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Situation on Livelihood Capital of Hired Khmer Households for Rice Production under Agricultural Mechanization in Thoi Lai District, Can Tho City

By Nguyen Quang Tuyen & Duong Be Thanh
Cantho University

Abstract- Agricultural mechanization is always an indispensable process in the modern agriculture. At the same time, the hired labor groups were marginalized. The case of the hired Khmer households in agriculture in Thoi Lai of Can Tho is a typical example for this study. Data of study was collected through interviews of households by Key informants, and group discussion. the interviews of Key Informants (KI), the interviews of the households and the group discussions. This study was analyzed on the livelihood and its outcomes of 101 hired Khmer households for rice production by the quality and quantity methods.

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Situation on Livelihood Capital of Hired Khmer Households for Rice Production under Agricultural Mechanization in Thoi Lai District, Can Tho City

Nguyen Quang Tuyen [α] & Duong Be Thanh [σ]

Abstract- Agricultural mechanization is always an indispensable process in the modern agriculture. At the same time, the hired labor groups were marginalized. The case of the hired Khmer households in agriculture in Thoi Lai of Can Tho is a typical example for this study. Data of study was collected through interviews of households by Key informants, and group discussion. the interviews of Key Informants (KI), the interviews of the households and the group discussions. This study was analyzed on the livelihood and its outcomes of 101 hired Khmer households for rice production by the quality and quantity methods.

The study results showed that (1) The livelihood of the hired Khmer households has not been improved such as low education, plenty of children, more dependent labors, limited physical capital/property; (2) The participation of the household members in the local associations was limited; (3) Many households had less farmland for agricultural production; (4) The income of the households was still low and there was problem to access to the credit. Those households had the adaptable strategies through the livelihood change and livelihood diversification. However, the financial status of the hired Khmer households has reduced compared to the previous period. The income sources of the hired Khmer households were less diverse and their unstable employment.

Some solutions were suggested for improving the livelihood capital and creating the employment for the hired Khmer households in order to adapt with the limited status of the hired employment in agriculture.

I. Introduction

The Mekong Delta (MD) is the biggest granary of Vietnam with more than 2.8 household millions for the farming and the hired employment in agriculture. Therefore, the agricultural mechanization has been developing in the agriculture of the region. Nevertheless, this event has the employment limited and has negatively impacted on the livelihood of the hired households in the rural area (Vo and Ho, 2012). In recent years, this problem has been the challenge in the provinces/cities of the country, especially in the Mekong Delta, which having got getting the quite high rate of the hired labors in agriculture.

The hired labor in agriculture has been impacted on the process of mechanization in MD, the hired Khmers were paid more attention by most of the hired Khmer households in agriculture were the poor. Many previous studies showed that the property and the ability to approach on the capital of the poor Khmer households in MD were minimized. Thus, Khmer people got difficult to adapt with the shocks and the influences of the multiple factors such as marketing, policy, institution. Hence, they were hard to set up the appropriate livelihood strategies in the context as such. (Vo and Tran, 2011; Nguyen T.A and Nguyen, T.N, 2013; Vo and Ho, 2012; Dang, 2013; Pham and *et al*, 2008).

Thoi Lai district in Can Tho is also the place where many poor Khmers have lived from the hired labors in agriculture. In the previous period, the hired employment in the seasonal agriculture created the important opportunity in the livelihood of the poor Khmer labors. At present, this activity has become unstable due to many affects including the impact of the agricultural mechanization. (Tuyen, 2012). Just now, many Khmer households in Thoi Lai employ in agriculture as the hired labors. Therefore, they perhaps face the risks or the difficulty in the livelihood being an unavoidable thing.

Thus, evaluating the livelihood resources of the households to understand the livelihood strategies and the livelihood outcomes of the households is necessary. The comprehensive study helps recommenting on the technology and the policy for improving the suitable livelihood strategies and minimizing the failure in the development of the livelihood households.

II. Study Objectives

- Evaluating the livelihood resources of the hired Khmer households in the rice production.
- Analyzing the outcome of livelihood of the hired Khmer households.
- Suggesting some feasible solutions for improving the resources of livelihood to increase the income for the hired Khmer households.

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III. Study Methodology

a) Analytical framework

The study based on the livelihood analysis (DFID, 1999) to understand the livelihood resources of the hired Khmers for setting the strategies of the povery reduction in the long term. The livelihood resources of Khmers included the human, natural, physic, social and financial capitals.

b) Selection of Study site and Households

Can Tho city had 22.718 Khmers who lived in Co Do, Thoi Lai and O Mon districts, in which Thoi Lai had 4.158 Khmers; most Khmer households were poor, their livelihoods were mainly from doing farming and hiring in agriculture. (People's Committee of Can Tho city, 2013). This typical site of Thoi Lai was selected for the study.

There were 101 study samplings selected in the four villages of Thoi Lai. The hired Khmer households who had employed for rice production were selected in the study.

c) Data collection and Analysis

The primary data were collected by interviewing the KI, the hired Khmer households and the group discussions.

SPSS software 20.0 was applied for analysis. Data were analyzed by the methods of the descriptive statistic, verification of Paired samples T-test and Independent T-test.

IV. Results and Discussions

a) The livelihood

i. *Human capital*

The education of the householder (i.e.household head) obtained the fourth grade of the twelfth grades. There are four people in the family in which there were two dependent labors. The results confirmed the real situation of Khmers in MD was low education, a household with high number of family members and high dependent labors, (Nguyen T.A and Nguyen, T.N, 2013). It is/was very difficult to create the emloyment and increase the income for households here

Labor source of the Khmer households has considerably changedfive years ago. The development of the combine harvesters marginalized the the hired Khmer households for rice harvesting since 2010 (Tale 1), so the hired employment for the rice production (i.e. most hired labors in harvesting rice) until now has been shifted to the hired employment for non-farm activity in most Khmer households by strengthening mechanization in the agricultural sector.

Table 1: Verifying the number of labors in the Khmer household by Pair-Samples T-test

Kinds of labors	2010 (No.of labors)	2014 (No.of labors)	P-value
Rice farming	0.63	0.45	0.016
Hired employment in rice farming	2.07	0.95	0.000
Hired employment in agriculture	0.10	0.14	0.287
Hired employment in non-agriculture	0.26	1.07	0.000

The agricultural mechanization impacted on shifting the form of hired employment of the household members. In general, the human capital of the hired Khmer households still faces more difficulties.

ii. *Physical capital*

Concrete house is an important property for the Khmer households. About 21.8% of the total households had the concrete houses, 65.3% had the semi-concrete houses and 12.9% had the temporary houses. In addition, more than 46.5% of the total households, people said that their houses have been downgraded but they have not been enough money to repair. The rate of the households increasingly possessed televisons, fans, and cookers in five years ago but the life condition of Khmers still faces many difficulties at present. The tools in the hired employment are the necessary properties in the livelihood of the hired Khmer households. The main farm tools of the Khmer households are hook, sprayer, small boat and bicycle in 2010. However, more hooks and small boats were replaced by bycicle, Honda and mobile phone in 2014 because many hired Khmer households demanded buying the means of transportation and the communication. The changes were interpreted that the hired employments of the hired Khmer households in rice harvest season were reduced too much due to the development of the combine harvesters. Therefore, the households had to buy those useful means for travelling and contacting with the various social actors to improve their incomes in the process of their livelihood changes to adapt with development of mechanization in MD (Table 2).

Table 2: Rate of the households possessing the tools and means for the hired employments

Tools and means	2010 (%)	2014 (%)
Hook	87.3	37.5
Small boat	33.3	15.9
Bycicle	17.5	71.6
Spayer	19.0	20.5
Medium boat	9.5	6.8
Honda	4.8	45.5
Mobile phone	1.6	65.9

iii. *Social capital*

The social capitals were considered on the relationship of the social actors in the community and the participation of the households in the formal associations and informal groups. The formal associations in the study site were very diverse including the association of farmers, the women union, the association of elders, the Red Cross, etc. These associations importantly contributed in improving the household livelihood such as providing credits, necessary information, supporting production, etc. However, the fifty percents of Khmer households participated in the associations, most households had farmland. It meant that the Khmer households perhaps have not recognized the profit which was brought from the participation of the associations. This was also the disadvantage of their livelihoods.

