoption of Improved Crop Varieties and Participatory Approaches to Overcome These Barriers

Adoption of improved crop cultivars has been limited in some systems. Three main reasons are often suggested for this poor rate of adoption:

a) Varieties selected on research stations may not perform well under farmer management.

The problem of variety trials conducted on the research station are often managed very differently from farmer practice. For example, researchers apply more fertilizer, achieve more complete weed and pest control, and irrigate more frequently than farmers can. High-yield varieties that perform well under these "high-input" conditions may not perform well under more stressful conditions faced by poor farmers who cannot spend much on purchased inputs or who lack the labor to completely control weeds. So participatory variety trials, which are conducted on-farm and under the complete management of farmers, provide information about the performance of new varieties under the real conditions faced by farmers. Traits like weed competitiveness and yield under low-fertility conditions can be assessed in PPB and PVS trials.

b) Breeders may not be aware of some of the important traits that are needed or preferred by farmers

Similarly the difficulty of conventional varietal testing focuses on agronomic performance (traits like yield, duration, and disease resistance), but farmers consider many other features of a new variety when deciding whether or not to adopt it. Cooking and eating quality is a critical factor in the adoption of new varieties. Farmers may also be concerned with straw quantity, weed competitiveness, harvestability, and storability. These factors are very hard to evaluate in conventional variety testing programs, but may be strongly related to farmers' decisions on adoption. Therefore, conducting PPB & PVS trials involving farmers include formal steps in which farmers express their opinions and preferences about varieties under evaluation. Farmer input is sought on both production and end-use traits, using tools that ensure that traits important to farmers are emphasized. This input is very useful in predicting whether or not farmers are likely to adopt a variety.

c) Farmers may not have access to information about or seed of new varieties

Many farmers in rain fed environments rely almost entirely on their own seed supply for planting material, and on their relatives, friends, and neighbors for new germplasm. They may be unaware of or have no access to improved varieties. Therefore, PPB & PVS trials are an inexpensive and effective way to expose farmers to new germplasm. Farmers often spontan -eously adopt varieties they observe or grow on their own farms in PVS trials. In some situations, dissemination of varieties is one of the goals of PVS trials. However, the main purposes of participatory approaches are to provide information about variety performance and acceptability. Other mechanisms, notably large-scale seed distribution schemes, are likely to lead to more rapid dissemination of farmer-preferred varieties.

VI. PPB and PVS Experiences, Achievements and Farmers Evaluations in Different Countries

Farmers involved in PPB and PVS are researchers alongside the plant breeders. Smith and Weltzien (2000) also indicated that certain farmers are known for their skill in seed selection and saving and are especially good to have on a participatory breeding team. Though the skill of farmers in selection and their ability to handle distinct populations is often questioned, in many projects farmers have proved to be vastly knowledgeable.

In Nepal in participatory rice breeding program farmers increased the effort and time they invested in breeding as the project started showing results (Sthapit et al. 1996). Joint selections by farmers and breeders have produced most of the successful lines from this program. Lines selected by farmers have become popular and are spreading to other villages in the area (Gyawali et al. 2007).

In Syria, farmers were more effective than breeders at selecting superior barley genotypes in their own fields, and farmers were able to handle large numbers of entries, including segregating materials in early generations in participatory barley breeding program (Ceccarelli et al. 2001).

Ashby (2009) highlighted the impact of PPB and PVS on various crops such as cassava in Brazil and Colombia; pearl millet in Namibia and India; beans in Colombia, Tanzania, Ethiopia and Rwanda; tree species in Burundi; potatoes in Rwanda, Bolivia, Peru and Ecuador; rain fed rice in India; paddy rice in Bangladesh, India and Nepal; maize in Mali, India, Ethiopia, Honduras and Brazil; and barley in Syria, Morocco and Tunisia by citing different authors.

In Burkina Faso, varieties with a short growing cycle are planted in villages or house fields –mainly due to better bird control – while later-maturing varieties are allocated to farmland or bush fields Selection decisions can thus vary depending on availability of fields and human resources for managing two sowing dates (Kirsten, 2010).

In Rwanda, farmers identified as bean experts helped make selections on-station by ranking breeding lines for traits of interest and then taking 2–3 of these lines to grow in home gardens alongside their traditional mixtures. The lines identified by local farmers out-yielded the local mixtures 64–89% of the time, with an average increase in yield of 38%. In contrast, breeder selections out-yielded local mixtures 41–51% of the time on a national scale, with an average 8% increase in yield (Sperling et al. 1993).

In Ethiopia, efforts have been made to develop and popularize common bean varieties through both PPB and PVS (Asfaw *et al.,* 2004; Gurmu, 2007); popularize through PVS. On common bean (Fekadu, 2013); on maize (Daniel etal.2014, De Groote et al. 2002), on bread wheat (Asaye et al., 2014), on soybean (Adissu etal.2016) and on Faba bean (Tafere etal.2012).

a) PVS in Bread wheat in West Gojam Zone in Ethiopia

Participatory varietal selections are farmer-centered varietal selections limited to testing of the finished varieties. Farmers evaluate multiple traits that are important to them and help to increase on-farm varietal diversity, faster varietal replacement and rapid scaling up. Moreover, quality traits on wheat like milling percentage, cooking and keeping quality, taste, and market price can be assessed in PVS that are difficult or expensive to evaluate in conventional trials (Asaye et al, 2014)

Table 1: Farmers' preference scores and ranking on grandmother trial

Varieties	Parameters and scores								
	Plant stand	Number of tillering	Seed coat color	Seed size	Spike length	Number of kernel	Disease resistance	Total scores	Rank
Paven-76	3.6	2.3	2	2.3	2.6	2	1.3	16	8
Paven-76	3.6	2.3	2	2.3	2.6	2	1.3	16	8
HAR1685	4.3	5	3.3	4	4.3	4.3	3.3	28	2
Millennium	4	2.6	2	2	2	2	2	17	7
Plcafeor	3.3	3	2	2	2	2	2	16	8
HAR3730	5	3.6	4.6	4.6	5	4.4	4.6	31	1
ETBW5518	4.3	3	2.3	2.3	4.3	3.6	4.3	24	4
ETBW5519	2.6	3	2	2	2	2	4.3	18	6
ETBW5520	3.6	3.6	2	2	3	2.6	3	20	5
ETBW5521	5	3.3	3	3	4.6	3.3	5	27	3

Global Journal of Science Frontier Research (D) Volume XVII Issue I Version I Year 2017

ETBW5522	3.6	3.6	2	2.3	2.6	3.3	3	20	5
ETBW5525	5	4	2.6	3.3	4.3	4	4	27	3
ETBW5526	4.6	3.6	3	3	5	4	4.6	27	3

N.B: Farmers preference ranking, key for scaling (1-5); 1=least 5=best. (Source: Asaye et al., 2014)

Table 2: Mean separation of different agronomic traits for 11 treatments in grandmother trial

Treatments	PH	SL	SKPSP	YD	HLW	TGW	LR	GFP	MA	HD	HI
Paven-76	92.2abc	8.2dc	16.4bcd	3.4d	75cde	27ef	21.6cd	43.6f	103.3e	59.6f	34.2cde
HAR1685	85d	8.2dc	15.8cd	4bcd	72.2e	25f	23.3cd	47bc	111ab	64abc	32.7cd
Millennium	93abc	7.8d	16.6bcd	3.7cd	77.2abc	30.3cde	33.3ab	46.6bcd	110.3b	63.6bcd	35.5bcde
Plcafeor	90.1bcd	8.4dc	16.6bcd	4.8ab	77.3abc	35ab	18.3d	49a	105de	56g	41.2ab
HAR3730	97.4a	9.2ab	17.2b	5.4a	80.8a	35.3a	33.3ab	45.6de	107.6c	62de	45.6a
ETBW5518	93.6abc	8.4dc	17bc	5.3a	79.8ab	33.6abc	28.3bc	46.6bcd	110.3b	63.6bcd	40.7abc
ETBW5519	88.8cd	8.4dc	17.2b	3.5d	74.5cde	26f	21.6cd	47.6b	113.3a	65.6a	31e
ETBW5520	92.5abc	8.2dc	15.3d	4.4abcd	75.7cde	31bcde	28.3bc	46cde	107cd	61ef	37.1bcde
ETBW5521	94.9ab	8d	16.8bc	4.7abc	77.6abc	33abcd	23.3cd	47.3b	111.6ab	64.3ab	37.6bcd
ETBW5522	94.8ab	9.73a	15.7cd	4.1bcd	74.8cde	31.6abcd	16.6d	45.3e	107.6c	62.3cde	37.3bcde
ETBW5525	96.6a	8.7bc	19.1a	4bcd	73de	29def	21.6cd	47bc	111ab	64abc	34.4cde
ETBW5526	95.3ab	9.8a	16.2bcd	4.6abc	76.2bcd	30.6cde	36.6a	47bc	112.3ab	65.3ab	37.2bcde
Mean	92.88	8.61	16.68	4.36	76.2	30.63	25.55	46.58	109.22	62.63	37.07
CV (%)	3.55	4.32	4.88	14.05	3.05	7.8	19.09	1.44	1.33	1.72	10.48
LSD	5.58	0.63	1.38	1.03	3.94	4.05	8.26	1.14	2.46	1.83	6.58
SE	1.9	0.21	0.46	0.35	1.34	1.37	2.81	0.38	0.83	0.62	2.24

PH=Plant height (cm), SL= spike length (cm), SKPSP= spikeletes per spike, YD= grain yield (t/ha), HLW= hectoliter weight (kg/hl), TGW= thousand grain weight (g), LR= leaf rust (%), YR= yellow rust (%), GFP= grain filling period, MA=days to maturity, HD= days to heading, HI= harvest index, CV(%)= coefficient of variation, LSD= least significant difference, SE= standard error,Alpha = 0.5. (Source: Asaye et al., 2014)

Table 3: Table 3 Mean yield of the bread varieties in grandmother trial

Treatments	Yield(t/ha)	Ranks for yield
Paven-76	3.4d	11
HAR1685	4bcd	8
Millennium	3.7cd	9
Plcafeor	4.8ab	3
HAR3730	5.4a	1
ETBW5518	5.3a	2
ETBW5519	3.5d	10
ETBW5520	4.4abcd	6
ETBW5521	4.7abc	4
ETBW5522	4.1bcd	7
ETBW5525	4bcd	8
ETBW5526	4.6abc	5
Mean	4.36	
CV (%)	14.05	
LSD	1.03	
SE	0.35	

CV(%) = coefficient of variation, LSD= least significant difference, SE= standard error, Alpha = 0.5 .(Source: Asaye et al., 2014)

b) PVS in common bean in Sidama Zone of Southern Ethiopia

The farmers' usually give priority to common bean qualitative traits such as seed color, drought tolerance, disease and pest resistance, marketability, seed size, shattering tolerance, taste and cooking time which indicates farmers selection criteria for common bean were beyond yield (Fekadu, G. 2013). Based on these criteria, all farmers who participated in the mother trial preferred the variety Ibado as a number one variety due to its seed color (red speckled), seed size (large), demand in the market (high), early maturity (<90 days) and relatively good yield (>2 tons ha-1). The local variety was ranked second due to its seed color (light red), marketability and taste (Table 5). Whereas researchers selected Awash-1 and Omo-95 based on grain yield (Table 4). He stressed also that farmers were well aware of the selection criteria and they know how to select and rank the varieties. Some of the criteria match with the breeder's ones and some are beyond breeder's expectations. This is substantiated by the report of Gemechu *et al.* (2002), who reported that farmers and researchers have their own unique and common know-how, which should be effectively exploited in the research process.

Table 4: Grain yield (kg ha-1) of common bean varieties tested across three locations at Umbulo Watershed in 2004 and 2005

S.No	Varieties	Years x locations									
		2004				2005				Overal l mean	Overall Rank
		Umbulo Wacho	Umbulo Kejima	Umbulo Tenkaka	Mean	Umbulo Wacho	Umbulo Kejima	Umbulo Tenkaka	Mean		
1	Awash-1	2365.2	2350.5	2458.0	2391.2	2367.6	2112.3	2530.0	2336.6	2363.9	1
2	Awash M.	2226.3	1990.4	2094.6	2103.8	2205.6	2070.5	2109.7	2128.6	2116.2	4
3	Roba-1	1892.4	1595.2	1688.2	1725.3	1902.2	1984.2	1865.9	1917.4	1821.4	6
4	Ibado	2065.0	2479.2	1894.4	2146.2	2004.5	2142.3	2163.3	2103.4	2124.8	3
5	Omo-95	2228.4	2117.7	2244.6	2196.9	2206.2	2292.4	1897.2	2131.9	2164.4	2
6	Local	2415.6	1264.0	1711.2	1796.9	2102.4	2036.7	1882.0	2007.0	1902.	5
	CV (%)	14.7									
	LSD	74.6									
	SD	305.1									
	Mean yield	2082.1									

(Source: Fekadu, G. 2013)

Table 5: Mother trial farmers' preference ranking of common bean varieties for different qualitative traits in Umbullo Watershed

Varieties	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	Av. R.	Av. R. R.
Awash-1	4	4	3	3	4	2	4	4	4	4	3	3	2	2	3	3.3	4
Awash M.	2	3	3	4	3	2	1	5	3	3	4	3	2	2	3	2.9	3
Roba-1	6	6	4	5	5	4	2	2	5	3	5	4	3	4	4	4.0	6
Ibado	1	1	1	2	1	1	3	1	2	1	1	1	2	1	1	1.3	1
Omo-95	5	2	4	6	5	3	5	2	3	5	5	3	4	5	2	3.9	5
Local	3	2	2	1	2	3	3	3	1	2	2	2	1	3	2	2.1	2

F1= Farmer1, F2= Farmer2, F3= Farmer3… Av. R. = Average rank, R = Rank, Awash M. = Awash Melka ***NB:*** *The qualitative traits were seed color, drought tolerance, disease and pest resistance, marketability, seed size, shattering tolerance, taste and cooking time.(Source: Fekadu, G. 2013)*

c) PVS in faba bean in Dabat district in Ethiopia

According to Tafere et al., 2012, participatory variety selection was carried out at four different growth stages by organizing a field day at each stage i.e. at vegetative, flowering, physiological maturity, and harvesting using farmers' selection criteria such as plant establishment (PES), stem strength (STS), number of branches (NOB), overall performance (OAP) and seed size (SS) and grain yield (Table 6 & 7). He also indicated that farmers and the researcher used different parameters and methods to evaluate the tested genotypes. Thus researchers must consider farmers selection traits in their varietal development such as seed yield, seed size and overall field performance. The current selection process also demonstrated that farmers were capable of selecting important traits for grain yield (yield components) and based on those traits demonstrated to identify superior varieties adapted to their locality. Generally, PVS was effective and reliable for identifying appropriate faba bean cultivars through partnership with resource-poor farmers (Tafere etal.2012).

Table 6: Sum of scores at three farmer sites for each trait, overall mean value of each selection criterion and ranking of genotypes

	Farmer's criteria							
Variety	PES	OAP	STS	NOB	SS	Total	Mean	Rank
HOLETTA-2	9	8	8	10	13	48	9.6	6
DOSHA	14	12	12	15	15	68	13.6	1
EH99051-3	11	10	8	10	8	47	9.4	7
CS20DK	8	8	7	7	13	43	8.6	8
WOLKI	13	13	15	13	12	66	13.2	2
SELALE	11	12	15	12	7	57	11.4	4
GEBELCHO	8	7	10	8	10	43	8.6	8
DEGAGA	8	8	8	10	7	41	8.2	9
WAYU	12	12	15	12	12	63	12.6	3
MOTI	13	8	8	10	15	54	10.8	5

PES=Plant Establishment, OAP=Overall Performance, STS=Stem Strength, NoB=Number of Branches, SS=Seed Size; Rating of the performance of variety for a given criteria: 5= very good, 4= good, 3= average, 2= poor and 1 = very poor. (Source: Tafere et al., 2012)

Table 7: Mean yield (t/ha) of the faba bean varieties for grandmother trial

Genotype	Grain yield(t/ha)	Rank for yield
HOLETTA-2	5.7cd	8
DOSHA	13.2b	3
EH99051-3	9.7bcd	5
CS20DK	7.0cd	7
WOLKI	11.2bc	4
SELALE	24.9a	1
GEBELCHO	4.5d	10
DEGAGA	8.0bcd	6
WAYU	21.9a	2
MOTI	5.4d	9
Mean	11.1	
LSD (5%) 8	5.54	
CV (%)	28.97	

LSD=Least Significant Difference, CV=Coefficient of Variation. (Source: Tafere et al., 2012)

d) PVS in Soybean bean in Pawe District of North-Western Ethiopia

Farmers' participatory evaluation of soybean varieties was done at vegetative and physiological maturity stage and they were agreed with plant height, no of pods per plant, seed Size, shattering, uniformity and market demand as selection criteria (Addisu etal., 2016). Most of the farmers preferred Awassa-95 from the early set, Gishama from the medium set and Wegayen from the late maturing soybean varieties and Researchers based on the average yield selected soybean Wegayen for late set, Gishama for medium set and Awassa-95 for early set recorded high (Table 8 &9). In this case the farmers' preferences coincide with the breeders' selection (Addisu etal., 2016).

Participatory varietal selection is premised on the basis that only a small percentage of varieties developed by breeders are eventually utilized because farmers are left out of the selection process (Olaoye et al., 2009). Farmer's Participatory Varietal Selection is a way to overcome the limitations of conventional breeding by offering farmers the possibility to choose, in their own environment, the varieties that better suit their needs and conditions (Ceccarelli and Grando, 2007).

Table 8: Farmers' selection criteria and varieties preference

Variety	Ph	NPP	Sh	MD	SS	U	Total	mean	Rank
Awassa 95	15	16	16	17	16	18	98	12.25	1
Crowford	6	4	10	14	14	15	63	7.875	3
Willams	6	9	12	17	18	17	79	9.875	2
Belase-95	9	14	16	15	13	18	85	10.625	3
Ethio-Yugoslavia	16	15	14	15	16	16	92	11.5	2
Wegayen	17	14	12	17	17	18	95	11.875	1
AFDAT	18	14	13	16	16	17	94	11.75	2

Gishama	15	13	19	17	17	17	98	12.25	1
Gizo	10	13	12	15	14	16	80	10	3

Where, Ph= plant height, NPP=No of pods per plant, SS=Seed Size, Sh=Shattering, U=uniformity, MD=market Demand, The Rating of the performance of variety for a criteria: 5= very good, 4= good, 3= average, 2= poor and 1 = very poor

(Source: Addisu etal. 2016)

Table 9: Mean yield of the varieties

Variety	Maturity class	Yield (kg/ha	Rank for yield
wegayen	Late set	1496.7a	1
Belase-95	Late set	1411.5a	2
Ethio-Yugoslavia	Late set	1398.5a	3
Gizo	Medium set	1114.4a	3
Gishama	Medium set	1461.3a	1
AFGAT	Medium set	1335.7a	2
Awassa 95	Early set	1095.5a	1
Willams	Early set	882.2a	3
Crowford	Early set	948.5a	2
	CV(%)	23	
	LSD	669.9	
	Alpha	0.05	

Mean values with the same letter indicated that there is no significant difference among them.

e) PVS in Maize varieties in Chilga District of North Western Ethiopia

Farmers' participatory evaluation of maize varieties was done at vegetative and physiological maturity stage and farmers' selection criteria were earliness, drought tolerance, grain yield, vigorousity, husk cover, cob size, grain color and, grain size(Daniel etal.,2014). This shows farmers may require multiple traits from one key crop such as maize and emphasized that farmers' varietal selection criteria should be taken into by researcher consideration during crop improvement programme (Daniel et al., 2014).However, researchers may not know the traits that are important to farmers and vice versa. Participatory varietal selection has significant role in technology adaptation and dissemination in short time than conventional approach.

The rank given by researchers rank did not match with farmers rank except for single variety clearly showed that farmers a major selection criterion is not yield rather combination of other non reproductive parameters (Table 10 & Table 11). Bellon (2002) also confirms the observation that farmers' perception about crop varieties are not always the same as researchers and if given the opportunity, farmers are able to express their preferences differently for early maturing maize varieties rather than yield. This is in agreement with De Groote *et al.* (2002) who stated that there were growing interests among farmers in the use of early maize varieties in short rain fall season.

Participatory plant breeding/selection has shown success in identifying more number of preferred varieties by farmers in shorter time (than the conventional system), in accelerating their dissemination and increasing cultivar diversity (weltzien, E. *et al.*, 2003). Therefore, adding information on farmers' perspectives of plant and grain trait preferences to these criteria will be helpful to the variety selection process. Research costs can be reduced and adoption rates increased if the farmers are allowed to participate in variety testing and selection (yadaw *et al.*, 2006).

Table 10: Farmers two years Average Varietal Assessment Result in Chilga district of North West Ethiopia (2012 and 2013)

Varieties	Anguaba Village	Serako Village	Eyaho Village	Average	Rank
BH-540	1.812	1.750	2.000	1.854	1
BH-543	1.875	2.125	3.250	2.417	5
BHQPY-545	1.875	1.875	2.312	2.020	2
BH-660	2.000	2.375	2.812	2.396	4
BH-661	2.625	2.437	2.562	2.541	6
BH-670	2.187	2.312	2.500	2.333	3

(Source: Daniel et al., 2014)

Table 11: Ranking of the varieties according to farmers and researchers

Varieties	Researchers' rank	Farmers'
BH-540	5	1
BH-543	4	5
BHQPY-545	6	2
BH-660	2	4
BH-661	1	6
BH-670	3	3

(Source: Daniel et al., 2014)

VII. Impact of Participatory Approaches

These PPB and PVS approaches had various types of impact:

- Variety development: a number of varieties have been already adopted by farmers even though the program is relatively young in breeding terms
- New variety adoption and enhancement of biodiversity

In PPB and PVS approaches different varieties have been selected in different areas within the same country, in response to different environmental constraints and users' needs. In Syria, where this type of impact has been measured more carefully, the number of varieties selected after three cycles of selection is 4-5 time higher than the number of varieties entering the on-farm trials in the conventional breeding program. In Bangladesh wheat varieties were being demonstrated and selected through PVS approach could make remarkable impact in replacement of farmers' old varieties as result varietal diversity and adoption of new varieties were also increased amazingly (Pandit et al., 2007). Joshi and Witcombe (1996) reported that adoption rates of cultivars would be improved by increased farmers' participation and poor farmers adopt new varieties as rapidly as wealthier ones through PVS. PVS approach again proved itself as a superior concept than the traditional one. Witcombe et al. (1996) stated that it was a more rapid and cost effective way of identifying farmers-preferred cultivars if a suitable choices of cultivars are supplied to test.

- Seed production and preservation

Providing training to the farmers for seed production and preservation was very important for higher yield. PVS activity has improved the knowledge of farmers in seed production and preservation. PVS helped the farmers getting rapid advantage from new varieties. Otherwise, reaching seeds of new varieties to the farmers in normal channel needs at least 5 years.

- Sources of agricultural knowledge

The farmers of Bangladesh get agricultural knowledge from different public and private organizations and personnel. After few years of PVS activity, there were remarkable changes in information sources due to frequent visit and discussion of researchers and extension personnel with the farmers (Pandit et al., 2007). Development agent and research personnel were the most reliable sources of agricultural information.

- Income change

Farmers of PVS villages have brought changes in their income participating in PVS research. Due to cultivation of modern wheat varieties and use of recommended production technologies, yield was increased remarkably. They were also able to save seeds using recommended seed rate. Farmers' participating in PVS research who grew only new varieties using recommended production technologies got additional income(Pandit et al., 2007). A financial analysis revealed that a very high internal rate of return is possible to get from investment in participatory variety selection (Witcombe, 1999; Grawali et al., 2002).

- Attitude change

PVS activity has changed the attitudes of the farmers, researchers, extension and NGO personnel, and policy makers. During PVS activity, lots of interactions were made with the farmers by the researchers, extension and NGO personnal and a good number of trainings were imparted to them. As a result, their attitudes about researchers and extension personnel were changed remarkably. In several countries, the interest of policy makers and scientists in PPB as an approach which is expected to generate quicker and more relevant results has considerably increased. Atlin et al., 2002 has also emphasized on institutionalization of the PVS approach for getting long term sustainable advantage of the system.

- Farmers' (men and women) skills and empowerment

The cyclic nature of the PPB and PVS programs has considerably enriched farmers' knowledge, improved their negotiation capability, and enhanced their dignity. In the impact assessment interview, all farmers of them replied that their knowledge on agricultural activity was increased through PVS and PPB due to interaction with the researchers.

VIII. Challenges of Participatory Approaches

Participatory processes take strong commitment and time to work along with men and women farmers. Cook and Kothari (2003) and Misiko (2010) articulated that regardless of the benefits and growth of participatory work, there are fundamental drawbacks that persist. While the opportunity seems very promising, there are likely to be some bottlenecks in the participatory plant breeding. For example, there are numerous methodological difficulty due to too many forms of ''participation'' being implemented in spite of insufficient insight into systems complexity, differences in reference frameworks, and methodological errors (Van Asten et al., 2008). The methods used to involve farmers in research can lead to the collection of inaccurate and/or misleading information (Misiko, 2009; Werner, 1993). Misiko (2010) also reported that it can be very wasteful when implementing researchers are unskilled, negligent or do not systematise collection of social and other contextual data for lessons building. The increase in participatory plant breeding and other collaborative programs involving farmers, their communities and formal sector scientists raise new questions and challenges for recognizing innovation in plant breeding:

- High cost for participating farmers: Unlike traditional approaches to plant breeding in which most work is done by scientists, farmers participating in PPB have to invest resources – their time and intellectual capital, and sometimes traditional production inputs such as land, labor, and capital. The amount of resources farmers must invest increases in proportion to their degree of participation. Therefore, poor farmers may be unwilling or unable to participate in PPB schemes because participation tends to be relatively costlier for them.
- Additional training needed for scientists: Scientists require specialized skills that are not normally taught in traditional plant breeding programs to be proficient at using PPB methods.
- High overall cost for breeding programs: Scaling up PPB methods for work at the regional, national, or international level could require large investments in resources.

Despite several technical reports on the success of PPB and PVS, more analysis is required to assess its emerging challenges.

IX. Conclusion

Participatory approaches are the selection by which farmers evaluate adavanced, finished or near-finished products from plant breeding programs on their own farms. Most importantly, it was noted that farmer‟s adoption of new crop varieties came during and after the implementation of PPB and PVS as revealed by the fact that collaborating farmers in participatory approaches had higher adoption rates than non-participating farmers. The related link between research and development effort and adoption may be because collaborating farmers receive more information that facilitate their appreciation of the value of new crop varieties. Thus, the results affirm the importance of adopting participatory approach in the transfer of technology in various countries. Findings of PPB & PVS on different crops have shown the possibility of enhancing on-farm varietal diversity and increasing adoption rates. The approach allows evaluation of new crop varieties under a range of biological and socio-economic conditions; it increases chances of success and offers the benefit of new genetic resources five to six years in advance of the formal research system. Developed participatory approaches solve many constraints related to farmers' participations, set parameters, select superior varieties, evaluating the performance of better varieties, and identify better varieties and accelerating the dissemination of farmers' selected varieties in the target areas. Once identified, the seed of farmer-preferred cultivars needs to be rapidly multiplied and cost-effectively supplied to farmers. Farmers' exposure to evaluate and select new varieties is an advantage to exploit their potential knowledge of identifying adapted varieties that best meets their interest which further helps to include such selections in their varietal portfolio for seed production. Most farmers also recognized well that improved cultivars will perform better if accompanied by recommended cultural practices.

Hence, interaction of researchers and farmers will also help to design research objectives to overcome rejection of varieties developed by researchers alone, enhances the acceptance of varieties and reduces costs associated with variety development. Moreover, as women have an important role in post-harvest quality assessment, in spreading new genetic materials, biological yield and indigenous knowledge systems are important considerations while developing new crop varieties to enhance varietal adoption and diversification

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Study on the Extracts of some Ornamental Plants on Germination and Seedling Growth of Pea

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Abstract- An experiment was conducted to study the effects of aqueous extracts of few ornamental plants viz. China box *(Murraya exotica),* Indian Medlar *(Mimusopsel engi),* Parrot tree *(Buteamonosperma)*Mussaenda *(Mussaen daerythr -ephytta),* Mast tree *(Polyalthialongi folia)* and Swamp tree (*Swamp tree occidentalis*) on the germination and growth of Pea *(Pisumsativum)*. Mussaenda *(Mussaendaerythrephytta)* plant extract showed the highest percentage of germination and shoot length of pea and lowest percentage was found from aqueous extract of Indian Medllar *(Mimusopselengi)*. The longest root length was found on control condition (water) and shortest found on Mussaenda *(Mussaendaerythrephytta)*. The highest chlorophyll contents was found on Parrot tree *(Buteam -onosperma)*and lowest was found on Mussaenda *(Mussaendaerythrephytta)*. So, it may be concluded that aqueous extract of Mussaenda *(Mussaendaery -threphytta)* is good for germination, growth and developments of pea *(Pisumsativum)*.

Keywords: aqueous extract, germination, seedling growth, pea.

GJSFR-D Classification : FOR Code: 079999

STUDYONTHEEXTRACTSOFSOMEORNAMENTALPLANTSONGERMINATIONANDSEEDLINGGROWTHOFPEA

Strictly as per the compliance and regulations of :

Study on the Extracts of some Ornamental Plants on Germination and Seedling Growth of Pea

M. M. Rahman [α], M. R. Islam [σ], M. M. A. Islam [ρ], M. R. Zaman [Ѡ] & M. K. Hasan [¥]

Abstract- An experiment was conducted to study the effects of aqueous extracts of few ornamental plants viz. China box *(Murraya exotica),* Indian Medlar *(Mimusopsel engi),* Parrot tree *(Buteamonosperma)* Mussaenda *(Mussaen daerythr -ephytta),* Mast tree *(Polyalthialongi folia)* and Swamp tree (*Swamp tree occidentalis*) on the germination and growth of Pea *(Pisumsativum)*. Mussaenda *(Mussaendaerythrephytta)* plant extract showed the highest percentage of germination and shoot length of pea and lowest percentage was found from aqueous extract of Indian Medllar *(Mimusopselengi)*. The longest root length was found on control condition (water) and shortest found on Mussaenda *(Mussaendaerythrephytta)*. The highest chlorophyll contents was found on Parrot tree *(Buteam -onosperma)*and lowest was found on Mussaenda *(Mussaendaerythrephytta)*. So, it may be concluded that aqueous extract of Mussaenda *(Mussaendaery -threphytta)* is good for germination, growth and developments of pea *(Pisumsativum)*.

Keywords: aqueous extract, germination, seedling growth, pea.

I. Introduction

Pea (*Pisumsativum*) is an annual plant with a life cycle of one year. It is a cool season crop grown in many parts of the world; it is used as a vegetable, fresh, frozen or canned. The nutritional value of pea is amazing. Pea contains protein, potassium, phosphor us, Magnesium, calcium, sodium, selenium, iron, zinc, manganese, and iron, niacin, vitamins A, C, B1, B6 and other vitamins in small amounts.

Certain plant extracts have been found to affect the germination as well as growth of different crop plants. Today farmers are well aware about the application of organic fertilizer to improve their crop production as well as farming land (Galbiatti *et al.*, 2007). In order to fill the demand of organic fertilizer, one of such option is use of *Moringaoleifera* leaf extracts as fertilizer (Davis, K. 2000). In agriculture and horticulture, use of these extact has proved beneficial for the growth and yield (Kannaiyan2000), deeper root development and better seed germination (Chang Ed-Harun*et al.,* 2007), delay of fruit senescence, and improved plant vigour and yield quality/quantity (Hossain, *et al.,* 2012, Phiri,*et al.,* 2010). MOLEs also impart the crops the ability to withstand adverse environmental conditions. Again (Tripathi*et al.*, 1981) showed that the aqueous extract of *Terminaliachebula* and *Eupatorium adenophor -um*strongly inhibited the germination, radical and plumule growth on wheat. Banana plant extract found to inhibit the germination of lettuce (Roy*et al.,* 2006). Certain reports also indicated the growth regulatory effects of different plant extracts. The aqueous extract of *Terminaliabelirica*found to increase the germination, shoot and root growth in okra and swamp cabbage (Roy et al., 2012).

For better production of crops, higher germination as well as seedling growth is very important factor and various efforts are being applied to achieve this. Use of plant extracts for improved crop growth might be an effective way to reduce the chemical pollution. Though here are a lot of studies indicating the positive effects of various herbal plants extracts on germination and seedling growth, but reports on extracts of ornamental plants is very limited. Therefore, the present study was conducted to investigate the effect of aqueous extracts of six ornamental plants on germination, seedling growth and Chemical Investigation of Pea (*Pisumsativum*).