In the informal groups in the study site, the groups of hired households played the important role in the decision making of the hired employments. Before the year of 2010, some informal groups of the hired Kinh households and the hired Khmer households were organized to do services in the rice harvest seasons in the study site. Each informal group was divided by many teams separately with the different works including the team for cutting and gathering rice, team for threshing rice and team for transporting rice from the rice fields to the farm gate. The employees worked very professional in the chain of rice harvest activities (Tuyen, 2012). Since 2010 the rice fields of the farmers have been gradually harvested by the combine harvesters by the model of agricultural mechanization in MD. At present, the informal groups of the hired labors for harvesting rice have reduced considerably due to the process of mechanization. However, these hired groups have still played the important role in the production process in the rural area. Study result showed that 27.7% of the hired Khmer households participated in the informal groups and the selection of the group members became strict. Therefore, the informal group leaders selected their relatives or their close neighbors. The relationship of the hired Khmer households were determined that more than a half of them have increased the social communication each other to create the opportunities for finding the hired employments in the community in the context of influencing the agricultural mechanization in the five years ago. This matter reflected that the hired Khmer households adapted in their social relationship for improving their livelihoods.

iv. *Natural capital*

Khmers' livelihoods in the MD mainly were based on farming. Hence, farmland was their important natural capital. However, the study results showed that 36.6% of the hired Khmer households possessed farmland with small farmland size of 0.26 hectares. Vo and Ho (2012) asserted that farmland played an impotant role in the life of the hired Khmer households, though farmland size was not large but it provided food enough for their families and reduced a part of expenditures in the households.

The hired households possessing farmland had the total of incomes was 1.350.900 VND/person/month while the hired households without farmland had the total of incomes were only 1.010.900 VND/person /month. Therefore, the income of the hired households possessing farmland was higher than that of the ones without farmland. Farmland helped the livelihood of the hired Khmer households be stable. Thus, the agricultural mechanization lost the employment opportunities of the hired Khmer households without farmland more than the case of the hired Khmer households having farmland.

About 15% of the hired Khmer households said that the scale of their farmland was reduced in five years ago which was caused by reducing their hired employment in agriculture leading to the low income and the difficult living condition. Hence, they had to sell or mortgage their farmland.

The agricultural mechanization development in the study site impacted indirectly on decreasing the farmland area of the hired Khmer households. These hired Khmer households faced more difficulties when their employments have become scare in the rice harvest seasons by using the combine harvesters. Thus, the solutions shifting the works in the livelihoods of the hired Khmers are needed to improve their life.

v. *Financial capital*

In the previous years, the hired Khmer households had the main income from harvesting rice, besides, they still had the other incomes such as production of rice, catching the natural fish and some hired employment in rice farming such as broadcasting rice, retransplanting rice and hand weeding, etc. At present, the hired Khmer households have to change the works to improve their incomes because most hired Khmer households have no more farmlands while the resource of aquaculture is scarce and the process of mechanization in rice farming is replacing most hired employments of the hired Khmer households. Therefore, they have changed the work and have diversified also the work in their livelihoods for improving their incomes. Now, the income from hired employment in agriculture of the hired Khmer households is considerably reducing,

meanwhile, the income from hired employment in non-agriculture of the hired Khmer households becomes the main income. The main income of the households having the farmland is from the agricultural production.

Though the source of incomes changed but the income of the hired Khmer households is not improved considerably at present. The income of the household obtained 1.135.468 VND/person/month which was two times lower than in MD and was 2.3 times lower than in Vietnam.

About 86% of the farm households asked for a loan in both the governmental sector and the private sector. In fact, the few of the hired Khmer households effectively used the loans due to the income of many hired Khmer households for rice farming reduced. Hence, most hired Khmer households asked for loans to spend for their expenditures, buying the farming tools, paying their debts, only spending a little of loan for production. Thus, they were hard to pay back the loan in a year round. In fact, about 50% of the hired Khmer households faced more difficulties to access the credit.

b) The livelihood outcomes

The livelihood outcome was reflected clearly by the income of the household. The incomes of the hired Khmer households were decreased in five years ago. With 63.4% of the hired Khmer households asserted that the process of the agricultural mechanization reduced considerably the income from hired employments for the rice production in Thoi Lai district (Table 3).

With 45.6% of the hired Khmer households said that the income total of the household reduced due to the loss of the hired employment in rice production, particularly in the rice harvest seasons. Besides, about 23.8% of the hired Khmer households asserted that their incomes increased in processing the mechanization in agriculture. The results showed that the certain hired Khmer households had the strategies of the livelihood diversification and the shift of livelihood to obtain the incomes which could compensate for loss of hired employments in rice farming and in the rice harvesting by the combine harvesters (Table 3).

Table 3: Proportion of the hired Khmer households having opinion on changing their incomes in five years ago

Level of change	Proportion of opinion on income from hired employment in rice farming (%)	Proportion of opinion on total of incomes (%)
More reduction	63.4	13.9
Less reduction	28.7	31.7
No change	3.0	30.7
Less increase	5.0	22.8
More increase	0.0	1.0
Total	100	100

However, about 40% the hired Khmer households said that their employements were unstable occupying 40% while the seasonal employments comprised 50%. It showed though the households had the strategies for the livelihood diversification, the labor migration and the livelihood have changed but the livelihood of the hired Khmer households was still very unstable.

c) Some solutions for improving the income of the hired Khmer households

The short occupation training courses and the training courses of the medium term should be organized accordingly with the demands of the non-farm labors market in the study site. Besides, the occupation training centers should cooperate effectively and closely with the employers to create the employments for the labors after training. This solution will help the Khmer labors shifting gradually from the farm to the non-farm in the cases that the employments in the agriculture sector have reduced strongly by processing mechanization.

The living condition and housing condition of Khmer labors should be improved through the support programs of government, the non-government organizations, the charitable organizations and the sponsors.

The role of the formal associations in the study site should be promoted to enhance the ability of the community and strengthen the relationship of social actors in the community. Then, the connection among households will be created for helping together, sharing information of employments and also experiences in production.

The special support program of credit for the hired Khmer households should be organized to help them buy tools and invest production. Besides, the program for supporting, monitoring and evaluating should be established to ensure the use of loan of the households effectively.

V. Conclusions

The livelihood capital of the hired Khmer households changed in five years ago. However, most changes did not bring the active trend on the five livelihood capitals of the households.

The human capital was weak such as low education, plenty of children and dependent family members.

The physic capital was shortage. The properties for living only demanded basically. The households shifted from possessing production tools to possessing production equipment.

- In the social capital, the participation of the household members in the local associations was limited. Nevertheless, Khmer households paid more attention on strengthening their relationships in community.
- The farmland was most important natural capital of Khmer households which reduced so much. Therefore, a lot of Khmer households had no more farmland for farming.
- The financial capital had not improved much. The income was low and the ability of accessing loan faced more problems.

The hired Khmer households adapted through changing the livelihoods, diversifying the livelihoods and strengthening some capital sources of livelihoods in the context of mechanization. However, the livelihood outcomes of the hired Khmer households had not improved actively yet in terms of income and living standard due to low incomes and unstable employments.

Based on the study findings, some feasible solutions were recommended following: (1) Being short training for occupation and introducing the employments for Khmer labors; (2) Improving the living condition or knowledge about life and the housing condition through the support programs of government, non-government and sponsor; (3) Enhancing the ability of the community and strengthening the relationship of the community through the formal organizations in local area; and (4) Supporting the loan and monitoring the effect of using the loan of the Khmer labors.

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Effects of Replacing Groundnut Meal with Cotton Seed Meal or Palm Kernel Meal on the Performance, Blood Metabolite and Cost on Return of Finishing Cockerels

By Okosun S.E. & Ehebha, E. T. E
Ambrose Alli University

Abstract- Three hundred day-old black Harco cockerel chicks were started on a standard fish meal diet containing 2.65 Kcal/g ME at 21% crude protein for the first four weeks. At the end of which one hundred and forty of the birds were allocated to another diet of 2.65 Kcal/g ME at same 21% protein but without fish meal. The remaining 160 birds were maintain alongside on a fish meal diet containing 2.65Kcal/g ME and 21% protein till they were eight weeks old. At the finisher phase the two set of birds were assigned to eight experimental rations in a 4x2 factorial design; differently maintained. The diets were a control which contain fish meal and groundnut meal (GNM) as the major protein source. The next had only GNM as the major protein source. In the next consecutive diets, one-third, two-third and all of the GNM protein contribution was replaced by corresponding protein value of cotton seed meal (CSM) and palm Kernel meal (PKM).

Keywords: *cockerels, groundnut meal, cottonseed meal, palm kernel meal and fish meal.*

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Keywords: cockerels, groundnut meal, cottonseed meal, palm kernel meal and fish meal.

I. Introduction

The feed crisis in terms of cost, quality consistency and availability besetting livestock production in Nigeria strongly point to finding alternative sources of raw material for feed formulation. Cockerel chicks because of its longer period of production to meet market weight tend to be most unappealing to local medium scale farmers particularly when conventional commercial feeds for broilers and pullets are used. Of all the ingredients use for feed compounding protein sources in terms of cost is second to none, and is either soya bean meal (mostly use) or groundnut meal (next alternative). These feedstuffs of recent has become prohibitive in term of cost.