II. Materials and Methods

The experiment was conducted at research laboratory, Department of Agricultural Chemistry, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh. Six ornamental plants namely China box *(Murraya exotica),* Indian Medlar *(Mimusopselengi),* Parrot tree *(Buteamonosper -ma)* Mussaenda *(Mussaendaerythrephytta),* Mast tree *(Polyalthialongifolia)* and Swamp cedar *(Swamp tree occiiidentalis)* were selected to study the effects on the growth of Pea *(Pisumsativum)*

a) Preparation of aqueous extracts

200 gm of fresh and clean leaves were taken and cut into smaller pieces, it was then blended by

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using blender and was taken in a 1000 ml reagent bottle and 800 ml of water was added to it. It was then kept for 72 hours at room temperature of 18±2^{0}C and relative humidity of 75±5% with regular interval of stirring. After 72 hours the aqueous slurry was filtered through What man filter paper No.1 and was taken in another 500 ml bottle. The filtrates of individual plant extract were stored and used for treating the seeds of vegetable crops along with water as a control and other comprehensive study.

b) *Treatments:* There were seven treatments. These are;

T_1= Aqueous extract of china box
T_2= Aqueous extract of Indian Medlar
T_3= Aqueous extract of Parrot tree
T_4= Aqueous extract of Mussaenda
T_5= Aqueous extract of Mast tree
T_6= Aqueous extract of Swamp cedar
T_c= Water or control

c) Set up for the investigation of Pea Seed

For the investigation of germination percentage, growth and development of vegetable seeds, fifteen ml of each aqueous extract was put in each pot. In control, only distilled water was used and amount of distilled water was also same. Then twenty five seeds of each vegetable crop were kept in each pot and each treatment was replicated into three times. The pot were kept in natural diffused light under laboratory conditions at 18±2°C temperature and relative humidity of 75±5% after placing. 5 ml of water was used per day per pot to keep constant moisture. In control, only water was added if necessary per day per pot.

d) Data collection and analysis

After setting the experiment, the germination percentages, shoot length, root length and completion of germination were recorded. Effects of different treatments on morphology of seedlings were also recorded. The data were subjected to analyze statistically using analysis of variance (ANOVA) technique by MSTST-C (Gomez and Gomez, 1984) and means were compared by the DMRT method.

III. Results and Discussion

a) Germination percentage (%)

The percent germination was counted in 7th, 8th, 9th, 10th, 11th, 12th and 13th days presented in Table 1. In the, the highest germination (77.00, 89.00, 90.00, 93.00, 94.00, 94.00 and 95.00 at 7th, 8th, 9th, 10th, 11th, 12th and 13th days respectively) was found in T_4 (Aqueous extract of Mussaenda) followed by T_6. The extracts of other plants performed moderately but the lowest germination (67.00, 76.00, 84.00, 88.00, 89.00, 89.00 and 91.00 at7th, 8th, 9th, 10th, 11th, 12th and 13th days respectively) was recorded in T_2 (Aqueous extract of Indian Medllar). Increased germination of pea might be due to the presence of some growth regulatory substances present in the extract. These results were partially similar with (Sona, R. R. 2007) who stated that the highest germination of country bean was found in seeds treated with aqueous extract of Parrot tree and the second highest germination was found with aquous extract of mouchanda.

Table 1: Effects of leaves extracts of ornamental plants on germination percentage of Pea

Treatments	% Germination at						
	7 DAS	8 DAS	9 DAS	10 DAS	11 DAS	12 DAS	13 DAS
T_1	73.00 b	89.00 ab	89.00ab	93.00 a	93.00 a	9300 a	9400 a
T_2	67.00 c	76.00 c	84.00 b	88.00 c	89.00 c	89.00 d	91.00 b
T_3	69.00 c	80.00 bc	82.00 b	86.00 d	86.00 d	86.00 c	86.00 c
T_4	77.00 a	89.00 a	90.00 a	93.00 a	94.00 a	94.00 a	95.00 a
T_5	68.00 c	81.00 bc	88.00 ab	85.00 d	9.200b	92.00 b	94.00 a
T_6	74.00ab	88.00 ab	87.00 ab	91.00ab	92.00 b	92.00 b	91.00 b
T_c	70.00bc	84.00abc	89.00 ab	90.00 bc	92.00 b	92.00b	92.00b
CV %	2.21	2.56	3.27	3.49	3.78	3.13	3.21

In a column, figures having the similar letter (s) or without letter (s) do not differ significantly by DMRT at P ≤ 5% level.

b) Shoot length (cm)

Shoot length of pea was significant at 27 DAS and 37 DAS but insignificant at17 DAS and47 DAS influenced by different types of extracts (Table 2). However numerically, the highest shoot length (6.80cm and 9.79cm at 17DAS and 47DAS) of pea seedling was found in T_4 and the lowest shoot length (6.26cm and 9.37cm at 17DAS and 47DAS) was found in T_2. Again, at 27DAS and 37DAS, it was significant where the highest shoot length (8.58cm and 9.52cm at 27DAS and 37DAS) of pea seedling was found in T_4 and the lowest shoot length (7.98cm and 8.40cm at 27DAS and 37DAS) was found in T_2. These results were partially similar with (Sona, R. R. 2007).

Table 2: Effects of leaves extracts of ornamental plants on shoot length (cm) of pea

Treatments	Shoot length (cm) at			
	17 DAS	27 DAS	37 DAS	47 DAS
T_1	6.67 a	8.54 a	9.76 a	9.68 a
T_2	6.26 a	7.98 c	8.40 c	9.37 a
T_3	6.60 a	8.32 b	9.46 b	9.51 a
T_4	6.80 a	8.58 a	9.52 a	9.79 a
T_5	6.46 a	8.00 c	8.72 c	8.77 a
T_6	6.77 a	8.55 a	9.47 b	9.57 a
T_c	6.47 a	8.34 b	9.33 b	9.62 a
CV %	2.03	2.09	2.99	2.87

In a column, figures having the similar letter (s) or without letter (s) do not differ significantly by DMRT at P ≤ 5% level.

c) Root length (cm)

The effect of ornamental plants leaf extract on the root length of Pea was significant throughout the growth period (Table 3). Root length of Pea at 17 and 37 Day's After Sowing (DAS) was statistically similar. At 27 (DAS) highest root length (7.95 cm) was observed in the treatment T_c(water). While, the shortest (6.30 cm) was recorded in T_6 (Swamp tree) treatment. However, at 47 DAS, the highest root length (8.40 cm) was observed in the treatment applied with no leaf extract (control) and the shortest root length (7.71 cm) was recorded in the treatment T_6 with application of Swamp tree leaf extract which was statistically different from others. The lowest root length of pea seedlings was found in seeds treated with Swamp tree due to the presence of some toxic compounds or other inhibitory materials. These results were partially similar with (Sona, R. R. 2007).

Table 3: Effects of leaves extracts of ornamental plants on root length (cm) of Pea

Treatments	Root length (cm) at			
	17 DAS	27 DAS	37 DAS	47 DAS
T_1	7.36 a	7.22 ab	8.25 a	8.32 ab
T_2	7.05 a	7.29 ab	8.30 a	8.36 ab
T_3	7.13 a	7.74 a	8.22 a	8.27 b
T_4	7.23 a	7.47 ab	8.00 a	8.06 b
T_5	7.06 a	7.64 ab	8.14 a	8.16 b
T_6	6.85 a	6.30 b	8.06 a	7.71 c
T_c	7.36 a	7.95 a	8.37 a	8.40 a
CV %	1.98	1.88	1.06	1.21

In a column, figures having the similar letter (s) or without letter (s) do not differ significantly by DMRT at P ≤ 5%

d) Calcium and Magnesium content in plant sample

The effect of ornamental plants leaf extract on the Calcium and Magnesium content in Pea was significant throughout the growth period (Table 4). The highest calcium content in plant (106.1 mg/kg) was recorded in T_6 treatment which was statistically identical with T_1. However, the lowest (87.62 mg/kg) calcium content was recorded in T_3 (Parrot tree) which was statistically different from other treatments. Magnesium content of various treatments was observed statistically similar.

Table 4: Effects of leaves extracts of ornamental plants on Calcium and Magnesium (mg/kg) content of Pea

Treatments	Ca (mg/kg)	Mg (mg/kg)
T_1	104.7 a	5.94 a
T_2	94.32 abc	5.50 a
T_3	87.62 c	5.39 a
T_4	88.29 bc	5.78 a
T_5	100.2 ab	5.76 a
T_6	106.1 a	5.61 a
T_c	95.88 abc	5.45 a
CV %	2.50	2.9

In a column, figures having the similar letter (s) or without letter (s) do not differ significantly by DMRT at P ≤ 5% level.

e) Chlorophyll content of Pea plants leaf

The effect of ornamental plants leaf extract on the Chlorophyll content of pea was significant throughout the growth period (Table 5). Different Chlorophyll content of pea was observed which was statistically varied at different treatments. Highest (0.91mg/gm) content of chlo. a was observed in the treatment T_6 (Swamp tree) and the lowest (0.81mg/gm) was recorded in T_4 (Mouchanda) treatment, which was statistically different from other treatments. On the other hand, the highest (0.43mg/gm) Chlo.b was observed in the treatment applied with Parrot tree leaf extract (T_3), which was statistically similar with treatment T_4 and the lowest Chlo. b (0.16mg/gm) was recorded in the treatment T_6 with application of Swamp tree leaf extract which was statistically different from others.Whereas, highest total Chlorophyll content was observed in the treatment T_3, which was statistically similar with treatment T_1, T_2 and T_4 respectively. And the lowest (1.08mg/gm) total Chlo. Was observed in the treatment T_6 (Swamp tree) which was statistically similar with treatment T_5 . Maximum carotenoide (4.12mg/gm) content was observed in the treatment T_6 applying Swamp tree leaf extract, which was statistically similar with treatmentT_4 and T_5 respectively and the minimum carotenoide (3.49mg/gm) content, was observed in the treatment T_c(control).

Table 5: Effects of leaves extracts of ornamental plants on chlorophyll content of Pea

Treatments	Chlo. a (mg/gm)	Chlo. b (mg/gm)	Total Chlo. (mg/gm)	Carotenoide (mg/gm)
T_1	0.85 ab	0.36 b	1.22 a	3.94 b
T_2	0.87 b	0.34 b	1.22 ab	3.70 bc
T_3	0.84 bc	0.43 a	1.27 a	3.63 bc
T_4	0.81 c	0.40 a	1.22 ab	4.23 a
T_5	0.87 b	0.21 c	1.08 c	4.00 ab
T_6	0.91 a	0.16 d	1.08 c	4.12 a
T_c	0.86 b	0.29 c	1.15 b	3.49 c
CV %	1.02	0.98	1.21	1.51

In a column, figures having the similar letter (s) or without letter (s) do not differ significantly by DMRT at P ≤ 5% level.

IV. Conclusion

The exteriment was carried out to investigate the effects of aqueous extracts of few ornamental plants on germination, shoot length, root length, calcium content, magnesium content and chlorophyll contents of pea. Mussaenda *(Mussaendaerythrephytta)* plant extract showed the highest percentage of germination and shoot length of pea and Aqueous extract of Indian Medllar (T_2) lowest. The longest root length was found on control condition and shortest found on T_6. The highest chlorophyll contents were found on T_3 and lowest was found on T_6. Further research might isolate and investigate the allelochemicals for determining their potential and farm application.

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Prevalence and Associated Risk Factors of Bovine Schistosomiasis in and Around Bakko Town, west Shoa Zone, Oromia, Ethiopia

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Abstract- Schistosome are a treamatode, snail-born parasitic of circulatory system in domestic animals and man. Ruminants are usually infected with cercariae by active penetration of the unbroken skin. *Schistosoma bovis* is the main cause of cattle schistosomiasis and is common in marshy area. A cross sectional study was conducted from November 2015 to March 2016 in and around Bakko town of Oromia, Ethiopia to investigate the prevalence and associated risk factors of bovine schistosomiasis. Simple random sampling technique was used to select 384 study animals and householders, whereas peasant associations (PA) were selected purposively focusing on those residing around Gibe River. Coprological examination with faecal sedimentation technique was used to recover the eggs of schistosoma. This revealed an overall prevalence of 22.92% (88/384) (95%CI: 18.71, 27.12). Multivariate logistic regression was used to examine the strength of association between predictor variables and the occurrence of schistosoma infection.

Keywords: *cattle, bakko tibe, risk factors, prevalence, bovine schistosomiasis.*

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Keywords: cattle, bakko tibe, risk factors, prevalence, bovine schistosomiasis.

I. Introduction

Ethiopia has the largest livestock population in Africa. An estimate indicates that the country is a home for about 57.83 million cattle, 28.04 million sheep and 28.61 million goats (CSA, 2016). These farm animals are the major backbone of agricultural sector's income for Ethiopia and its livestock owners. Parasitism is one of the major bottle necks to livestock development in the tropics including Ethiopia (Sissay *et al.,* 2007). From these parasites cattle schistosomiasis is one of the major economically important animal diseases as it causes mortality, retarded growth, poor productivity, low milk yield and increased susceptibility to other parasitic or bacterial disease '(Marquardt and Greive, 2000; Lefevre *et al.*, 2010)'. It is caused by parasitic schistosome which is a treamatode, snail-born parasitic of circulatory system in domestic animals and man. Although this parasite occur in many tropical and subtropical areas, the disease is important in livestock mainly in eastern Asia, Africa and India (Sewell and Brocklebsy, 1990). Other names given to schistosomiasis are blood fluke disease and bilharzosis (Parija, 2004). The term shistosome or schistosoma means split body and refers to the fact that the males have a ventral groove called a gynaecophoric canal (Marquardt and Greive, 2000). They are thin, elongated fluke, up to 2cm long primarily parasitize in blood vessels of alimentary, nasal vein and bladder.

The geographical distribution has been determined primarily by the distribution of snail intermediate host, particularly *Bulinus conturtus, Bulinus truncates, Physopsis africana and physopsis globosa* are important for bovine and ovine schistosomosis (Urquhart *et al.*, 1996). Domestic animals in various tropical areas may be infected with *Schistosoma bovis* (cattle and sheep), *Schistosoma indium* (horses, cattle, goats in Indian), *Schistosoma matheei* (sheep, South Africa), *Schistosoma suis* (Swine and goats in India), *Schistosoma japonicum* (humans, carnivores, artiodactylids, perissodactylids, rodents and primates) and *Schistosoma margrebowei* (horses, ruminants and elephants in Africa), *Schistosoma spindale* (ungulates); *Schistosoma nasale* (cattle, causing 'snoring disease') '(He *et al.*, 2001)'. *Schistosoma mekongi*, conversely, is limited to humans and dogs, with pigs also possibly a natural host (Crosby & Garnham, 2009). *Schistosoma haematobium* affects (human and non-human primates (not apes), artiodactylids (pigs, buffalo) in Africa, and Middle East); *Schistosoma mansoni* has vast host (Human and non-human primates (including apes), rodents, insectivores, artiodactylids, procyonids (raccoon) in Africa, Middle East, South America, and Caribbean) (Standley *et al.*, 2011).

Transmission of Schistosomiasis is mainly based on contamination of water with cercaria, use of such water for drinking or irrigation and the presence of snails in area. All adult species of genus schistosoma are found in the mesenteries, portal, sub-serosal,

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pancreatic, and sometimes splenic veins and the branches of the pulmonary arteries and also in the nasal mucosal veins. They copulate there, and the female lay eggs which reach the outside either through feces or urine (Nithiuthai *et al.*, 2004). Eggs passed in the feces must be deposited in water if they are to hatch and release miracidia, which invade suitable water snails (*Bulinus* and *Physopsis*) and develop through primary and secondary sporocysts to become cercariae. When fully mature the cercariae leave the snail and swim freely in the water to find new hosts. Ruminants are usually infected with cercariae by active penetration of the unbroken skin, although infection may be acquired orally while animals are drinking water (Marquardt, 2000; Jozef, 2015).

Schistosoma bovis is the main cause of cattle schistosomiasis. It has localized distribution, which is found commonly in northern, eastern, southwestern and central parts of Ethiopia (Yalelet, 2004). Reports on animal schistosomes are very scanty and epidemiological studies conducted on Bovine schistosomiasis are suggestive of the endemicity of the disease particularly in the area with large permanent water bodies and marsh pasture area (Mersha *et al.*, 2012). The prevalence of *Schistosoma bovis* has been reported from different regions of the country by a number of authors; in Kemissie it was 28% by Ameni *et al.* (2001), in Bahir Dar it was 33.8% by Solomon (2008), in Fogera it was 10.17% by Mengistu *et al.* (2012), and 13.70% by Mersha *et al.* (2012), in Debre Tabor it was 7.6% by Mihret and Samuel (2015), in Dangila it was 11.5% by Alemayehu *et al.* (2015) and in and around Bahir Dar it was 26.3% by Samuel *et al.*, (2016) were evident by coproscopic examination. The report from Bahir Dar Abattoir by Hailu (1999) revealed that prevalence 48%; 30.3% by Yalelet (2004) and 28.14 by Almaz (2007) 28.14% and in Jimma 13.46% prevalence by Abebe *et al.* (2011).

When these are an evident on its endemicity in the country, there is no any assessment and report regarding the prevalence, and associated risk factors of bovine schistosomiasis in and around Bakko town, Oromia, Ethiopia. This area is endowed with large water body and marshy areas. Moreover, estimation of prevalence and associated risk factors of the disease is important for decision making, planning, development and implementation of control and prevention strategies. Therefore, the present study was carried out to investigate the prevalence and associated risk factors of bovine schistosomiasis in and around Bakko town.

II. Materials and Methods

a) Study Area and Period

The study was conducted in and around Bako town from Nevomber 2015 to March 2016. Bako town is the center of Bakko-Tibe district in Oromia National Regional State of Ethiopia. The town is located 250 km in the west of Addis Ababa, the capital of Ethiopia, at an altitude of 1650 meter above sea level on 37° 09' E and 9° 06' N. The town has hot and humid climate with average relative humidity of 60%. It gets a bimodal pattern of rainfall with the main rainy season extending from June to September and a short rainy season that extends from March to May with an average annual rainfall of 1300 mm. Mean monthly maximum and minimum temperatures are about 28 and 14°C, respectively, with an average monthly temperature of 21°C. It has larger boundary border with Gibe River. Farm animals are the major source of agricultural income for the livestock owners. The livestock estimate of the year 2014\15 given by Bakko Tibe District office of Animal Healthy and Marketing indicates that the district has 180046 indigenous livestock population which constitutes ox 40334, cow 47681, heifers 22982, bulls 25891, calves 1720; sheep 12627; goats 14354; donkey 8499; horse 3721; mule 1033, poultry 1204 and 219 exotic breed. Livestock is reared in the area with mixed farming and extensive free grazing animal husbandry practice. In addition the farmers in study area are carrying out the agricultural irrigation channel and dam activities around the river that favor the survival and multiplication of intermediate host. These grazing areas are potential source of schistosoma infection due to the frequent contact of animals to the water bodies (BTWOAHM, 2016).

b) Study Design

A cross-sectional study was used to determine the prevalence and associated risk factors of bovine schistosomiasis. It involved categorization of the study population according to their origin namely Peasant Association (PA), body condition score (BCS), sex and age. From the total of eleven kebeles in and around Bakko town, six peasant association namely Dambi gobbu, Dambi dima, Gajo, Bakko 01, Bakko 02 and Abbo metti were selected purposively as they are the near border of Gibe river and have stagnant water bodies that is a favorable environmental condition for the intermediate host; while simple random sampling technique was employed to select house holders and the study animals from all the six PAs.

c) Sample Size Determination

The desired sample size was calculated by using the formula given by Thrusfield (2005); with 95% confidence interval, 5% desired absolute precision and 50% expected prevalence because it gives maximum minimal sample size. Accordingly, the determined number of animals was 384.

d) Study Population

The study animals were privately owned by small holder farmers and managed under traditional loose extensive husbandry system. The dominant cattle breed in the region was local indigenous zebu cattle most were Horo breed. These animals are often kept out, grazed and crossed all day near the vicinity of the Gibe river as it is communal grazing lands and watering points for the farmers. All age groups and both sexes are included in the study. Body condition scores of the study animals was categorized as poor body condition score (1-2), medium body condition score (3-4) and good body condition score (5) according to Morgan *et al*. (2006).

e) Data collection and laboratory analysis

After proper restraining and recording all the relevant information like date of sample collection, identification number of the animals and the hypothesized risk factors into the pre-prepared data recording sheet, fresh fecal samples were directly collected from the rectum of the animals in the field using gloved hand. The collected sample was preserved in 10% formalin in clean and labeled screw cap universal bottle to prevent hatching of miracidia before reaching laboratory to diagnose within 24 hours of collection. It was placed in ice box and transported to Bakko Agricultural Research Center laboratory. Then, the samples were concentrated using sedimentation technique and, smears were made on microscopic slide and observed under low power (10x) microscope. The slides were judged positive when oval to spindle-shaped with centrally bulged and terminal spine on one side of egg was identified according to the keys and description recommended by Urquhart *et al.* (1996) in the laboratory.

f) Statistical Analysis

The data were first entered in to Microsoft Excel work sheet version 2010 and analyzed using Statistical Package for Social Sciences (SPSS) software version 20. Descriptive and inferential statistics were utilized to summarize the data. The overall prevalence of schistosomiasis was calculated by dividing the total number of animals positive to the total number of animals examined. For inferential analysis multivariate logistic regression was used to infer on the level of strength of association of explanatory variables hypothesized with the outcome variable after calculating the odds ratio. A 95% confidence interval of the OR and p-values were used to describe statistical significance associations. The association is judged as significant when p- value is less than 0.05.

III. Results

Among a total of 384 cattle examined using coprological examination 22.92% (88/384; 95% CI (18.7, 27.1)) were positive for *schistosoma bovis* eggs. The multivariate logistic regression analyses of the risk factors indicated the presence of strong statistical association of schistosoma infections with the body conditions (p=0.001) and animal origins (p=0.000) while variables like sex, age and months are not significantly associated with the risk of acquiring schistosoma infection.

a) Prevalence of Bovine Schistosomiasis Based on Risk Factors

The prevalence of bovine schistosomiasis was higher in Bakko 02 (43.75%) than the other five PAs. As indicated in table 1, statistically significant difference (p=0.000) was observed among origins with occurrence of bovine schistosomiasis. Cattle from Bakko 02 PAs were 1.626 times more likelihood to be infected by bovine schistosomiasis than animal from Dambi dima PAs, while animal from Dambi gobbu, Gajo, Bakko 01 and Abbo metti PAs had 0.447, 0.061, 0.256 and 0.794 times less likely to be infected by bovine schistosomiasis than animals from Dambi dima respectively.

Based on the body condition score of the study animals the prevalence of bovine schistosomiasis was highest in poor body condition (32.46%) followed by medium body conditioned animals (21.42%) and good body conditioned (11.86%). Strong statistical association (p= 0.001) was observed between body condition scores and occurrence of schistosomiasis (Table 1). Cattle with good and medium body condition scores had 0.254 and 0.708 times less likelihood to harbor bovine schistosomiasis than animal with poor body condition score respectively.

The highest prevalence of bovine schistosomiasis according to the study months (period) was recorded in January (27%) followed by November (25%) and the lowest was during March (15.58%) as indicated in (Table 1). Eventhough the result was higher in January, the difference was not statistically significant.

The prevalence of bovine schistosomiasis based on sex was 18.45% and 28.09% in male and female respectively. Although the prevalence was relatively higher in female; the differences in infection probability is not statistically significant (p=0.126) as indicated in Table 1. The prevalence of bovine schistosomiasis regarding to the age groups of study animals was lower in adult (19.2%), versus (24.6%) in young indicating the odds of schistosomiasis to be 1.236 more likely in young but was not statistically significant (Table1).

IV. Discussion

The cross-sectional study was primarily conducted to assess the prevalence of bovine schistosomiasis and investigate potential risk factors related to its occurrence. Its overall prevalence was 22.92% (88/384; 95% CI (18.7, 27.1)). This is important because quantitative assessment this disease provided good evidence to look for its economic burden. Accordingly, the present study revealed that bovine

Global Journal of Science Frontier Research (D) Volume XVII Issue I Version I Year 2017

schistosomiasis is found to be an important livestock disease in and around Bakko town.

This result is higher when compared with previous findings of Lo and Lemma (1973) 1.5% prevalence in Gewanie; Amero (1993) 12.4% prevalence in Awassa; Yalelet (2004) 17.4% prevalence, and Almaze (2007) 10.93% prevalence in Bahir Dar; Zelalem (2010) 12.5% prevalence, Mengistu *et al*. (2012) 10.17% prevalence, and Mersha *et al*. (2012) 13.70% prevalence in Fogera; and Mihret and Samuel (2015) 7.6% prevalence in Debre Tabor. The difference could be due to the presence of stagnated water bodies and marshy pasture land, epidemiological factors like hosts' breed, agro-ecological factors like irrigation practices, husbandry (management) practice of animal like freely grazing or tied, health care of animals. For example, Hailu (1999) had reported that Fogera breed is known for its tolerance to parasitic diseases. As described by Mersha *et al*. (2012) cattle schistosomiasis is dependent on environmental factors such as moisture, rain fall, temperature, water bodies (stagnate, swampy, marshy), snail intermediate hosts and husbandry practice such as grazing system, keeping animals whether they are kept all together or separately, feeding (contaminated pasture with cercaria) and drinking areas.

This finding is almost comparable with the reports of Solomon (2008) 24.73% prevalence, and Samuel *et al.* (2016) 26.3% prevalence in and around Bahir Dar, Belayneh and Tadesse (2014) 24.3 % prevalence and Assefa *et al*. (2016) 26.6% prevalence in Bahir Dar.

However, it is lower than the previous studies conducted in Bahir Dar by Hailu, (1999) 34% prevalence; in Kemissie by Amen *et al*. (2001) 28% prevalence; in Bahir Dar by Almaz and Solomon (2011) 37.7% prevalence and in Dembia by Alemseged (2015) 27.13% prevalence. These variations may be due to the difference in humidity and water (moisture) contents, and irrigation practice of the study areas. It also might be due to variation in sample size, study season and duration of the studied area from current study site. As stated by Maqbool *et al.* (2003) and Cameron *et al.* (2004), the presence of schistosomiosis and difference in their prevalence will be influenced by the local climatic conditions, presence or absence of water reservoirs, lakes, rivers and availability of suitable intermediate hosts. Irrigation practice is favorable for development and multiplication of snail intermediate hosts as reported by Mersha *et al*. (2012).

The result showed relatively highest prevalence of cattle schistosomiasis in Bakko 02 (43.73%) and Dambi dima (32.81%) Kebeles while the lowest prevalence in Gajo (3.12%) and Bakko 01(10.94%) with statistically significant difference (p=0.000). The variation in the prevalence of the disease may be due to presence of stagnant water bodies, number of rivers and streams, high moisture nature of most of the grazing areas, and larger boundary border of Bakko 02 and Dambi dima to Gibe River than others. This make more favorable condition for the multiplication of intermediate host, hence the schistosoma infection and give more chance of infection to occur. Mersha *et al*. (2012) and Samuel *et al*. (2016) have reported that logged water, poorly drained areas with acidic soil are often endemic to schistosomiasis. As compared to other Kebeles Gajo has lowest number of tributary rivers, stagnated water bodies and far from Gibe River that may contribute to lowest prevalence of the disease.

When the data on the monthly prevalence of bovine schistosomiasis were analyzed, it was observed that highest prevalence of bovine schistosomiasis occurred in the January (27.28%). This is may be due to the agricultural practices of the study area that the farmers are carrying out the irrigation activities for potatoes, tomatoes, cabbages and chili pepper mostly during January; after collecting their usual summer agricultural products. Also lack of feed and water during the dry month of January may make the animal to graze around marshy area that might be contaminated by the infective cercaria. William (2001) also reported that the two important factors influencing the incidence of schistosomiasis are adequate temperature and moisture in the environment, which helps the hatching of fluke eggs, the availability of cercariae and population of the snails. Pfukeni *et al.* (2005) in Zimbabwe also reported similar finding.

The sex level result difference indicated that prevalence was relatively higher in female (table 1). This finding agrees with the previous findings of Solomon (2008) 29.61% prevalence in female and 19.54% prevalence in male in and around Bahir Dar, Belayneh and Tadesse (2014) 25.9% prevalence in female and 22.4% prevalence in male in Bahir Dar, Asressa *et al.* (2012) 11.22% prevalence in female and 4.94% prevalence in male in Andassa Livestock Research Center and Alemseged *et al*. (2015) 30.70% prevalence in female and 23.30% prevalence in male in Dembia district but not in line with previous findings of Mersha *et al*. (2012) 15.38% prevalence in males and 12.14% prevalence in female, Mengistu *et al*. (2012) 12.05% in male and 8.33% in female and Marawe *et al*. (2014) 4.2% in male and 3.2% in female in Fogera; Assefa *et al*. (2016) 28.7% in male and 25.1 % in female in and around Bahir Dar. The insignificance of the difference may show that both sexes were at about the same risk to acquire the infection for the reason they graze at the same time, in the same grazing area with the same grazing behavior because there is no interference on movement for grazing, drinking and contact with the parasite in terms of sex as it is extensive management system. Therefore, the disease appeared to be well distributed between the two sexes. Similar finding was reported by Almaz and Solomon (2011) in Bahir Dar.

The prevalence of schistosomiasis in this study in relation to was higher in young (24.6%) than the adult animals (19.2%) as indicated in (table 1). This result is in agreement with previous finding of Marawe *et al.* (2014), who reported 9.57% prevalence in young and 2.06% prevalence in adult in Fogera, but it is not in line with the report of Alemseged *et al.* (2015) 30.10% prevalence in young, 27.80% prevalence in adult and 17.60% prevalence in calves in Dembia district. The absence of significant difference between age categories might be because of equal exposure to the risk factors. Since the management was freely grazing extensive husbandry system; all age has equal chance of contacting infective cercaria and acquiring the infection on the field. All the animals were grazing in the marshy and stagnated area that is suitable for the snail intermediate vector. The lower result in adult as compared to young could be due to strong acquired immunity against the parasites, which could suppress the worm fecundity and decrease the release of parasitic eggs within the faeces. Samuel *et al.* (2016) also reported similar justification in and around Bahir Dar.

The statistical analysis of this study showed that body condition score of the animals had significant influence on the prevalence of bovine schistosomiasis in the study area. The highest prevalence was observed in animals with poor body conditioned (32.46%) followed by medium body conditioned (21.42%); while the lowest was observed in cattle with good body conditioned (11%), in which the difference was statistically significant (table 1). This could be due to the fact that acquired immune status of animals with poor body condition and that are weak become suppressed and prone to become more susceptible to harbor parasites as stated by Marquardt and Greive (2000) and Mihret and Samuel (2015).

This finding is in line with the result reported by Merawe *et al.* (2014) in Fogera, where higher prevalence (9.3%) was observed in animals with poor body condition than medium (0.4%) and good (3.9%) body condition, Belayneh and Tadesse (2014) who reported high prevalence in poor body condition (68.88%) than that of medium (17. 54) and good (11.36%) body conditions in Bahir Dar and Samuel *et al.* (2016) who reported 36.8% in good, 19.7% in medium and 10.6% in good body condition in and around Bahir Dar.

The overall prevalence of this study is 22.9%; which is big and can cause a significant economic loss to the local communities. It can be concluded that origin and body condition of animal were highly associated with the occurrence of bovine schistosomiasis. The disease might be present in endemic pattern in the study area that deserves serious attention. Therefore, it is important to obtain detail epidemiological investigation with regard to the host parasite relationship, available snail species which will aid for further control and prevention strategic development. Schistosomiasis should be taken into consideration as a one of the major limiting factor to livestock productivity in and around Bakko town; hence any attempt towards animal disease control strategy must include it in the priority list.

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Table 1: Final multivariable logistic regression model output of factors associated with fecal shedding of schistosomia eggs from cattle (n=384) from Bakko, Ethiopia.