The need to encourage cockerel production point not only to defining their nutritional norms (Okosun 1987) but also making efforts to reducing their cost of production. In an earlier study of starting cockerel chick Okosun and Oyedeji (2016) recommended a 20% and 10% for cotton seed meal (CSM) and palm kernel meal (PKM) respectively for raising cockerels till when they are 8 weeks old without fish meal incorporation in their diet. This present study is designed to look at possible alternatives to the less expensive groundnut meal (plant protein) in finishing cockerels. Cotton seed meal (CMS) has been tolerated by both broilers (NAPRI, 1984) and cockerels chicks (Okosun and Oyedejie, 2016) but unfortunately contains gossypol, a naturally occurring polyphenolic factor which is injurious to non-ruminants (Albrecht *et al,* 1972; Clawson *et al,* 1975). This has been the major criticism against its incorporation in diets for non-ruminants. Palm kernel meal on the other hand is limited in its use as livestock feedstuff because of its grittiness, dryness in texture and unpalatability (Oyenuga 1968). These two aforementioned protein sources are cheap and readily available. This study, designed to investigate their effects in replacing groundnut meal on performance and economics of finishing cockerels is aim primarily to encouraged cockerel production. Some blood protein parameters were also analysed.

II. Materials and Methods

a) Management of birds

This research work was conducted at the poultry unit of the Teaching and Research farm of the University of Ibadan, south- west Nigeria. Three hundred day-old black Harco cockerel chicks were started on a standard fish-meal diet containing 2.65 Kcal/g ME at 21% crude protein level for the first four weeks. At the end of which one hundred and forty of the birds were allocated to another diet of 2.65kcal/g ME at same 21%

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protein but without fish meal (table 1). The remaining 160 birds were maintained alongside on a fishmeal diet containing 2.65Kcal/g ME and 21% protein till they were eight weeks old. At the finisher phase, the 160 birds were continued on finisher rations indicated in table 2 while the 140 birds on diets without fish meal were distributed to diets 2 to 8 differently maintained alongside others. All the treatments were in triplicate of 6 birds each. The chicks were divided in such a manner that the average initial weight of each group was identical. The study lasted till the birds were thirteen weeks old.

Anti-stress mineral-vitamin were given in water for the first three days and a few days after vaccination Routine vaccination and necessary medication were administered. Feed and water were provided *ad libitum*.

Table 1: Composition (%) of rations used at the starter phase (0-8weeks) of cockerels fed varying diets with and without fish meal

Ingredients	0-4 Weeks	5-8 Weeks
Maize	43.40	43.15
Groundnut meal	20.00	28.00
Fish meal	5.00	-
Wheat offals	27.35	24.60
Bone meal	2.00	2.00
Oyster shell	1.00	1.00
Premix*	1.00	1.00
Salt	0.25	0.25
Calculated		
Metabolisable energy	2.65	2.65
(kcal/g)	21.24	21.10
Crude protein (%)	4.24	4.35
Crude fibre (%)		
Determined (DM Basis)	21.40	20.62
Crude protein (%)	5.21	5.10
Crude fibre (%)	4.53	5.10
Ether extract (%)		

Starter Chicken: A vitamin trace mineral mix manufactured by Pfizer Feed Company, Lagos, for starting chickens to supply/Kg feed the following: Vit. A (I.U.) 10,000; Vit, D_3 (I.U.), 2,000; Vit, E (I.U.) 2.5; Vit, K 2.0mg; Riboflavin (mg) 4.2 Pantothenic acid (mg) 5.0; nicotinic acid (mg) 20.0; choline (mg) 300.0; folic acid (mg) 0.5; methionine (mg) 0.225; Mn 1(mg) 56.0;1 (mg) 1.0, Fe (mg) 20.0; Cu (mg) 10.0; (mg) 10.0; Zn (mg) 50.0; C. (mg) (12.5).

b) Experimental rations

Eight experimental rations were formulated. The dietary treatments were made up of the control, diet 1, which contain fish meal and groundnut meal as major protein sources. Diet,2, had only groundnut meal as the major protein source (table1). In the next consecutive diets, one-third, two-third and all of the groundnut meal protein contribution (C.P. 45%) was replaced by corresponding protein value of CMS (C.P. 37%) and PKM (C.P. 27%). The percentage ingredients composition of the diets are indicated in table 2 for the finisher phase.

c) Chemical analysis

The proximate composition of the protein sources and the diets were determined by using the AOAC (2000) methods. At the 13th week blood of two birds from each replicated treatments were collected and the serum separated were used for some metabolites determination. Total serum protein was determined by the biuret method as described by Weichelbaum (1946). Serum creatinine and uric acid were obtained by the method of Scott (1965) and Caraway (1955) respectively; while cholesterol levels were determined according to method of Roschlau*et al* (1974). Serum albumin was assessed by the method of Doumas and Briggs (1972) and globulin by the method of Rodkey (1965).

d) Cost analysis

Current price of feed ingredients at Ibadan and prevailing prices of chicken at the University meat shop were used to estimate cost and revenue indices.

e) Statistical analysis

A 4 x 2 factorial analysis with factor A consisting of four diets (plant protein; 33.3%, 66.6% and 100%) and factor B at with and without fish meal was used in this finisher phase (8-13 weeks). A Duncan multiple range test (Steel and Torrie, 1980) at 5 percent level of probability was used to assess significant differences.

Table 2a: Composition (%) of rations used at the finisher phase (9-13weeks) of cockerels fed varying levels of CMS/PKM replacement of GNM

Ingredients	Rations							
	1	2	3	4	5	6	7	8
Maize	27.08	27.08	26.73	26.22	26.34	24.92	25.86	22.71
Groundnut meal	3.31	4.11	3.04	3.31	1.62	2.09	-	-
Cotton seed meal	-	-	1.52	-	3.23	-	5.34	-
Palm kernel meal	-	-	-	1.66	-	4.18	-	8.48
Fish meal	1.50	-	-	-	-	-	-	-
Wheat offals	21.33	18.00	18.00	18.00	18.00	18.00	18.00	18.00
Dried brewers grains	42.53	46.56	46.56	46.56	46.56	46.56	46.56	46.56
Bone meal	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Oyster shell	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Premix*	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
CALCULATED								
Metabolisable								
Energy (kcal/g)	2.25	2.29	2.28	2.28	2.27	2.26	2.26	2.22
Crude protein (%)	16.13	15.99	16.04	16.00	15.99	16.00	16.00	16.00
Crude fibre (%)	11.76	11.59	11.71	11.73	11.84	11.95	12.00	12.31
DETERMINED (DM Pasis)								
Crude protein (%)	18.27	18.42	18.15	17.65	18.36	17.66	17.49	15.97
Crude fibre (%)	12.70	12.49	13.89	15.29	13.53	15.00	13.74	16.12
Ether extract (%)	3.53	3.56	4.10	3.49	4.15	3.00	3.49	4.45

Growing Chicken: Vit A (I.U.) 7500; Vit. D_3 (I.U.) 1.0; Vit K (mg) 2.0; Riboflavin (mg) 4.0; pavtothenic acid 9.0; Nicacin (mg) 20.0; choline chloride (mg) 1500.0; Vit B_{12} (mg) 110.0; C. (mg) 0; Cu (mg) 2.0;1 (mg) 1.2; Zn (mg); 50; Mn (mg) 80.0; Fe (mg) 25.0

Table 2b: Calculated amino acid composition as percentages of experimental finisher ration

Amino acids	Rations							
	1	2	3	4	5	6	7	8
Arginine	1.08	1.08	2.15	1.30	1.11	1.18	1.13	1.28
Histidine	0.38	0.38	0.39	0.38	0.39	0.38	0.40	0.37
Isoleucine	1.03	1.02	1.40	1.03	1.03	1.03	1.03	1.05
Leucine	1.70	1.70	1.70	1.79	1.70	1.71	1.70	1.73
Lysine	0.69	0.64	0.65	0.65	0.66	0.58	0.67	0.68
Methionine	0.29	0.28	0.29	0.29	0.29	0.30	0.30	0.31
Phenyalanine	0.95	0.95	0.96	0.95	0.97	0.95	0.98	0.96
Threonine	0.69	0.68	0.69	0.69	0.70	0.70	0.71	0.71
Tryptophan	0.27	0.27	0.27	0.27	0.27	0.26	0.27	0.26
Valine	1.05	1.05	1.06	1.06	1.07	1.08	1.09	1.11

Table 3: Effect of replacing GNM with CSM on the performance of cockerels (9-13 weeks)