Risk factors	Categories	No	(Prevalence %)	95%CI	OR	95%CI	P-value
Origin	Dambi Dima	64	21 (32.81%)	(21.3, 44.3)	ref.	ref.	
	Dambi Gobbu	64	13 (20.03%)	(10.5, 30.2)	0.447	(0.193, 1.035)	
	Gajo	64	2 (3.12%)	(-1.1, 7.4)	0.061	(0.013, 0.278)	0.000
	Bakko 01	64	7 (10.94%)	(3.3, 18.6)	0.256	(0.097, 0.675)	
	Bakko 02	64	28 (43.75%)	(31.6, 55.9)	1.626	(0.756, 3.497)	
	Abbo Metti	64	17 (25.56%)	(15.7, 37.4)	0.794	(0.357, 1.769)	
Months	November	76	19 (25%)	(15.3, 34.7)	ref.	ref.	
	December	77	19 (24.67%)	(15, 34.3)	0.855	(0.382,1.911)	0.410
	January	77	21 (27.28%)	(17.3, 37.2)	1.105	(0.494, 2.468)	
	February	77	17 (22.08%)	(12.8, 31.3)	0.738	(0.324, 1.681)	
	March	77	12 (15.58%)	(7.5, 23.7)	0.491	(0.205, 1.174)	
Sex	Female	178	50 (28.09%)	(21.5, 34.7)	ref.	ref.	0.126
	Male	206	38 (18.45%)	(13.8, 23.7)	0.662	(0.389, 1.125)	
Age	Young	264	65 (24.62%)	(19.4, 29.8)	1.236	(0.684, 2.236)	0.483
	Adult	120	23 (19.2%)	(12.1, 26.2)	ref.	ref.	
BCS	Poor	154	50 (32.46%)	(25.1, 39.9)	ref.	ref.	
	Medium	112	24 (21.42%)	(13.8, 29.0)	0.708	(.377, 1.329)	0.001
	Good	118	14 (11.86%)	(6.0, 17.7)	0.254	(0.126,0.510)	
Total		384	88(22.92%)	(18.7, 27.1)			

OR=Odds Ratio, No-=Number of animal examined, CI=Confidence Interval, ref=reference cell

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The Maps for Precision Fertilization, Manuring and Liming - Requirements for their Preparation. A Case of Poland

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Abstract- Fast development of precision agriculture in last years requires detailed maps for precise application of lime, manure and mineral fertilizers. Two kinds of maps are required: a general, base map, and application maps of a particular inputs. The general base map should contain management zones, resuming all factors affecting field management and fertilization, such as the water bodies, trees and windbreaks in direct neighborhood of the field, field topography, soil texture to a depth of about 1m, organic matter content, overall assessment of moisture/drainage conditions on the field and other factors, which may affect field management in long-term period. The application maps regarding a particular applications of lime, manure and mineral fertilizers should be prepared using the current results of soil analyses and the base map before each input application. Variable N application during crop vegetation should take into account also the weather conditions in a period preceding the application and current canopy N status or yield predicted in a particular vegetation period. The scale/resolution of the maps for precision agriculture should be concordant with the technical possibilities of the equipment used for application of various materials on a particular farm.

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Michał Stępień

Abstract- Fast development of precision agriculture in last years requires detailed maps for precise application of lime, manure and mineral fertilizers. Two kinds of maps are required: a general, base map, and application maps of a particular inputs. The general base map should contain management zones, resuming all factors affecting field management and fertilization, such as the water bodies, trees and windbreaks in direct neighborhood of the field, field topography, soil texture to a depth of about 1m, organic matter content, overall assessment of moisture/drainage conditions on the field and other factors, which may affect field management in long-term period. The application maps regarding a particular applications of lime, manure and mineral fertilizers should be prepared using the current results of soil analyses and the base map before each input application. Variable N application during crop vegetation should take into account also the weather conditions in a period preceding the application and current canopy N status or yield predicted in a particular vegetation period. The scale/resolution of the maps for precision agriculture should be concordant with the technical possibilities of the equipment used for application of various materials on a particular farm.

I. Introduction

During last few years fast development of precision agriculture has been observed. It results from the interest of farmers to optimize their production, new farm equipment and software available and online services dedicated to precision agriculture.

The main purpose of a precise field and crop management is an optimal utilization of inputs in particular parts of the field. These inputs comprise not only different substances applied to soil (fertilizers, manures, amendments, some pesticides) or over crop canopy (pesticides) but also amount of seeds or other sowing material and fuel, which use is affected for example by a tillage depth and other inputs. This paper is focused on variable lime, manures and fertilizer application using precision agriculture techniques. For example, fertilizers should be applied in greater doses in field zones with higher yielding potential and in smaller doses in field zones without potential to obtain high yields, if both zones have the same status of nutrients availability. However, sometimes the same soils may have high yielding potential in wet years and low yielding potential in dry and vice versa (Delin and Berglund 2005). A proper establishment of variable doses of fertilizers and similar materials within a field combine two aspects: economic and environmental. The optimal use of production means – only dose and time, when they are actually to reduce crop production costs. The application of inputs at right dose and at the right time also results in avoidance of excessive use of the inputs, which could contribute to soil degradation or soil, air and water pollution (Anonymous 1991, Duer et al. 2004).

A great variability of crop yields and soil properties, even within one field and at small distances is frequently found in Poland (Kośmit and Podlasiński 2002, Podlasinski 2013, Usowicz et al. 2004) and other countries (Lucas et al. 2009, Czech Republic). For this reason preparation of large scale, detailed soil maps is needed for precision field and crop management purposes.

The present paper has the aim to discuss requirements, which should be fulfilled by detailed soil maps and about the possible sources of data for these maps preparation and which are available in Poland.

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II. Requirements, which should be Met by Maps for a Precision Fertilization

a) Map content

The content of a map depends on the purposes of the creation of a such map. The maps used for precise manuring or liming in a particular year or even at a date, should contain, above all, the doses of material to be applied in particular place. However, depends on many factors (Table 1). A field topography is one of the factors affecting fertilization indirectly, because it influences movement of water – not only on a field surface, but also a subsurface run of water in soils with a finer subsoil. Such water movements cause also translocation of nutrients applied with fertilizers, mainly nitrogen (N) and potassium (K), but also others. For this reason it should be considered to increase doses of fertilizers in higher parts of the field and reduce these doses in lower parts. The field surroundings also certain importance in the application of fertilizers and manures. First, the open water bodies adjacent to the field limit

Global Journal of Science Frontier Research (D) Volume XVII Issue I Version I Year 2017

manuring and fertilizers applications (DEFRA 2009, Duer 2004). Trees close to the field borders in a form of windbreaks or forest cause reductions of yield in their nearest proximity, within a distance approximately equal to the half of their general effect on crops grown at quite greater distance is positive (David et al. 1994, Jakubczak i Wołk 1977). Doses of fertilizers should be reduced in the nearest vicinity of forest or windbreak.

The dose of lime is determined by soil pH and buffer properties, which are determined mainly by soil texture and soil organic matter (DEFRA 2010). Common recommendations of lime doses in Poland take into account pH values and simplified classification of soil texture according to the content of soil particles finer than 0.02mm (IUNG 1990, Jadczyszyn et al. 2010).

The manure, as conventional fertilizers, if applied in excess, may be a source of pollution of surface water and groundwater (Moshia et al. 2014). On the other hand farmyard manure and other organic materials may consist an effective amendment to improve majority of properties and productivity of degraded soils (Mercik et al. 2004a, b). They slightly increase pH of acid soils (Mokolobate and Haynes 2002, Narambuye et al. 2008, Stępień et al. 2004a, Whalen et al. 2000), organic matter content and availability of nutrients (Mokolobate and Haynes 2002, Stępień et al. 2004a, Whalen et al. 2000). As consequence, the places and doses of manure application should consider the risk on environmental pollution, i. e. the distance to surface of water bodies, soil drainage capacity, groundwater level, and potential yields, to avoid excessive nutrient application. On the other hand, the applications of maximum manure doses admitted by the law or more frequent applications should be considered in places without a risk of environmental pollution and with different constraints for crop production, which may by amended or alleviated by addition of organic matter. These constraints comprise low organic matter content, extreme acidity, places susceptible to shortage of water (e. g. sandy field areas) and/or susceptible to waterlogging (fine soils). Also a depth of manure application may depend on local soil conditions, for example it should be deeper in more sandy soils.

The doses of P and K, but also N fertilizers, if applied before sowing or planting should be based on crop nutrient demand, which depends mainly on crop potential productivity in particular site and current soil fertility status – i.e. the content of available forms of particular nutrient in soil. Crop productivity worldwide is limited mainly by supply of water (Mueller et al. 2010), especially in rainfed agriculture. The main factors affecting plant water supply at field scale is surface and subsurface soil texture to a depth of about 100cm, field topography and organic matter content.

The doses of N applied during crop growth are also determined by crop demand, depending mainly on soil productivity in particular sites. However, the soil productivity is frequently not the same across years (Delin and Berglund 2005, Singh 2016). Some sites, especially with coarse (sandy or gravelly) soils have generally low productivity, but in some years with exceptionally favourable distribution of precipitation may be very productive. As opposite to this, some sites with fine soil or with strong increase of clay in subsoil, located especially in flat and low parts of the field have drainage problems. Such sites are characterized by low or even null productivity in wet years, but might be the most productive in dry years. For this reason, the N doses should be modified according to weather conditions in a particular year. For example, during the wet years, the N-doses should be increased in the places with good drainage and reduced in places of being in danger of water logging. Opposite modifications of N doses should be performed during dry years. Currently, the main factor modifying N doses, within fields, during crop growth is canopy N status, assessed by the use of various optical sensors. The current crop N status is determined by both soil properties and weather conditions in the time preceding N applications. However, the prescription of a variable N-rate based only on crop status, expressed by NDVI (Normalized Difference Vegetation Index) reading and without a direct consideration of soil variability did not produce consistent, positive and strong effects on grain yields (6-8.5t/ha) of intensively managed winter wheat in northern Poland (Samborski et al. 2016). It indicates, that the N-prescriptions during vegetation must be based on combination of various criteria such as canopy status, soil maps indicating areas with problems with both excessive and poor drainage, yield limiting factors and estimated yield potential in a particular year due to weather condition in the period preceding N application.

The analysis of the Table 1 and above considerations allow to draw a conclusion, that precise applications of lime, manure and N, P and K fertilizers require maps with doses prescribed for each of the inputs separately. However, precise base maps of so-called management zones (MZs) are even more important than application maps. The delineation of these MZs should not be based only on potential yields (Blackmore 2000, Diker et al. 2004, Moshia et al. 2014), but on all important factors affecting crop productivity, directly interacting with materials applied to soil and the environmental risk of excessive input applications. These factors include presence of open waters in areas adjacent to a field, groundwater level, field topography, and soil properties relatively stable in time, such as texture of topsoil and subsoil, drainage conditions (actually – determined by topography, soil texture and groundwater level) and organic matter content. It might be noted, that almost all these factors can be derived from agricultural soil maps at a scale of 1:5000 and

1:25000, comprising the whole agricultural area of Poland (Terelak and Witek 1995, Bednarek et al. 2011). These maps were made about 40 years ago and their content not always reflects the current status of the fields (Koćmit and Podlasiński 2002, Podlasinski 2013, Stępień et al. 2016, Świtoniak et al. 2016), but may be a useful source of information about the field at the beginning of introduction of precision agriculture, before preparation of better maps with modern techniques. The detailed base maps might be prepared once for a longer time period comprising 10-30 years, if there is no any natural or anthropogenic change regarding field conditions during this time, such as flood, artificial draining, surface levelling, etc. Such maps should be considered, together with results of soil chemical analyses and used for preparation of detailed maps for precise application of lime, manure and mineral fertilizers.

Table 1: Main factors to be considered in precise application of lime, manure and N, P and K fertilizers

Material applied		Surroundings of field	Topography	Yield potential	Current crop status	Topsoil texture	Subsoil texture	Drainage conditions	pH	Organic matter content	Available (mineral) N	Available P	Available K
Lime		-	+	-	-	+	?	-	+	+	-	-	-
Manure		+	+	+	-	+	+	+	+	-	+	+	+
Fertilizers applied before sowing or planting	N	+	+	+	-	+	+	+	-	+	+	-	-
	P	+	+	+	-	+	+	-	-	+	-	+	-
	K	-	+	+	-	+	+	-	-	-	-	-	+
N after planting or sowing		+	+	+	+	+	+	+	-	+	+	-	-

+ factor is or should be considered in precision agriculture

- factor does not have to be considered

b) Map resolution/scale and quality (precision)

Nowadays, the map resolution is of greater importance than the scale. This statement results from the fact, that current computer software permits to zoom in any existing image to the scale desired by the user. For this reason it is much more important to consider, what is a minimum field area to be shown on the map or simply map resolution. This field area should depend on: 1) variability of the mapped feature (recommended dose of lime, manure or mineral fertilizer) on the particular field and 2) resolution of the farm equipment and 3) resolution of methods used for mapping.

The changes of soil properties within one field may occur at very small distances, even of several meters (Koćmit and Podlasiński 2002, Lucas et al. 2009, Podlasiński 2013, Usowicz et al. 2004), and these could create a need of preparation of very detailed maps. However, the technical possibilities of variable application of particular input are more likely to determine the required resolution of application maps, than the variability of a particular soil property within the field. It would be rather unreasonable to prepare maps of greater resolution, than the working width of the input application equipment currently used or supposed to be used within next years on farm. Consequently, the required map resolution depends on a particular farm – mainly production scale and the area of fields to be fertilized. The working width of farm equipment depends on production scale and destination of machinery. For example, the working width of a tractor sprayer usually ranges between 6 and 50 meters and the working width of spreader used for lime, or mineral fertilizer application generally varies between about 4 to 40 meters. The applications of solid manures are generally performed by spreaders with working width of 2-20m. Except the working width of the input application equipment, it is important, how fluently and quickly the equipment may change the application dose. In case of spreaders and sprayers it does not occur immediately, but requires a distance of several meters. Probably, this distance is rather not significantly greater, than the working width of equipment. The technological progress in agriculture makes possible to design of machines applying different doses of inputs by different sections of a pneumatic spreader or sprayer at the same time. However, for now it can be assumed, that the required resolution of the maps prepared for precision agriculture purposes should be of a half to a full working width of machines used on a particular farm for spreading fertilizers. In other words, this resolution should be of about 5-30m

It is important to ask a question, if currently existing technologies make possible to create of field maps at this resolution. Certainly yes, however the technical possibilities of mapping soil properties may be limited mainly by costs. It is unreasonable to sample or analyse soil at dense grids, as mentioned above 5 or 15 meters, but currently existing technologies for proximal and remote soil sensing permit to map the fields with a higher resolution and at relatively low costs and to locate the places on the fields, which should be

Global Journal of Science Frontier Research (D) Volume XVII Issue I Version I Year 2017

sampled more densely or more sparsely, depending on local soil heterogeneity. The main technologies, which may be helpful in a preparation of detailed maps for precision agriculture purposes, comprise mapping of yield, vegetation indices such as NDVI, and EC/ECa (electrical conductivity/apparent electrical conductivity on the farm Stępień et al. 2016). There are also many external sources of data, which may be available for farmers. The most important sources of such data may be images obtained from airplanes, drones and satellites. All these sources of images may provide useful data concerning field topography – derived from LIDAR and spectral data, which may be used for the calculation of vegetation indices. Some satellite data are freely available at the resolution which may be useful for precision agriculture, e. g. 30m in case of Landsat 8 satellite or 10m for Sentinel 2 satellites (Turner et al. 2015).

The last issue to be considered is the required quality of maps prepared for precision agriculture purposes. This should be understood rather in terms of a correct delineation of particular areas (MZs) on the map and internal uniformity of these delineations than obtaining of smooth map contours. Correct delineation of MZs, means, that their placement and extent on the map should be as close as possible to the field's reality, to assure adequate and precise application of fertilizers. In the author's opinion, the agreement between map and field should be greater than 90%. Although it may be very difficult to achieve on very variable fields and at low cost. However, only such maps will be a good base for a precise fertilization. On the other hand, if soil texture is considered as an example, it is not necessary to delineate each soil texture group on the map, as they are presented on a agricultural soil map (Stępień et al. 2016). It is rather recommended to map, in case of Poland, soil texture groupings based on the content of particles smaller than 0.02mm, and called "agronomical categories" ("kategorie agronomiczne" in Polish, IUNG 1990), because these groupings are considered in liming and K and Mg fertilizer recommendations (IUNG 1990, Jadczyszyn et al. 2010). As the fertilization/liming/manuring is supposed to be uniform within a particular MZ, this MZs should also be as uniform as possible, with minimum internal variability. In other words, the generalization of these maps should be strictly related to the possibilities – resolution of application – of the equipment used on a particular farm. The delineations present on the application map may include generalized spots of different soil, if their dimensions are smaller than the working width of machines used in the map.

III. Summary

In author's opinion, precision applications of lime, manure and mineral fertilizers require 2 kinds of maps: a general base map, and an application map of a particular input. The general base map should contain so called management zones, resuming all factors affecting field management and fertilization. These factors should include water bodies, forests and windbreaks in direct neighborhood of the field, field topography, soil texture to a depth of about 1m, organic matter content, overall assessment of moisture/drainage conditions of the field and other relatively stable factors, which may affect field management in a long-term period. The maps regarding application of a particular input: lime, manure and mineral fertilizers should be prepared on the base of actual results of soil analyses and on the base map before each application. Variable N application during crop vegetation should take into account also weather conditions in the period preceding the application and current canopy N status, soil moisture yield predicted in a particular vegetation period.