Parameters	Replacement Levels					Fish Meal Effect		
	0%	33.3%	66.6%	100%	S.EX	+FM	-FM	S.EX
Daily weight gain (g)	13.58^{ab}	12.99^{b}	14.44^{a}	13.65^{ab}	0.39	14.04	13.29	0.16
Feed intake (g/bird)	119.71	119.79	125.14	126.09	13.49	122.18	109.74	7.98
Feed conversion ratio	8.85	9.31	8.69	9.27	0.33	8.72	9.33	0.88
Protein intake (g)	22.05^{ab}	21.74^{b}	22.98^{a}	22.05^{ab}	0.32	22.11	22.29	0.28
Protein efficiency ratio (per)	1.63	1.69	1.59	1.62	0.06	1.58^{2}	1.69^{1}	0.88
Mortality (%)	0.00	0.00	2.50	5.00	0.00	0.50	0.00	0.00
Feed cost (₦)	2.07	2.03	2.04	1.97	0.03	2.02	2.04	0.03
Total weight gained (kg)	0.48	0.46	0.51	0.48	0.01	0.50	0.48	0.01
Feed cost/kg live weight (₦)	4.28	4.39	3.96	4.08	0.15	4.05^{2}	4.31^{1}	0.01

a,b,/2,3 Means without common superscripts in horizontal rows are significantly different (P<0.05)

Table 4: Effect of replacing GNM with PKM on the performance of cockerels (9-13 weeks)

Parameters	Replacement Levels					Fish Meal Effect		
	0%	33.3%	66.6%	100%	S.EX	+FM	-FM	S.EX
Daily weight gain (g)	13.58^{ab}	13.64^{ab}	14.28^{a}	12.23^{b}	0.49	13.74	13.12	0.35
Feed intake (g/bird)	119.71	120.79	119.15	119.34	0.86	118.41	120.58	0.89
Feed conversion ratio	8.85^{ab}	8.93^{ab}	8.30^{b}	9.85^{a}	0.38	8.74	9.22	0.35
Protein intake (g)	22.05^{a}	21.32^{b}	20.86^{b}	18.98^{c}	0.16	20.64	20.96	0.12
Protein efficiency ratio (per)	1.63	1.57	1.47	1.57	0.06	1.52	1.60	0.06
Mortality (%)	0.00	0.00	3.00	0.00	0.00	1.50	0.00	0.00
Feed cost (₦)	2.07^{a}	2.03^{a}	1.89^{b}	1.75^{c}	0.01	1.92	1.95	0.01
Total weight gained (kg)	0.48^{ab}	0.48^{ab}	0.51^{a}	0.44^{b}	0.02	0.49	0.47	0.01
Feed cost/kg live weight (₦)	4.28	4.21	3.78	4.06	0.18	3.98	4.18	0.13

a,b,/2,3 Means without common superscripts in horizontal rows are significantly different (P<0.05)

Table 5: Overall performance characteristics of cockerels fed varying GNM replacement levels with CSM (4-13 weeks)

Parameters	Replacement Levels					Fish Meal Effect		
	0%	33.3%	66.6%	100%	S.EX	+FM	-FM	S.EX
Daily weight gain (g)	12.08	12.05	12.65	12.22	0.19	12.45^{1}	12.05^{2}	0.02
Feed intake (g/bird)	72.58^{c}	74.44^{bc}	75.35^{b}	78.84^{a}	0.72	75.11	75.49	0.59
Feed conversion ratio	6.02^{ab}	6.19^{ab}	5.96^{b}	6.46^{a}	0.14	6.04	6.27	0.06
Final body weight (kg)	1.14	1.13	1.19	1.15	0.02	1.17^{1}	1.13^{2}	0.00
Mortality (%)	0.00	0.00	2.50	5.00	0.00	0.50	0.00	0.00
Feed cost (₦)	4.54^{ab}	4.59^{a}	4.47^{ab}	4.38^{b}	0.05	4.64	4.35	0.06
Feed cost/kg liveweight (₦)	4.01	4.05	3.76	3.82	0.10	3.98	3.85	0.07
Income/feed cost (₦)	32.03^{b}	31.28^{b}	35.87^{a}	36.32^{a}	0.04	31.26^{2}	34.49^{1}	0.05

a,b,/2,3 Means without common superscripts in horizontal rows are significantly different (P<0.05)

Table 6: Overall performance characteristics of cockerels fed varying GNM replacement levels with PKM (4-13 weeks)

Parameters	Replacement Levels					Fish Meal Effect		
	0%	33.3%	66.6%	100%	S.EX	+FM	-FM	S.EX
Daily weight gain (g)	12.08^{a}	12.30^{a}	12.21^{a}	10.87^{b}	0.19	12.37	11.36	0.20
Feed intake (g/bird)	72.58	71.64	70.90	72.08	1.15	70.95	72.66	0.96
Feed conversion ratio	6.02^{b}	5.86^{b}	5.82^{b}	6.69^{a}	0.18	5.76	6.43	0.19
Final body weight (kg)	1.14^{a}	1.15^{a}	1.15^{a}	1.02^{b}	0.02	1.16	1.07	0.02
Mortality (%)	0.00	0.00	0.00	3.00	0.00	1.50	0.00	0.00
Feed cost (₦)	4.54^{a}	4.45^{a}	4.20^{b}	3.90^{c}	0.04	4.54^{1}	4.01^{2}	0.00
Feed cost/kg liveweight (₦)	4.01^{a}	3.87^{ab}	3.65^{b}	3.81^{ab}	0.10	3.92	3.75	0.67
Income/feed cost (₦)	32.03^{b}	29.94^{c}	34.97^{a}	36.87^{a}	1.43	33.52	33.93	0.52

a,b,/2,3 Means without common superscripts in horizontal rows are significantly different (P<0.05)

Table 7: Serum components and cholesterol levels of cockerels fed replacement levels of GNM with CSM (at 13 weeks)

Parameters	Replacement Levels					Fish Meal Effect		
	0%	33.3%	66.6%	100%	S.EX	+FM	-FM	S.EX
Creatinine (mg/100ml)	0.73^{ab}	0.67^{ab}	0.55^{b}	0.83^{a}	0.05	0.82	0.57	0.02
Uric acid (mg/100ml)	1.39	1.65	1.21	1.49	0.20	1.49	1.38	0.01
Total protein (g/100ml)	5.93	6.28	5.73	5.59	0.39	5.94	5.83	0.02
Albumin (g/100ml)	2.79	4.10	3.99	3.73	0.36	3.86	3.45	0.09
Globulin (g/100m)	3.10^{a}	2.18^{b}	1.73^{b}	1.86^{b}	0.15	2.07	2.37	0.12
A/G*	0.89	1.91	2.47	2.23	0.27	2.11	1.64	0.25
Cholesterol (mg/100ml)	318.63^{a}	305.13^{a}	304.38^{a}	272.53^{b}	6.63	302.93	297.39	0.79

* *Albumin to globulin ratio*

a, b means without common superscripts in horizontal rows are significantly different (P<0.05)

Table 8: Serum components and cholesterol levels of cockerels fed replacement levels of GNM with PKM (at 13 weeks)

Parameters	Replacement Levels					Fish Meal Effect		
	0%	33.3%	66.6%	100%	S.EX	+FM	-FM	S.EX
Creatinine (mg/100ml)	0.73[c]	0.85[c]	1.96[b]	3.24[a]	0.25	2.27[1]	1.12[2]	0.06
Uric acid (mg/100ml)	1.39	1.11	1.26	1.60	0.24	1.40	1.28	0.15
Total protein (g/100ml)	5.93	5.85	6.00	5.57	0.41	5.72	5.95	0.06
Albumin (g/100ml)	2.79[b]	4.22[a]	3.78[ab]	3.43[ab]	0.28	3.57	3.54	0.11
Globulin (g/100m)	3.10[a]	1.62[b]	2.22[b]	2.16[b]	0.21	2.14	2.41	0.05
A/G*	0.89[b]	2.79[a]	1.71[b]	1.67[b]	0.29	1.93	1.60	0.19
Cholesterol (mg/100ml)	318.63	300.65	282.75	301.46	10.46	299.94	301.81	5.39

** Albumin to globulin ratio*

a, b means without common superscripts in horizontal rows are significantly different (P<0.05)

III. Results

The crude protein, crude fibre and ether extract of the CSM used were 37.08%, 13.75% and 12.05% while those for PKM were 27.34%, 8.94% and 7.32% respectively. Calculated and determined nutrient composition as well as the calculated amino acid profile of the various diets are indicated in table 2a and 2b respectively.

Results of the finisher phase with CSM or PKM replacement of GNM are indicated in tables 3 and 4 respectively. The feed consumption figures of cockerels fed CSM or PKM were similar with no significant difference (P>0.05) recorded among dietary treatments. However, birds previously (5-8 weeks) on fish meal formulated diet tend to consume more feed than those fed rations without fish meal only with the CSM supplemented GNM. Birds fed complete replacement of GNM with CSM, recorded no significant difference (P>0.05) in weight gain from those fed 0% and 33.3% replacement although the 66.6% replacement level recorded highest daily weight gain of 14.44g/bird/day. With the PKM (tables 4), cockerels fed the 66.6% level gave highest weight gain though statistically similar (P>0.05) to 0% and 33.3% replacement dietary treatments. Cockerels previously fed fish meal diet at the starter phase recorded higher daily weight gain than those denied fish meal while birds on CSM formulation tended to stimulate better weight gain of birds than the PKM formulated dietary treatments. Feed conversion ratio of birds fed CSM rations resulted in no significant difference (P>0.05) between treatments unlike what obtains with PKM. However, a 66.6% replacement of GNM with either CSM or PKM gave better overall (P<0.05) feed conversion ratio similar to birds fed GNM-diets without CSM or PKM supplementation (tables 5 and 6). Birds fed fishmeal diet during the starter phase gave better efficiency of feed utilization.

Mortality record from CSM treatments occurred at higher levels of replacement (66.6% and 100% levels). Although mortality with PKM dietary treatment similarly occurred at high replacement (66.6%), it was far lower in the latter than with the former. Overall performance data shown in tables 5 indicated the highest weight gain and better utilization of feeds from birds fed partials replacement of GNM with CSM at 66.6%. Similar result for PKM (table 6) show a 33.3 level for the former and a 66.6% level for the latter parameter. Generally, birds fed fish meal diets gave better performance in terms of daily weight gain and efficiency of feed utilization when compared to those that were denied fish meal in their starter (5-8 weeks) ration. However, mortality increased on these.

There was no detectable difference (P>0.05) in serum total protein and uric acid between birds fed the varying levels of CSM or PKM. Serum cholesterol decreased (P<0.05) with increasing levels of CSM (table 7). Although no decrease in cholesterol level was observed from the 66.6% to 100% replacement level of PKM for GNM (table 8), a progressive decrease was observed from the 0% to 66.6% replacement level. An increase in the albumin fraction with increasing level of total protein was evidence from both CSM and PKM dietary treatments. The globulin levels among varying levels of CSM or PKM (P<0.05) were relatively stable; while the albumin to globulin ratio (A/G ratio) decrease as serum protein increased.

At this finisher phase, a 100% and 66.6% replacement of GNM by either CSM and PKM gave least feed cost and feed cost per kg live weight respectively. In general, a 66.6% partial and above replacement of GNM with either CSM or PKM gave highest income to feed (income/feed) cost which were significantly higher (P<0.05) than what was realized from lower level (tables 5 and 6)

IV. Discussion

The crude protein content of CSM used in this study was lower than value obtained by Phelps (1966) but higher in ether extract than value reported by Nwokolo *et al* (1976). The fibre content of PKM was relatively lower than value obtained by Nwokolo *et al* (1984). The variation in nutrient composition of these ingredients from values obtained by earlier workers might be due to possible varietal differences and methods of processing. The crude protein, crude fibre

and ether extract content of PKM is relatively lower than that for CSM.

The 66.6% level of GNM replacement with either CSM or PKM gave the best results. This goes to complement results by Nzekwe and Olomu (1979), NAPRIL (1984), that at least up to 50% of GNM in finisher rations of broilers could be replaced with CSM without adverse effects on weight gain and feed efficiency. The lower value of daily weight gain from birds on PKM when compared to their counterpart on CSM might be due to unavailability of amino acids for growing chicks (Nwokolo, Bragg and Witts, 1976). The overall performance data followed the same trend for CSM as in the finishers phase. However, for PKM, a 33.3% replacement level gave highest weight gain and efficiency of utilization. This compliment the preliminary reports of Yeong and Robert (1977) that PKM could be used up to 30%in diet for chicken. Oyenuga (1968) reported that PKM causes heavy salivation during mastication and this can affect their utilization capacity by poultry particularly at a much higher level of inclusion in diets.

Mortality record at the finisher phases was as a result of snake bites that occurred in the unit at week eleven. The attack was on cockerels fed fish meal diets at the starter phase. This study suggest the possibility of replacing 50% of an all-plant GNM protein with CSM and a level of not more than 33.3% PKM replacement for cockerel production at the finisher phase. Generally, the weight gain, feed consumption of birds, feed conversion ratio and final live body weight of birds given rations with fish meal were higher than those of birds fed rations without fish meal. This obviously is explained by the better amino acid profile of rations with fish meal with a concomitant better carry-over effect of such starter diets on their overall biological productivity.

The data presented in this study demonstrated from values of creatinine and uric acid level (tables 7 and 8) that the 66.6% replacement of GNM with CSM and 33.3% for PKM is optimal for satisfactory protein utilization in finishing cockerel development. The low level values recorded on both parameters signified no observable muscular wastage brought about by inadequacy of protein. It is of particular interest to note that serum proteins and cholesterol levels of the different dietary treatments were relatively stable; an indication of appropriate balancing of protein for protein in the substituted and substituting ingredient in the various treatments. As pointed out by Allison (1955), total protein or serum albumin is an indication of the protein reserves in an animal. The increase in serum albumin and therefore total serum protein with reducing levels of CSM or PKM inclusion levels reflected the ability of the chicks on low CSM or PKM to store "reserve" proteins, when the animal has reached its maximum capacity for depositing tissue or less "labile" protein. The data of Seeler and Ott (1945) demonstrate the importance of the protein reserves of the chick in resisting stress. The relative stability of serum globulins as compared to serum albumin with either CSM or PKM dietary treatments is in accord with previous observations in the chick (Leveille*et al,* 1956). The resulting albumin globulin (A/G) ratios, however decreased after a threshold with either the CSM or PKM supplementation. Alteration in the A/G ratio have been reported as a consequence of a vitamin E deficiency in the chick (Goldstein and Scott, 1956); Bieri and Pollard, 1959) and various other pathological conditions in the chicken (Shelton and Olson, 1960). Since this study precluded these possible factors for A/G ratio variations, it will be impossible to account for such slight variation. The depression in cholesterol level with increasing levels of CSM contradicts the reports by Johnson *et al* (1958); Leveille and Fisher (1958); Leveille*et al*, (1960) that an inverse relationship exist between serum cholesterol and dietary protein levels. The diets used in this study was relatively iso-nitrogenous.

It has been observed that feed cost/kg of liveweight gain is lower with partial replacement of GNM (66.6%) with either CSM or PKM supplementation in cockerel diets (tables 4,5 and 6). Complete replacement improved income over feed cost significantly ($P<0.05$) because of the lower cost per unit of CSM or PKM in relation to GNM. Feed cost of birds fed diets fortified with fish meal were higher and gave lower income over feed cost when compared to those that were not fed fish meal diet.

Although maximum growth rate is an important objective for a feed compounder selling cockerel feeds, it may not be the only important criterion for cockerel production. At present fish meal is expensive and not easily available and were available there is problem of adulteration. Reasonable growth rate at cheaper production costs could be obtained by its complete elimination from the 5th week of age. The question remains as to what extent depression in performance could be acceptable in relation to the cost of cockerel feeds and elimination of fish meal. More information from research is needed in this respect.

V. Conclusion

In conclusion from data generated from this study in finishing cockerels, it is obvious that:

- Fish meal fortification although more expensive at the starter phase (0-8weeks) gave better efficiency of feed utilization.
- CSM gave better performance results than PKM substitution for GNM in finishing cockerels.
- For an all-plant protein formulation it is recommended that 60% of either CSM or PKM substitution of GNM will be ideal.

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Assesment of Crop and Irrigation Water Requirements for Some Selected Crops in Northwestern Bangladesh

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Abstract- Currently, almost 90% of the global water consumption is caused by the irrigation activities, and more than 40% of the crops are produced under the irrigated conditions. This study is an attempt to estimate the irrigation water requirement (IWR) and crop water requirement (CWR) for some selected crops (Aus, Amon, Boro, Maize, Potato, Bean, Sugarcane, Banana, Tobacco, Wheat, Tomato, Peas, Groundnut, Peeper, Cabbage and Watermelon) in northwestern Bangladesh. Two selected districts (Dinajpur and Rangpur) and an adjacent upazila of Saidpur of Nilphamari district have been taken as a case study area. Necessary meteorological (rainfall, temperature, humidity, wind speed, sunshine hours) and crop data (crop coefficient and crop calendar) have been collected for 30 years period from 1982 to 2012. FAO CROPWATv8.0 has been applied for necessary calculation of CWR and IWR along with the developing of cropping patterns.

Keywords: irrigation water requirement (IWR), crop water requirement (CWR), crop calendar & co-efficient, reference evapotranspiration (ET_o), FAO penman-monteith.