The scale/resolution of application maps should be concordant with the technical possibilities of the equipment used for application of various inputs on a particular farm.

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Water use Efficiency of Maize Crop under Deficit Irrigation Scheduling using Gravity Drip System in Samaru, Nigeria

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Abstract- The use of gravity fed drip irrigation systems is fast gaining popularity in Northern Nigeria. The drip kit uses gravity instead of a pump to provide the head (energy) for its operation. The water source (a tank or bucket) is usually place some meters above the ground to provide the pressure head. In the study reported herein, a field experiments were carried out at the Institute for Agricultural Research (I.A.R) irrigation farm Samaru-Nigeria during 2012/2013 irrigation season to evaluate the effect of deficit irrigation scheduling, using the gravity drip kit, on yield and water use of a maize (SAMAZ 14 variety) crop. The field experiment consisted of eight treatments replicated three times. The treatments comprises of a control treatment which was given full irrigation (irrigated at 100 % water requirement) and a full deficit treatment which was irrigated at 50 % water requirement. The other treatments were irrigated at 50 and 75 % of water requirement at different growth stages of the maize crop. The irrigation interval was alternated between three and four days.

Keywords: emission uniformity, emitter, discharge, application efficiency, water use efficiency, crop yield.

GJSFR-D Classification: FOR Code: 820401

WATERUSEEFFICIENCYOFMAIZECROPUNDERDEFICITIRRIGATIONSCHEDULINGUSINGGRAVITYDRIPSYSTEMINSAMARUNIGERIA

Strictly as per the compliance and regulations of :

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Oiganji Ezekiel α, Igbadun, H. E σ, O. J Mudiare ρ & M. A Oyebode ω

Abstract- The use of gravity fed drip irrigation systems is fast gaining popularity in Northern Nigeria. The drip kit uses gravity instead of a pump to provide the head (energy) for its operation. The water source (a tank or bucket) is usually place some meters above the ground to provide the pressure head. In the study reported herein, a field experiments were carried out at the Institute for Agricultural Research (I.A.R) irrigation farm Samaru-Nigeria during 2012/2013 irrigation season to evaluate the effect of deficit irrigation scheduling, using the gravity drip kit, on yield and water use of a maize (SAMAZ 14 variety) crop. The field experiment consisted of eight treatments replicated three times. The treatments comprises of a control treatment which was given full irrigation (irrigated at 100 % water requirement) and a full deficit treatment which was irrigated at 50 % water requirement. The other treatments were irrigated at 50 and 75 % of water requirement at different growth stages of the maize crop. The irrigation interval was alternated between three and four days. The drip system layout consisted of three drip lines of 5 m long each per treatment, given a total of 72 lines for the entire field. The drip tape was 16 mm diameter with in-built emitters spaced 30 cm interval. The drip lines were spaced 60 cm apart in each treatment, and a 2000 litres capacity GeePee tank placed 3 m above the ground was used to supply water. The hydraulic performance was drip system was evaluated, grain yield and crop water use were measured and crop water productivity was computed. The average variation of the emitter flow rate was found to be 19.7 %, the emission uniformity was 92 %, while the distribution uniformity was 91.9 %; which implies even distribution of water through the drip system. The average discharge coefficient of variation was 6.34 % and the average coefficient of variation uniformity was calculated as 93.6 %. The overall application efficiency of the system was 92.2 %. The overall average dripper discharge was found to be 0.557 liter/hr. Grain yield ranged between 1.56 and 3.39 t/ha, seasonal crop water use varied from 320 to 483 mm and crop water productivity ranged between 0.41 and 0.63 kg/m^3. The drip system was found to be very effective in administering deficit scheduling with high water application efficiency. The highest crop yield, seasonal water use and water productivity were obtained in the treatment that was fully irrigated, which implies that the deficit irrigation did not improve the crop response or water use efficiency. The results suggest that with gravity drip irrigation system, deficit irrigation practice will not lead to higher crop water use efficiency of the maize crop.

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Keywords: emission uniformity, emitter, discharge, application efficiency, water use efficiency, crop yield.

I. Introduction

The emerging threat to sustainability of irrigated agriculture in Nigeria requiresa paradigm shift in the way irrigation is practiced. The shift should embrace irrigation water management strategy that can facilitate the achievement of the goal of producing more crops per drop of water. Drip irrigation cum deficit irrigation scheduling seems a combination that may deliver on this goal. The drip irrigation system applies water tothe base of the plants as frequent as designed with a volume of water approaching the consumptive use of plants, thereby minimizing such conventional losses such as deep percolation, runoff and soil water evaporation (Mofoke *et al.*, 2006). Drip irrigation is accomplished by using small diameter plastic lateral lines with devices called emitters or drippers at selected spacing to deliver water to the soil surface near the base of the crops. The system applies water slowly to keep the soil moisture of the base of the plants within the desired range for plant growth (Ramalan *et al*., 2010; Angela 2012).

Deficit irrigation scheduling on the other hand is the practice of irrigating crops below the full water requirement. It can be described as rationing water applied to the cropped field. In economic terms, deficit irrigation increases irrigation efficiency, reduce cost of irrigation and opportunity cost of water, while in ecological terms it prevents rising water tables in areas where the water levels are near the surface and minimizes leaching of agrochemicals to ground water (Angela, 2012). The combination of drip irrigation system and deficit irrigation scheduling is therefore expected produce a remarkable improvement in terms of increased irrigation efficiency resulting from less water application, better water management irrigation improve.

The use of gravity fed drip irrigation systems is fast gaining popularity in Northern Nigeria. There are over a hundred units of drip kits scattered across Katsina, Zamfara and Kebbi States. Some are used with rainwater harvesting systems as the water source. The drip system uses gravity instead of a pump to provide the head (energy) for its operation. The water source (a tank or bucket) is usually place some meters above the ground to provide the pressure head to take water to the emitting points. In most cases, a drip irrigation system consists of raised water container, main-line, sub-main-line, drip laterals, filters, pressure gauges, flow meter and fittings (elbow, tee, nipple, socket, end cover, gate valve, ball valve, amongst others) (Mofoke *et al.*, 2006; Segal*etal.,*2000; Mofoke *et al*; 2006;Oyebode *et al*., 2011). Water is conducted under low pressure to a network of closely spaced outlets (emitters) which discharge water slowly at virtually zero pressure, with the purpose of supplying water to limited soil volume in which active root uptake can take place (Victor *et al.,* 2008; Ahmed, 2006).

Maize production in Nigeria is on the increase. The estimated average annual growth rate inmaize production over the last five years in Nigeria was 5.46% about twice the projected value of3.2% needed to meet demands. The FAO (2013) estimation of annual production of maize in Nigeria is 7.5milliontonnes. Maize production under irrigation is also on the increase, but the produce is largely harvested and sold as green maize, rather than dry grains. Irrigation water management is still a very major challenge for which drip irrigation system cum deficit irrigation scheduling can make significant impact. Yet knowledge gaps exist in terms of impact of deficit irrigation scheduling using drip irrigation kits on yield and water use efficiency of the maize crop. The objective of this study was to evaluate the effect of deficit irrigation scheduling, using the gravity drip kit, on yield and water use of a maize crop.

II. Materials and Methods

a) The Study Area

The field experiment was carried out at the Institute for Agricultural Research (I.A.R) Irrigation farm, Ahmadu Bello University, Zaria, Nigeria. Zaria lies on 11°11'N and 7°38'E, and at an altitude of 686 m above mean sea level, within the Northern Guinea Savannah ecological zone (Odunze, 1998). The weather data for the crop growing seasons are presented in Tables 1, while the characteristics of the soils of the study location are shown in Table 2.

Table 1: Weather data for crop growing season

Month	Humidity (%)	Max. temp(°C)	Min. temp(°C)	Sunshine (Hours)	Wind speed(km/d)	ETo[a] (mm/d)	Total Rainfall (mm)
January	19.37	32.48	17.74	8.01	142.66	6.82	-
February	13.52	35.50	18.79	7.49	131.44	8.56	-
March	26.37	39.29	22.77	7.63	118.24	9.14	-
April	38.85	37.47	24.77	7.09	143.03	7.89	58.76

Table 2: Physical properties of soils of the experimental site

Depth (cm)	FC (%Vol)	PWP (% Vol)	Bulk density (g/cm^3)	Hydraulic Conductivity (mm/hr)	Clay (%)	Silt (%)	Sand (%)	Textural Class[a]
0-15	24.8	13.6	1.58	70	22	28	50	Clay Loam
15-30	26.3	15.9	1.58	100	26	22	54	Clay Loam
30-45	27.4	17.1	1.57	100	28	18	54	Clay Loam
45-60	25.9	15.9	1.58	125	26	18	56	Sandy clay loam
60-80	29.5	18.2	1.55	125	30	22	48	Sandy clay loam

[a] *Based on USDA textural classification*

b) The Drip Irrigation System Setup

The drip system setup has a 2000-litre capacity Gee-Pee tank placed on a metal frame stand 3 m high which services as the water reservoir. (An 8 hp petrol pump (Robin Model) was used to lift water from a water sump to the Gee-Pee tank. The sump receives water supply from a lake located 65 m away from the experimental field). A low density polyethylene pipe (of length 2.5 m and diameter 0.25 m) connected at the bottom of the water tank takes the water to the ground level. A primary filter was installed at be base of the polyethylene pipe. Another pipe of 3.5 m long connected with an elbow joint to the polyethylene pipe takes the water to the main distribution line with a Tee connection. The entire field of 40 m by 20 m was divided into two wings (A and B). Each wing (20 m by 20 m) was use for a different experimental setup, which implies that two experiments were ongoing concurrently and each was being supplied water from the overhead tank. The work reported herein was the experiment in Wing A. The wing has three primary sub-mains which were connected to the main distribution line, and each sub-main has a control valve to regulate the flow. The primary sub-mains supply water to each experimental block. Over each experimental plot were laid three drip tapes (laterals) of 5 m long spaced 60 cm apart. The drip tapes were connected to some secondary sub-mains, and these secondary sub-mains were connected to the primary sub-mains with a valve to regulate the flow of water. With this arrangement, you can regulate the flow of water to each experimental plot. The drip tapes referred to laterals in this design has inline emitters (of 16 mm diameters) spaced 30 cm apart. In the layout for the wing whose experiment is reported herein, there were 72 laterals of obtained from three experimental blocks (which were the replicates of the experimental treatments), eight experimental treatments/ plots and each plots has three laterals. Plate 1 shows the picture of the entire field.

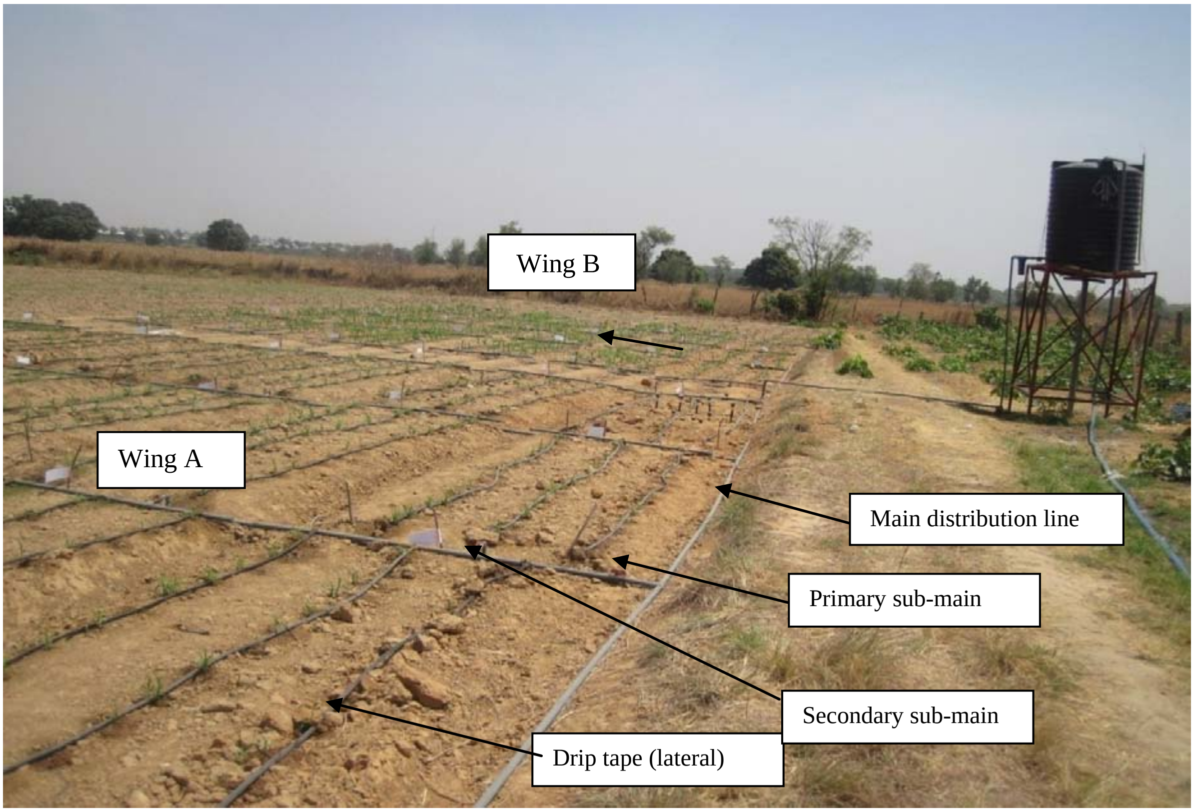

Plate 1: Experimental Layout of the field

The hydraulic performance of the drip system setup was evaluated using the Catch can test. Seventeen (17) drip points were randomly selected in the field; their distances from the water tank were noted and catch cans were used to collect water dripping from the drippers for one hour, and the following drip characteristics were determined: the emitter discharge (l/h) distribution uniformity (DU) (Merriam et al., 1980); emitter flow variation (Camp et al., 1997); emission uniformity (EU) (Michael, 1978), discharged coefficient of variation (Camp et al., 1997). coefficient of variation of uniformity, and water application efficiency (AE) (Vermeiren and Jobling, 1980).

c) *Experimental treatments, field practices and data collection*

The field experiment was carried out during the 2012/2013 irrigation season. The experiment consisted of eight (8) treatments replicated three times and laid in a randomized complete block design. The treatment description is as presented in Table 3. The $V_{100}F_{100}G_{100}$ treatments was full- irrigation (no deficit irrigation) while the $V_{50}F_{50}G_{50}$ treatment was full-deficit. In the other treatments, deficit water application took place in one growth stage which the other growth stages received full irrigation. The following growth-stages ranges were adopted: Vegetative (15-42 days after planting DAP); Flowering-tasseling to silking (43-57 DAP) and grain filling to physiological maturity stages (58-85 DAP).The variety of the maize crop planted was SAMMAZ 14 which is one of the releases of the Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria. Planted was done on the 7^{th} February, 2013. Manual weeding with the use of hoe was carried out three times for both fields at three, six and nine weeks after planting. Compound fertilizer (NPK 15:15:15) was applied at the rate of 60 kgN/ha at three weeks after planting, applied as basal dose. Urea fertilizer was used for topdressing at 6 weeks after planting at a rate of 60 kgN/ha as recommended by the Institute for Agricultural Research, Samaru, Zaria; thus the total N applied was 120 kg/ha. The fertilizers were applied after weeding on each occasion.

Table 3: Description of Experimental Treatments

Treatment Label	Treatment Description
$V_{100}\ F_{100} G_{100}$	Water was applied at 100% of ETo in all the growth stages.
$V_{75}\ F_{100}\ G_{100}$	Water was applied at 75% of ETo at Vegetative (V) Stage and 100% of EToat Flowering(F) and Grain filling (G) Stages.
$V_{50}\ F_{100}\ G_{100}$	Water was applied at 50% of ETo at Vegetative (V) Stage and 100% of EToat Flowering(F) and Grain filling (G) Stages.
$V_{100}\ F_{75}\ G_{100}$	Water was applied at 75% of ETo at Flowering (F) Stage and 100% of ETo at Vegetative (V) and Grain filling (G) Stages
$V_{100}\ F_{50}\ G_{100}$	Water was applied at 50% of ETo at Flowering (F) Stage and 100% of ETo at Vegetative (V) and Grain filling (G) Stages
$V_{100}\ F_{100}\ G_{75}$	Water was applied at 75% of ETo at Grain filling (G) Stage 100% of ETo at Vegetative (V) and Stages Flowering (F)
$V_{100}\ F_{100}\ G_{50}$	Water was applied at 50% of ETo at Grain filling (G) Stage 100% of ETo at Vegetative (V) and Stages Flowering (F
$V_{50}\ F_{50}\ G_{50}$	Water was applied at 50% of ETo in all the growth stages

The irrigation interval was alternated between 3 and 4 days throughout the crop growing season. The amount of water applied in each irrigation event depends on the experimental treatment. The full-irrigation treatment was given the depth of water equivalent of the sum of daily reference evapotranspiration (ETo) for the irrigation interval. The other treatments were given the percentage of the ETo, depending on the treatment. The depth of water applied varied from 15 to 40 mm per irrigation while the seasonal water applied varied from 434 to 699 mm. The water application efficiency was taken as 90 % being a drip system. The daily ETo was computed based in Hargreaves equation (Allen et al., 1998).

Soil moisture contents of the experimental plots were monitored throughout the crop growing season using calibrated gypsum blocks. Four blocks were installed in each experimental plot to monitor soil moisture resistance at intervals at 0-15, 0-30, 30-60, 60-90 cm depths. Soil moisture resistances were measured using Delmhorst soil moisture tester KS-D1 4862 model a day after irrigation and just before the next irrigation. The resistances measured were converted to gravimetric soil moisture content using the Gypsum-gravimetric moisture content calibration curve developed for the sets of gypsum blocks. The expression was obtained as:

$$GMC = 44.75 * R^{-0.24} \quad (1)$$

Where: GMC is the gravimetric moisture content (% dry weight basis) and R, the electrical resistance in ohm (Ω). The coefficient of determination for the expression was 0.8770.

The actual crop evapotranspiration ETa was calculated from the measured soil moisture content data using the expression:

$$AET = \frac{\sum_{i=1}^{n}(MC_{1i} - MC_{2i}) * AZ_i\ D_i}{t} \quad (2)$$

Where AET is average daily actual evapotranspiration between successive soil moisture content sampling periods (mm/day); MC_{1i} is gravimetric soil moisture content at the time of first sampling in the i^{th} soil layer; MC_{2i} is gravimetric soil moisture content at the time of second sampling in the i^{th} layer; AZ_i is the bulk density of depth i^{th} layer, D_i is depth of i^{th} layer (mm); n is number of soil layers sampled in the root zone depth D, and 't' is number of days between successive soil moisture content sampling.

There was no incidence of pests or diseases during the cropping season. The crop attained physiological maturity at 85 days after planting; irrigation was withdrawn thereafter to allow the crop to dry. Accordingly, harvesting was done by cutting the above ground dry matter, and the grains were removed from the cob. Both dry matter and grains were weighed in the Laboratory. The grain and biomass yield, seasonal crop water use, biomass and grain yield irrigation water productivity were subjected to statistical analysis of variance and the significance among treatment means was evaluated with Duncan's Multiple Range Test (DMRT).

III. Results and Discussion

a) Hydraulic characteristics of the drip irrigation system setup

Table 4 shows the hydraulic parameters of the drip system setup which includes emitter discharge (ED), emission uniformity (EU), distribution uniformity (DU), emitter flow variation (Qvar); discharge coefficient of variation (CVq), coefficient of variation of uniformity (CvU) and application efficiency (AE).

Table 4: Dripper flow rate different plots as affected by Lateral Length

No of drippers	Distance from the tank (m)	ED (l/hr)	EU (%)	DU (%)	Qvar (%)	CVq (%)	CvU (%)	AE (%)
1	5.4	0.50	94.1	93.8	15.9	4.9	95.1	94.1
2	7.7	0.68	88.6	88.9	32.9	8.7	91.3	88.6
3	10	0.61	86.9	85.2	32.3	11.7	88.3	86.9
4	10.8	0.39	91.5	91.4	20.5	6.7	93.3	91.5
5	10.9	0.52	91.1	91.2	20	6.9	93.1	91.1
6	11.9	0.42	95.9	95.9	11.4	3.2	96.8	95.9
7	12.3	0.65	86.8	86.1	28.8	11	89	86.8
8	14.9	0.5	94.1	94.4	14.3	4.4	95.6	94.1
9	15	0.52	90.4	91	21.2	7.1	92.9	90.4
10	15.4	0.42	89.1	88.1	30.1	9.4	90.6	89.1
11	17.3	0.62	93.5	93.7	17.2	4.9	95.1	93.5
12	19.5	0.51	93.3	93.5	16.9	5.1	94.9	93.3
13	21.9	0.66	88.8	90.0	22.1	7.8	92.2	88.8
14	26.6	0.61	95.4	95.4	12.2	3.6	96.4	95.4
15	26.9	0.65	93.6	93.3	16.5	5.3	94.7	93.6
16	27.3	0.54	96	95.8	11.0	3.3	96.7	96.0
17	28.4	0.68	95.3	95.2	12.0	3.8	96.2	95.3
Average		*0.56*	*92.02*	*91.94*	*19.72*	*6.34*	*93.66*	*92.02*

The emitter discharges ranged from 0.489 to 0.612 l/h. The average emitter flow variation being 19.7% is satisfied Michael (1978) and Jensen (1983) who recommended that in drip irrigation setup the average variation of emitter flow rate in the entire field should not exceed 20%. The result obtained indicates that the arrangement of the drip lines were satisfactory in terms of uniformity of flow from individual emitters. The average emission uniformity was obtained as 92% while the distribution uniformity was 92%, which is an indication of even distribution of water in the system. The average discharge coefficient of variation was 6.34 % and the average coefficient of variation uniformity was calculated as 93.6%. These results were consistent with the recommendations of Keller et al. (2001) who stated that a drip irrigation system with uniformity parameters, emission uniformity and distribution of uniformity of 85% or more and discharge variation of the whole system less than 20% is considered to be satisfactory. The overall average water application efficiency of the system was 92.2% which implies that the hydraulic performance of the drip setup was satisfactory.

b) Grain and Biomass Yield

Table 5 shows the grain yield (GY), biomass yield (BY) and harvest index (HI) which is the ratio of grain yield to biomass yield. Table 5also shows the percentage decreases in grain (ΔGY)and biomass yield (ΔBY)with respect to the full-irrigation treatment for the different treatments. The grain yield varied from 1.56 to 3.39 t/ha while the biomass yield ranged from 5.6 to 11.1 t/ha. The statistical differences among the yields of the experimental treatments were highly significant. Grain yields reduction due to irrigating at 75 % and 50 % at vegetative growth stage 12.7 and 30.4 %, respectively. Biomass yields were found to also reduce by similar percentage for same deficit irrigation application. Interestingly, reducing water applied by 25 % of ETo (i.e. irrigating at 75 % of ETo) during flowering growth stages reduced both grain and biomass yields by less than 10 %; but at 50 % reduction of water application, grains and biomass yield reductions shot up to 26.8 % and 36.7 %, respectively. This shows how sensitive the flowering growth stage of the maize crop is to water deficit, irrespective of the irrigation method.

It may be noticed from Table 5 that the deficit irrigation schedule during the grain filling to maturity growth stage did not have significant effect on the crop yields. This result does not suggest that the growth stage is not sensitive to deficit irrigation. The result obtained was influenced by rainfall which occurred twice during this crop growing stage The total rainfall for that period was about 58.8 mm, which may have ameliorate the impact of the deficit treatment, making treatment not significant difference in yield from the control. Irrigating at half the water requirements throughout the crop growth stages (treatment: V_{50} F_{50} G_{50}) also led to about 50 % reduction in both grains and biomass yield.

Table 5: Grain yield, Biomass yield and Harvest index of the Maize crop

Treatments	GY(t/ha)	BY(t/ha)	HI (%)	ΔGY(%)	ΔBY(%)
$V_{100}F_{100}G_{100}$	3.39a*	11.12a	31	0.0	0.0
$V_{75}F_{100}G_{100}$	2.96 c	9.60c	30	12.7	13.7
$V_{50}F_{100}G_{100}$	2.36 d	7.65d	30	30.4	31.2
$V_{100}F_{75}G_{100}$	3.09c	10.07c	31	8.8	9.4
$V_{100}F_{50}G_{100}$	2.48d	7.04d	27	26.8	36.7
$V_{100}F_{100}G_{75}$	3.36a	10.90a	29	0.9	2.0
$V_{100}F_{100}G_{50}$	3.23b	10.46b	31	4.7	5.9
$V_{50}F_{50}G_{50}$	1.56e	5.63e	31	54.0	49.4

**Treatment means followed by the same letter(s) in any column are not significantly different at 5% level of significance.*

The range of grain yield obtained in this study were similar to those reported by Lyocks *et al.*(2013) being 2.05- 3.98 t/ha for Samaru, same study area as this experiment. Garba and Namo (2013) also reported grain yield of 3.88 and 3.49 t/ha for of Saminaka (lowland) and Vom (mountainous) in the same ecological belt as this study. However, maximum grain yield in this study was found to be far less compared to Sefer *et al*. (2011), who obtained grain yield ranging from 1.93- 10.4 t/ha under clay loam soil with the use of drip irrigation system in the Eastern Mediterranean climatic conditions of Turkey. It must however be understood that the magnitude of yield response to deficit irrigation is also dependent on the crop variety, extent of irrigation deficit, irrigation method, climate and other agronomic practices like weeding and fertilizer application.

c) *Crop water use*

Table 6 shows the seasonal evapotranspiration (SET), seasonal irrigation water applied (SIWA) and the total seasonal water applied (TSWA) which include the SIWA and the rainfall depth during the crop growing season. The seasonal irrigation water applied (SIWA) ranged from 375 to 640 mm. The highest SET value of 483 mm was obtained when 100% depth of water was applied throughout the crop growth stages, while the lowest crop water use value of 320 mm was obtained when 50% deficit was applied throughout the crop growth stages. This was expected since SET depends largely on moisture available for the crop uptake. The water applied in treatment $V_{50}F_{50}G_{50}$ was not within the range of 500-800mm given by Doorenbos and Kassam (1979) for a maize crop which further explains the differences in yield compared to the others treatments.

Table 6: Seasonal crop water use and water applied

Treatments	SET(mm)	SIWA(mm)	TSWA(mm)
$V_{100}F_{100}G_{100}$	483a*	640	699
$V_{75}F_{100}G_{100}$	441d	590	637
$V_{50}F_{100}G_{100}$	417e	540	574
$V_{100}F_{75}G_{100}$	453c	600	651
$V_{100}F_{50}G_{100}$	428e	520	599
$V_{100}F_{100}G_{75}$	470b	606	680
$V_{100}F_{100}G_{50}$	464bc	592	659
$V_{50}F_{50}G_{50}$	320f	432	434

**Treatment means followed by the same letter(s) in any column are not significantly different at 5% level of significance*

d) *Water Use Efficiencies*

Table 7 shows the seasonal water use efficiencies(WUE) of the maize crop expressed as yield over seasonal crop water use (SET). The WUE with respect to grain and biomass yields ranged from 0.41 to 0.63kg/m^3 and 1.76 to 1.98 kg/m^3, respectively. These values imply that about 0.41 to 0.63 kg of maize was produced from every cubic depth of water, while 1.76 to 1.98 kg of dry matter was produced from every cubic meter of irrigation water. Water use efficiencies of the treatments irrigated at 75 % of ETo at flowering and grain-filling to maturity stages were not statistically significantly different from the treatment which received full irrigation in all growth stages.

Table 7: Water Use Efficiencies of maize crop in the cropping season

Treatments	WUE(grain yield) kg/m	WUE(biomass yield) kg/m^3
$V_{100} F_{100} G_{100}$	0.6:	1.98 a
$V_{75} F_{100} G_{100}$	0.51 b	1.75 c
$V_{50} F_{100} G_{100}$	0.51 b	1.82 b
$V_{100} F_{75} G_{100}$	0.56 ab	1.86 ab
$V_{100} F_{50} G_{100}$	0.50 c	1.74 c
$V_{100} F_{100} G_{75}$	0.58 ab	1.88 ab
$V_{100} F_{100} G_{50}$	0.54 b	1.81 b
$V_{50} F_{50} G_{50}$	0.41 c	1.76 c

**Treatment means followed by the same letter(s) in any column are not significantly different at 5% level of significance*

IV. Conclusion

The effects of deficit irrigation scheduling with gravity drip irrigation kit on water use efficiency a maize crop in Samaru, Nigeria was studied using field experiments conducted in 2012/2013 irrigation season in Zaria Nigeria. This study reveals that applying water with the drip kit at a quarter less than crop water requirement at flowering and grain filling to maturity after full dose application at vegetative growth stage does not significantly reduced crop yield and water use efficiency. If such magnitude of reduction takes place at vegetative growth stage, yield will be reduced by over 12 %. Moreover, applying water using the drip kit at half the crop water requirement at any single growth stage significantly reduces crop yields and water use efficiencies. The highest crop yield, seasonal water use and water use efficiency were obtained in the treatment that was fully irrigated, which implies that the deficit irrigation did not improve the crop response or water use efficiency. The results suggest that under high water application efficiency deficit irrigation practice may not necessarily lead to higher crop water use efficiency of the maize crop.

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Effect of Radial Spacing on the Growth and Yield of Maize under Olla Irrigation

By Oiganji Ezekiel, I. I. Ibrahim & N. K. Kwatmen
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Keywords: *Olla irrigation, radial spacing, grain yield, maize.*

GJSFR-D Classification: *FOR Code: 820401*

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Strictly as per the compliance and regulations of :

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Keywords: Olla irrigation, radial spacing, grain yield, maize.

I. Introduction

On a global scale irrigated agriculture uses about 72% of available fresh water resources (Geerts and Raes, 2009).The rapid increase of the world population coupled with the corresponding demand for extra water by sectors such as industries and municipal, forces the agricultural sector to use its irrigation water more efficiently on the one hand and to produce more food on the other hand (Oiganji, 2016). This global water crisis has drawn worldwide attention to urgency of achieving a more efficient use of water resource(Andarzian *et al.,* 2011).

Water is the major threat to food security in Nigeria especially during the dry season; the dams located in different part of the country which are suppose to be engaged during the dry season are left redundant, and there are less water harvesting structures within the country which are suppose to be used during the rainy season to harvest water; the price of food in Nigeria is gradually beyond the reach of the poor, so there is need to uplift the incomes of users of rural land and water resources on a sustainable basis.

Drip is considered the 'choice' for water conservation but is ill suited for remote areas with low technology, unpressurized and unfiltered water systems. Drip systems are easily vandalized and repairs could be costly; the emitters are also easily blocked with sediment, salt, and several insect species. Olla irrigation system is one of the efficient systems of irrigation known to be more efficient than drip system and suitable for small scale farmers most of whom still use rudimentary hand tools for framing operations (Morrison, 1998).

The olla irrigation technology is a conservation irrigation system, which saves between 59% and 70% of water when compared to the conventional watering-can irrigation system. The clay pots can be made with locally available materials without pressurized filter (Morrison, 1998).Clay vessels or olla made from low fire terra cotta clay are porous enough to allow water to pass through them when buried in soil. The rate of water flow varies depending on the soil water potential and by the plants' uptake of water through their roots(Kirda C. 2002).

The water seepage is regulated by the water needs of any nearby plant. When the plant's water demands have been fulfilled and the soil is moist, the water seepage from the clay pot will stop. This process occurs at atmospheric pressure and requires no timers or pressure regulators to maintain soil moisture at near field capacity. The water seeps out through the walls of the buried clay pot at a rate that is in part determined by the water used by the plant; this auto regulation leads to very high irrigation efficiency. Buried clay pot irrigation allows soil amendments to be placed only where they will benefit the crops not the weeds. The precise water application minimizes weed growth and reduces both the labor requirement for weeding and weed competition with crops for water and nutrients (Morrison, 1998).

Buried clay pots is ideal for farmers and gardeners who are engaged in other income generating activities such as tailoring, trading, and household duties among others. The practice of having to irrigate

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several times a day strips them off the opportunity to undertake these other remunerative ventures (Mofoke, 2006).

Radial spacing for the clay pots depends on the crop and size of the pot, but there is yet to be a specified radial spacing for crops grown under olla irrigation in the study area. There is need to determine the extent to which radial spacing can affect the growth and yield of maize under olla irrigation system. This research work is intended to provide useful information in the terms of radial spacing to farmers of maize under olla irrigation.