GJSFR-D Classification: FOR Code: 079901

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Assesment of Crop and Irrigation Water Requirements for Some Selected Crops in Northwestern Bangladesh

Md. Robiul Islam [α], Mahmudul Hasan Mizan [σ], Mafruha Akter [ρ] & Golam Zakaria [ω]

Abstract- Currently, almost 90% of the global water consumption is caused by the irrigation activities, and more than 40% of the crops are produced under the irrigated conditions. This study is an attempt to estimate the irrigation water requirement (IWR) and crop water requirement (CWR) for some selected crops (Aus, Amon, Boro, Maize, Potato, Bean, Sugarcane, Banana, Tobacco, Wheat, Tomato, Peas, Groundnut, Peeper, Cabbage and Watermelon) in northwestern Bangladesh. Two selected districts (Dinajpur and Rangpur) and an adjacent upazila of Saidpur of Nilphamari district have been taken as a case study area. Necessary meteorological (rainfall, temperature, humidity, wind speed, sunshine hours) and crop data (crop coefficient and crop calendar) have been collected for 30 years period from 1982 to 2012. FAO CROPWATv8.0 has been applied for necessary calculation of CWR and IWR along with the developing of cropping patterns. The FAO Penman-Monteith method is used for estimating the reference evapotranspiration (ET_0) by using meteorological data in the framework of CROPWAT model as it regarded as a good estimator for a wide variety of climatic conditions. The analysis indicates that FAO Penman-Monteith suits very well for the study area and can be successfully used. The estimated monthly ET_0 demonstrates that evaporative demand from month April to October is very high, which reveals that the water losses are very high in these months. The obtained CWR for the selected crops indicates that maximum water requires for Rice. It also shows that Wheat, Peeper, Sugarcane and Banana exhibits comparatively higher water requirement than the other crops grown in the study area. The study concludes that IWR for month June to September is relatively low but for the other month irrigation requirements are comparatively very high due to the prevailing monsoon season in that period. The study also concludes that total IWR for Rangpur, Dinajpur and Saidpur are 644714, 1004745, and 47474 million liters, respectively only for the selected crops.

Keywords: irrigation water requirement (IWR), crop water requirement (CWR), crop calendar & co-efficient, reference evapotranspiration (ET_o), FAO penman-monteith.

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I. Introduction

Agriculture is the largest producing sector of Bangladesh's economy, contributing about 18.6% to the national GDP and employing about 45% of the total labor force. More than 85% of the country's population is directly and indirectly dependent on agriculture. The performance of this sector has great impact on the major macroeconomic objectives like employment generation, poverty alleviation, human resources development and food security(Abdullah and Rahman, 2015). Agriculture is responsible for about 75% of global freshwater diversions and 40% of the world's food is provided by irrigated agriculture on 20% of the world's cultivated land area(Shiklomanov, 1991). Though Bangladesh is a land of rivers, irrigation plays a vital role for half of the year when scarcity of water seriously handicaps farming operations. Irrigation is one of the leading input has direct influence to increase yields, food grain productions and plays vital role for increasing food security. Despite technological advances, agriculture is still vulnerable to the unfavorable weather events and climatic conditions.

Bangladesh is one of the most vulnerable countries in the world to climate change.Disaster and climatic risk management in agriculture is a major challenge for Bangladesh in achieving sustainable agricultural development(Abdullah and Rahman, 2015). Due to the increase in temperature, evapotranspiration (ET- water lost by evaporation and by transpiration) increases, resulting an increase in irrigation need. When the crop is small evaporation is the main process but transpiration becomes the dominant process after the crop is fully grown. There is no easy way of distinguishing evaporation and transpiration since they occur simultaneously (Zotarelli et al., 2009). It has been estimated that at crop sowing 100% of the total ET comes from evaporation while at full crop evaporation accounts for 10% of ET and transpiration for the remaining 90%.(Allen et all.,1998). Again the evapotranspiration from crops grown under management and environmental conditions that differ from the standard conditions is calculated by a water stress co-efficient (K_s) (Savva and Frenken, 2002). On the other hand higher rainfall will complement the irrigation. These contradictory phenomena will change

the dryness in climate and the total irrigation demand which is required to quantify for long term irrigation planning and management. Water requirement for irrigation is closely related to population, demand for food, production of non-food agricultural and industrial items, improvement in quality of life and preservation of ecology and environment.

Bangladesh has a land area of about 14.4 million ha of which 9.03 million ha (64%) are under cultivation. Irrigation is one of the leading inputs has direct influence to increase yield, food grains production and plays vital role for ensuring food security in Bangladesh (Rahman and Parvin, 2009).Irrigation is currently available to less than 50% of the land that can be irrigated in the Rabi season. At present, about 33% of the cultivable land (3.12 million ha) has irrigation facilities. This amounts to about 21.6% of the total cropped area. The percentage of total cultivable area under irrigation can be increased to a greater extent if proper irrigation system can be applied.To be able to plan effective irrigation schedule, the steps were followed as stated in (Kariyama, 2014) The application of proper irrigation system depends on appropriate estimation of crop water requirement (CWR) and irrigation water requirement (IWR), effective rainfall, suitable cropping pattern and appropriate irrigation system.

II. Methodology

The objectives of this study is to estimate the CWR and IWR and to developed cropping pattern in the study areas for the selected crops to ensure the optimum use of available irrigation water and the optimum use of the available land. So assessment of evapotranspiration loss, effective rainfall and the percentage of total area covered by each crops is very essential. Again to ensure the minimum loss of irrigation water crop coefficient at different stages with their stage lengths and various climatic parameters are adjusted for the study areas.

a) Study Area Selection

Two districts Rangpur and Dinajpur and an upazila named Saidpur of Nilphamari districts in the northwestern zone of Bangladesh are selected as the study area.

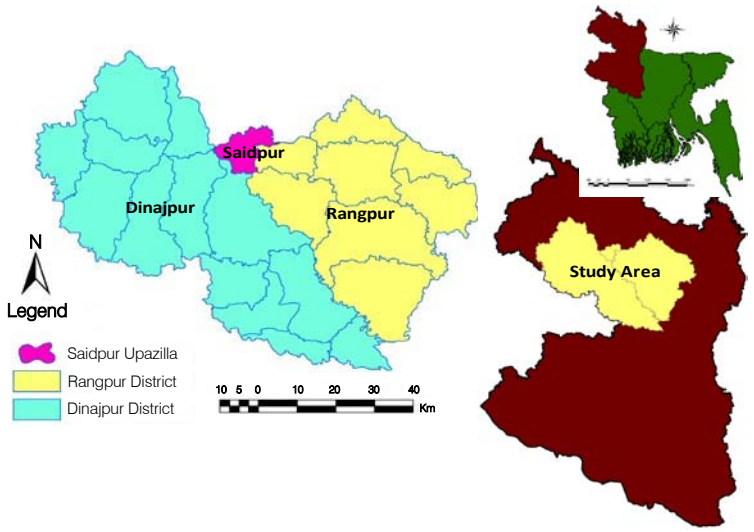

Figure 2.1: Location of the Study Area in Northwestern Bangladesh

Table 2.1: Study area latitude longitude and elevation (Source: Bangladesh Meteorological Departerment and Department of Agricultural Extensions)

Name of the stations	Latitude (N)		Longitude (E)		Elevation (Meter)	Total Area (Km^2)	Cultivable Area (Km^2)
	Deg.	Mts.	Deg.	Mts.			
Dinajpur	25	39	88	41	37.58	3437.98	2166..61
Rangpur	25	44	89	16	32.61	2707.78	1701.13
Saidpur	25	45	88	55	39.60	121.68	96.33

b) Data Collection

Various climatological data such as monthly maximum and minimum temperature, monthly average humidity, monthly average sunshine hours, daily average wind speed, monthly total rainfall, altitude, latitude, longitude are collected from Bangladesh Meteorological Department (BMD), Agargaon, Dhaka. Total area, total cultivable area, total area under

irrigation, planting date, harvesting date, stages length, rooting depth and percentage of the total area covered by each crops are collected from Department of Agricultural and Extension (DAE), Rangpur for all the study areas. The other data such as crop coefficients at various stages, yield response, critical depletion factors are collected from FAO table and then adjusted.

c) Data Processing

The estimation of all the climatic parameters are made based on Least Square Parabolic Method. In case of any missing data for a year, value of that parameters for that year are predicted from the previously available data.

d) Reference Evapotranspiration (ET_0)

Although over the last 50 years several empirical and semi empirical method has been developed for the determination of ET_0 but the FAO Penman-Monteith is now sole recommended. The Penman-Monteith Equation for determining reference evapotranspiration (ET_0) is given by the following equation (FAO 1998 a)

$$ET_0 = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T+273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)} \quad (1)$$

To ease the calculation, Food and Agricultural Organization (FAO) developed a software named CROPWAT v 8.0. The following figure shows the determination of reference evapotranspiration using CropWatv8.0.

Monthly ETo Penman-Monteith - C:\Documents and Settings\All Users\Application Dat...