II. Materials and Methods

a) *Study Area*

The experiment was conducted in Federal College of Forestry Jos during 2016 cropping season at the experimental farm, Jos lies at latitude 9^{0}56N, and 8^{o}53E and longitude 9.933^{o}N and 8.833^{o}E in the middle belt within the southern Guinea Savannah ecological zone of Nigeria with a mean annual rainfall of 1260mm (Olowolafe and Dung, 2002).

b) *Soil Analysis*

Soil sample at 0-15cm depth from study area was taken to Chemical and physical laboratories, Nigerian institute of mining and geo-sciences, Tudun Wada, Jos for analysis. The analysis showed that the soil is sandy loam, pH of 6.30, 0.035% of Nitrogen (N), 2.09% of organic matter (OM), exchangeable bases include 49 ppm of phosphorus (P) 0.1ppm of Na, 1.5ppm of Ca, 0.45ppm of mg, and 20ppm of K, exchangeable acidity 3.5 mMOL/10 of H^{+}, while the clay, silt and sand were 6.34, 8 and 85.9% respectively.

c) *Meteorological Data of the Study Area*

The pan evaporation ranged from 5.0 to 49.5mm per day, while relative humidity was fairly stable from September – October, humidity value of 76.52% was recorded in the month of September as the highest and 56% in November as the lowest observed humidity. The highest rainfall value of 14.70mm was observed in September while the lowest rainfall value of 2.20mm was obtained in November. The highest temperature value of 30.49^{0}C was observed in November, while the lowest temperature value of 23.25^{0}C.

d) *Experimental Design and Treatments*

The experiment consists of four (4) treatments each replicated three (3) times and laid in a randomized complete block design (RCBD), the description of the experiment is as shown in Table 1.

Table 1: Description of treatment

Treatment	Description of treatment
T_1	Intra row spacing of 25cm and radial spacing of 10cm
T_2	Intra row spacing of 25cm and radial spacing of 20cm
T_3	Intra row spacing of 25cm and radial spacing of 30cm
T_4	Intra row spacing of 25cm and radial spacing of 40cm

The study was carried out from 3rd February, 2016 to 3rd March, 2016.The maize variety planted was pod corn, which was obtained from ASTC Kassa in Jos South LGA.The field was prepared manually; a hole was dug about three times as wide and two times as deep as the clay pot. The buried clay pots were placed with the soil mix and gently firm it. The buried clay pot was filled with four (4) liters of water and was watered twice in a day (Morning and evening) every day to keep it from becoming completely dry. The radial spacing was measured using ruler and three seeds were sown per hill and the seedlings thinned to two plants per hill two weeks after emergence, the prepared plots were watered for four days before the maize seeds were sown at intra row spacing of 25cm and radial spacing from 10-40cm. All the treatments were given equal volumes of water and compound fertilizer 15-15-15 (N-P-K) was applied at a rate of 250 kg/ha as side dressing, two weeks after sowing. Top dressing with Sulphate of ammonia, at the rate of 125 kg/ha was applied six weeks after emergence. Four (4) plants were tagged randomly within each plot at 2 WAP (weeks after planting) till eight week when maize had attained full maturity, for the assessment of height (cm), stem girth (cm) and leaves count. The height of the plant (cm) was determined from the above ground level using graduated meter rule. The numbers of leaves per plant were counted to obtain the mean value in each treatment. The harvest was done manually by cutting stems with cutlass respectively. The maize cobs were harvested 90 days after planting, dehusked and further dried until the moisture level of the grains was 14% before yield records were taken. The above ground biomass was harvested to obtain the biomass of each plot using a weighing balance.

The Vegetative and yield data were collected and subjected to statistical analysis of variance and the significance among treatment means was evaluated with Duncan's Multiple Range Test to check significant differences between the treatments (SPSS,2003).

III. Results and Discussion

a) *Growth Parameters*

i. *Plant Height*

The plant height ranged from 14.90 to 182.67cm. The lowest plant height value of 14.90cm was recorded at 2WAP with radial spacing of 40cm, while the highest plant height value of 182.67cm was recorded at 8WAP with radial spacing of 10cm as shown in Fig.1.There was no significant difference between planting maize with radial distance of 20 and 30cm, throughout the crop growing season, while there was significant difference between plant height of maize planted with radial spacing of 10 and 40cm as shown in Fig 1.However, at 8 WAP there was no significant difference in height among all the treatments under consideration. The plant height obtained in this research was higher than that obtained by Oiganji *et al*.,(2016), variations could be as a result of difference in irrigation method (surface) employed, climate and other agronomic practices.

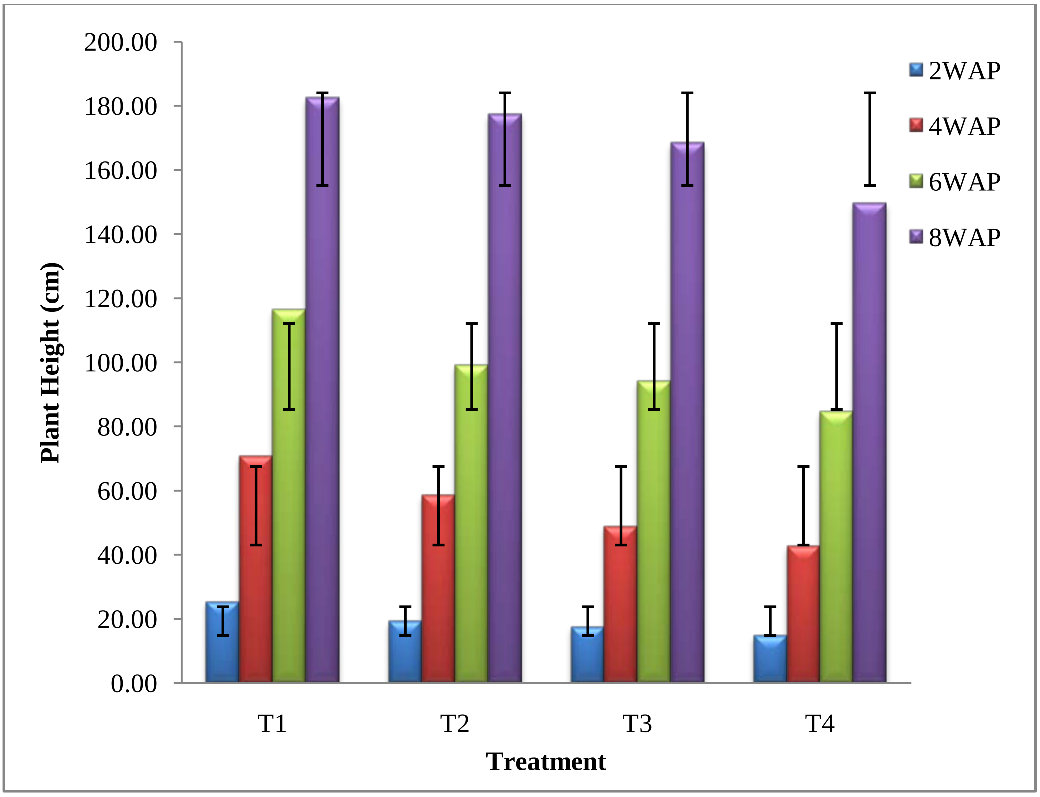

Figure 1: Plant height for period of 8WAP

b) Stem Diameter

Figure 2 shows the stem diameter of the maize crop which ranged from 3.30 - 9.03cm.The highest stem diameter was recorded when maize crop was planted with radial spacing of 10cm from the olla pot at 8WAP, while the lowest stem diameter was obtained with radial spacing of 40cm from the olla pot. The stem diameter at 4 and 8WAP were not significantly different, when maize was planted at 20, 30 and 40cm radial spacing from the olla pot. However, there was significant difference for stem girth at 2, 4, 6 and 8WAP, which indicate that the closer a maize crop is to the Olla pot, the higher the stem diameter.

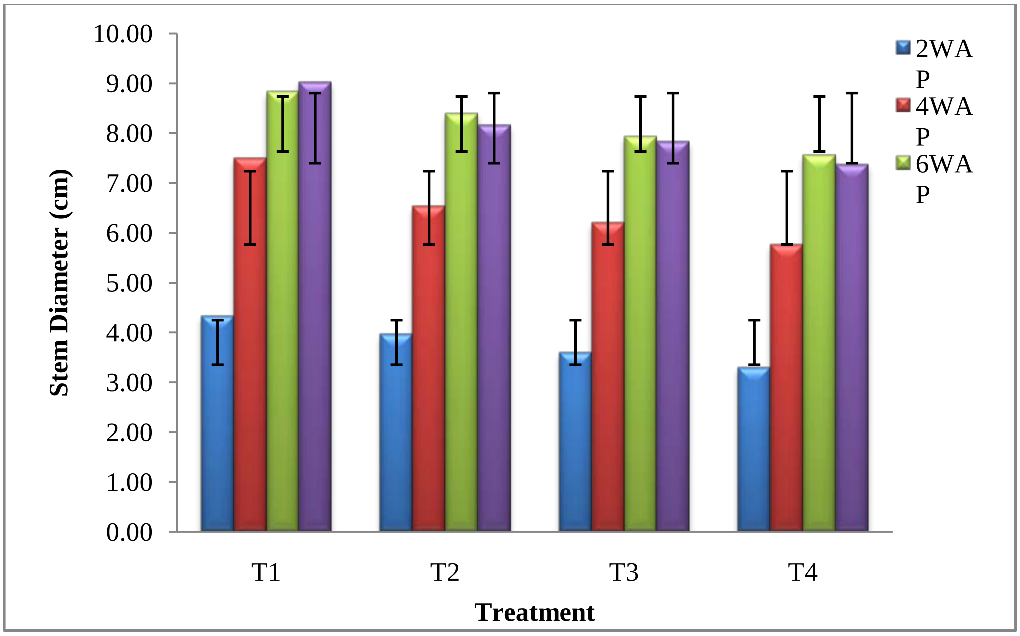

Figure 2: Stem Girth for Period of 8WAP

i. *Leaf Count*

Figure 3 shows the leaf count of the maize crop. The leaf count ranged from 7 - 16.50, the highest leaf count value of 16.50 at 8WAP was recorded when maize was planted at radial spacing of 10cm from the Olla pot, while the lowest leaf count value was recorded when maize was planted at radial spacing of 40cm at 2WAP. However, there was no significant difference on leaf count of maize when planted at different radial spacing from Olla Pot. However, the leaf count obtained in this research was higher than that obtained by Oiganji *et al*.,(2016), variations could be as a result of difference in irrigation method (surface) employed, climate and other agronomic practices.

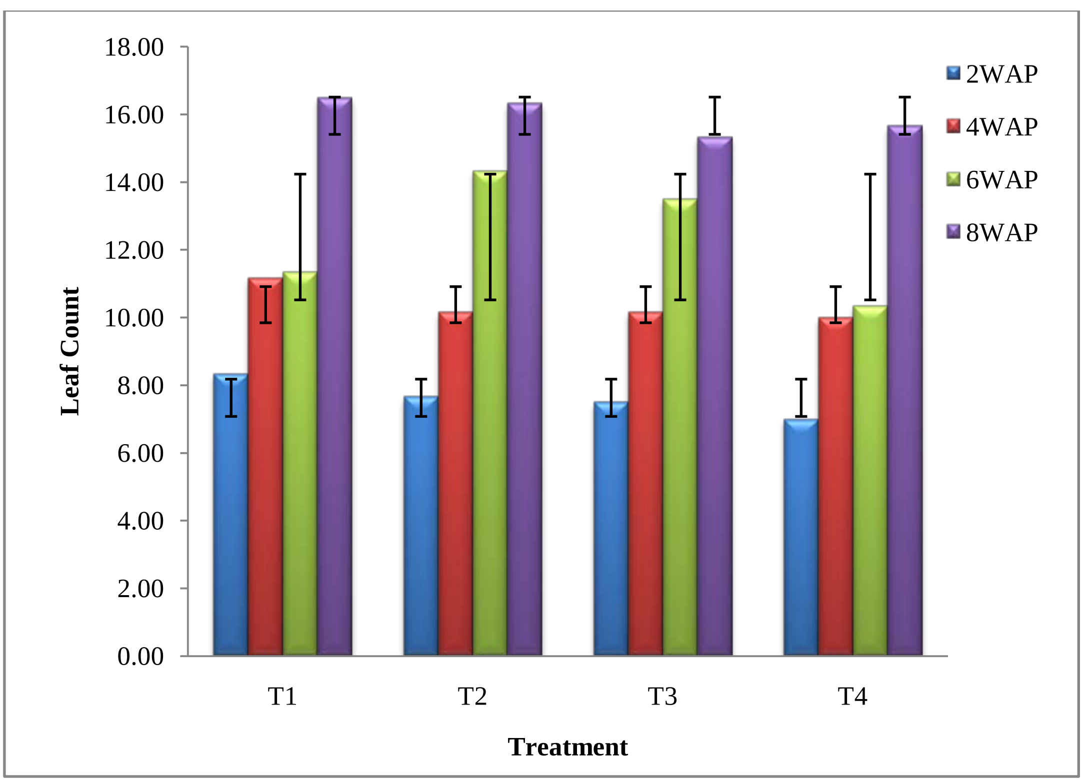

Fig. 3: leaf count for period of 8WAP

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ii. *Grain Yield*

The grain yield obtained ranged from 2.20 - 12.22 t/ha as shown in Fig 4. The highest grain yield value of 12.22 t/ha was obtained when maize was planted at a radial spacing of 10cm, while the lowest grain yield value 2.20 t/ha was obtained when maize was planted at a radial spacing of 40cm. When the radial spacing from the Olla Pot was increased from 10 to 20, 30 and 40cm; the corresponding yield reduction values were 33, 58 and 82%.

The grain yield ranges obtained in this study were in consonance with the report of Sefer *et al*. (2011), who obtained range of grain yield ranging from 1.93- 10.4 t/ha under clay loam soil with the use of drip irrigation system in the Eastern Mediterranean climatic conditions of Turkey; Lyocks *et al.,*(2013) who found that grain yield ranged from 2.05- 3.98 t/ha within Samaru region. Garba and Namo (2013) reported grain yield of 3.88 and 3.49 t/ha within two savanna agro-ecologies of Saminaka (lowland)and Vom (mountainous) in Nigeria. Differences in grain and biomass yield reported, may be due to the following: crop variety, extent of irrigation deficit, irrigation method, climate and other agronomic practices.

IV. Conclusion

There was no significant difference between grain yield of maize when it was planted at radial spacing of 20 and 30cm, implying that in the study area, planting at radial spacing of 20cm from Olla pot is recommended when a farmer is faced with a limited land spaced for farming, even though the impact on yield may be about 25% if 30cm is used instead of 20cm.

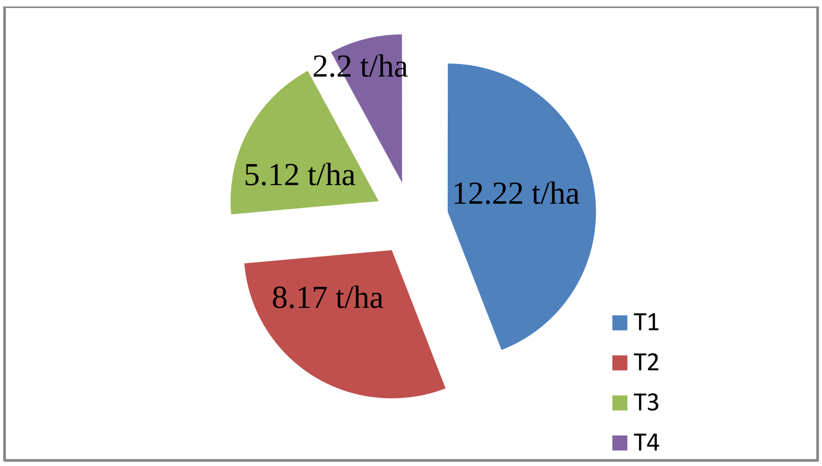

Fig.4: Grain yield of maize in tonnes/hectare

Plate 1: Application of water to the Olla pot during flowering stage (42DAP)

Plate 2: Maize crop during the Grain filling stage (63DAP)

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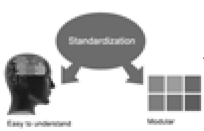

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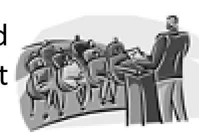

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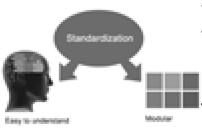

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29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

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- Please note the criterion for grading the final paper by peer-reviewers.

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- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
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- Significant conclusions or questions that track from the research(es)

Approach:

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- Explain the value (significance) of the study
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- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
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Approach:

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- If use of a definite type of tools.
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- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
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Approach:

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- Leave out information that is immaterial to a third party.

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The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

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Approach

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	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

Index

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