Country Bangladesh Station Rangpur

Altitude 33 m. Latitude 25.75 °N Longitude 89.27 °E

Month	Min Temp	Max Temp	Humidity	Wind	Sun	Rad	ETo
	°C	°C	%	km/day	hours	MJ/m²/day	mm/day
January	8.1	26.6	81	26	3.1	9.4	1.55
February	10.0	30.5	70	35	5.6	14.0	2.36
March	14.2	34.7	66	52	5.5	15.9	3.29
April	18.3	35.7	75	86	6.4	18.8	4.26
May	20.1	36.5	78	52	6.2	19.3	4.32
June	21.6	35.5	82	50	4.2	16.4	3.77
July	23.0	35.9	81	69	5.1	17.6	4.10
August	24.3	36.2	83	52	4.3	15.9	3.73
September	24.5	35.1	82	43	6.5	17.8	4.00
October	19.3	34.1	80	35	6.5	15.7	3.30
November	13.6	30.6	77	35	6.3	13.4	2.46
December	9.0	28.3	82	17	2.8	8.6	1.54
Average	17.2	33.3	78	46	5.2	15.2	3.22

Figure 2.2: Evapotranspiration of Rangpur Using FAO CROPWAT v-8.0

The CROPWAT v 8.0 required the following crop data as shown in table 2 as input. From the crop data the crop coefficient values are adjusted.

Table 2.2: Input data in CROPWAT v 8.0

	Non-rice crop	Rice crop
Input Crop Data	➢ K_C values at different stage ➢ Different stage lengths ➢ Rooting depth ➢ Critical Depletion fraction ➢ Yield response and ➢ Crop height	➢ K_C dry values at different stage ➢ K_C wet values at different stage ➢ Different stage lengths ➢ Rooting depth ➢ Pudding depth ➢ Critical Depletion fraction ➢ Yield response and ➢ Crop height ➢ Nursery area

After adjusting the crop coefficient values the data are plotted as shown in the following figures:

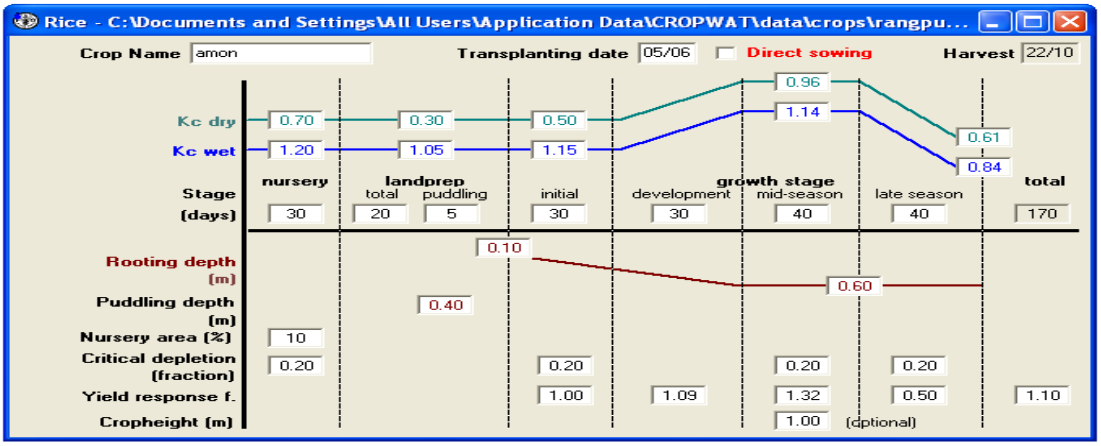

Figure 2.3: Rice data plotting for CROPWATv8.0

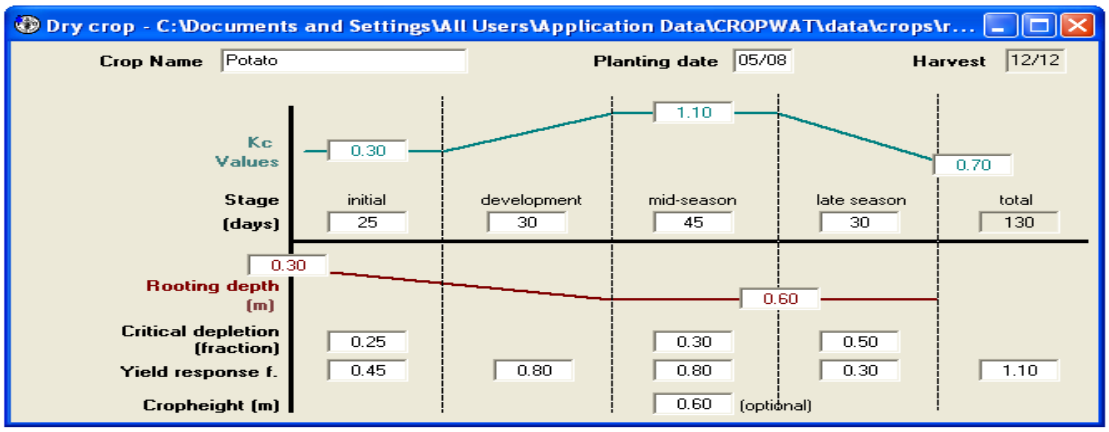

Figure 2.4: Non-rice data plotting for Rangpur station for CROPWATv8.0

After plotting the crop data, the required CWR and IWR for that particular crop estimated.

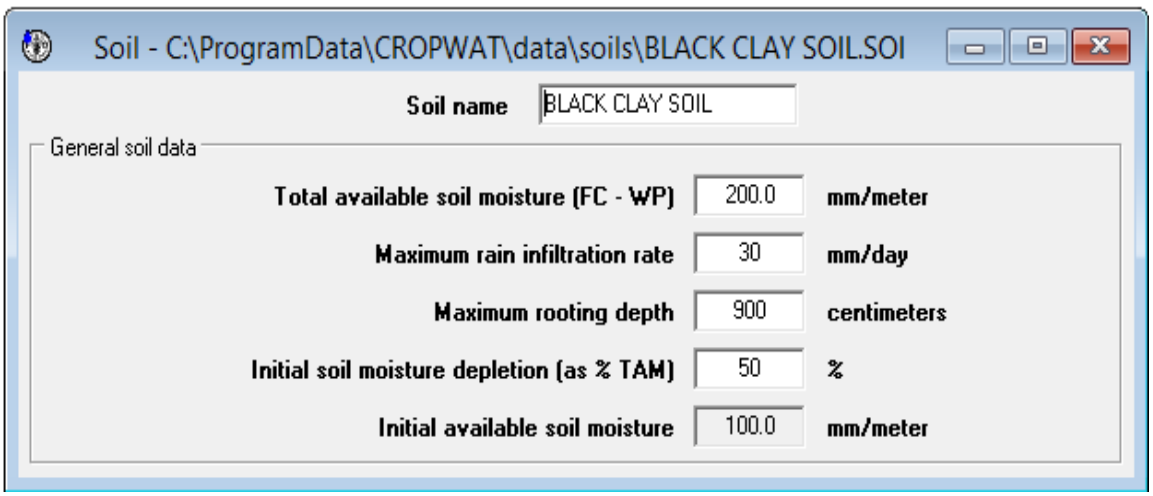

Figure 2.5: Soil Data Input for CROPWAT v 8.0

e) Cropping Pattern

To get the irrigation water requirement on daily or monthly basis for all the crops, a cropping pattern with planting and harvesting date with the total percentage of cultivable land covered by the each crops are inserted in the cropping pattern menu of the Cropwatv8.0.

f) Total irrigation Water Requirement

After inserting cropping pattern, CROPWAT v 8.0 provide net scheme irrigation water requirement for that particular study area and for all the crops at a time.

III. Results and Discussion

a) Reference Crop Evapotranspiration of the Study Area

Figure 3.1 shows the estimated reference evapotranspiration of Rangpur, Dinajpur and Saidpur for all the month of 2013. From this figure we found that the reference evapotranspiration are normally less from the month November to February and their values are below 3 mm/day. For month Mar to October its value ranges from 3 to 5 mm. For most of the month the evapotranspiration losses are greater for Saidpur district compared to Rangpur and Dinajpur. Although there is an increasing tendency of the values from December to May but the value decreases in month Jun and July due to the heavy rainfall and low temperature. Rangpur, Dinajpur and Saidpur shows the maximum value of evapotranspiration in month May, August and May respectively.

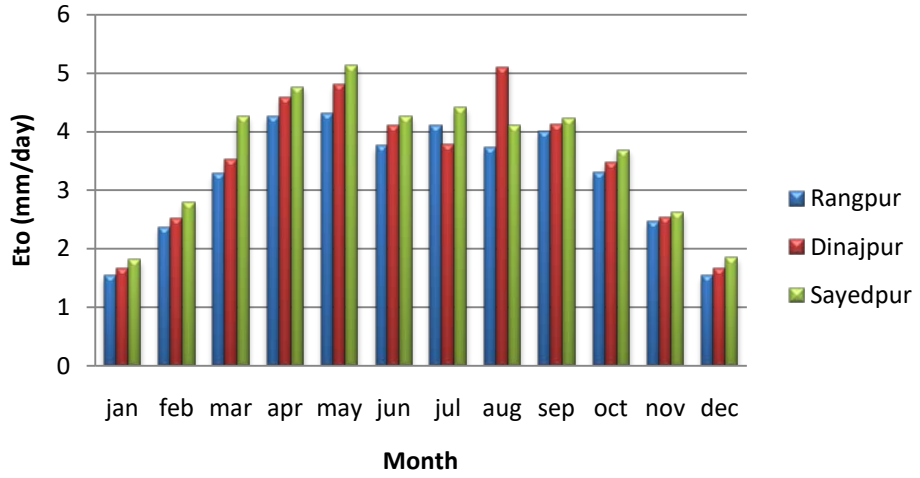

Figure 3.1: Monthly ET_O of Rangpur, Dinajpur and Saidpur

b) Estimation of Effective Rainfall

Figure 3.2 represents the estimated rainfall and effective rainfall of the selected stations. From figure it is found95% of the rainfall occurs during April to October, leaving the winter months, i.e. November to March, very dry. Therefore, irrigation is a prerequisite for obtaining stable high yields during the dry season hence irrigation water requirements for month November to March are very high so that crop can make intensive use of the land. The rainfall intensity is the maximum from month May to August. The rainfall intensity from November to March is very lower. April, September and October shows moderate rainfall. The maximum intensity of rainfall for Rangpur and Dinajpur occur in month Jun and for Saidpur occurs in month August.

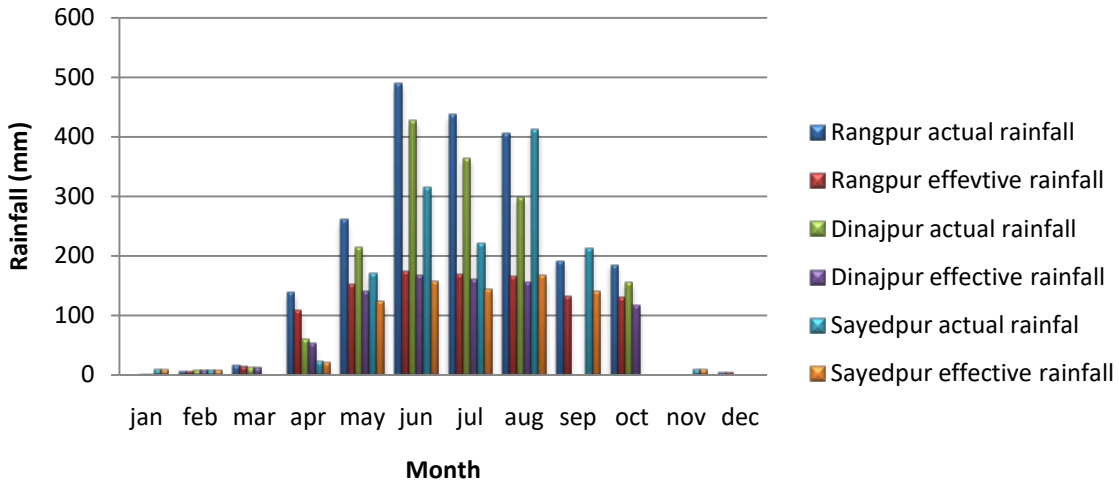

Figure 3.2: Actual and effective rainfall of Rangpur, Dinajpur& Saidpur for all the months.

c) *Net Scheme Irrigation Water Requirement in the Selected Area*

Figure 3.3 shows the irrigation requirement only for the selected crops. From the figure it is found that the minimum irrigation requirement is from month Jun, July and Aug because in these periods rainfall intensity is the maximum. Again from month October to May irrigation water requirement is the maximum. For Saidpur in October month net Scheme irrigation requirement is maximum and excessively higher than the other months because of severe drought condition in this month.

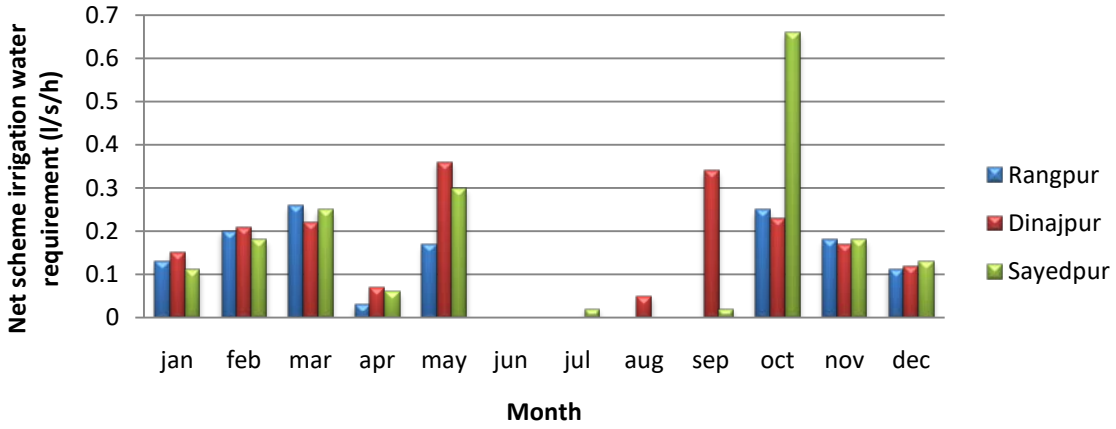

Figure 3.3: Net scheme IWR for Rangpur, Dinajpur and Saidpur for all month

d) *Crop water requirements for the selected crops in the study area*

Figure 3.4 shows the CWR of Various crops in their lifetime and expressed in mm. On the basis of total crop water requirement per unit area Banana shows maximum CWR. If we consider Daily basis or total CWR in the area where it is cultivated then rice require the maximum CWR as rice grown in a huge area.

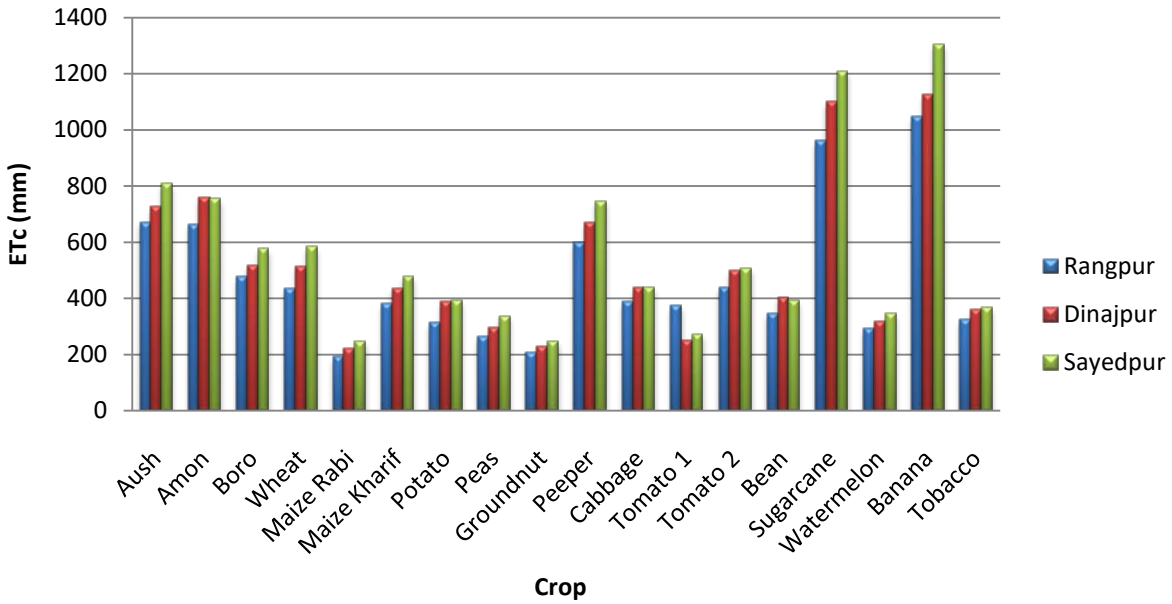

Figure 3.4: Crop water requirements for the selected crops for the Rangpur, Dinajpur and Saidpur

e) *Cropping Pattern in the study area*

The following figure shows the cropping pattern of Rangpur based on the Planting and Harvesting date and the percentage of total area that each of the crop occupied. The above figure gives an idea about the total area that a crop is cultivated. From Peas to Banana it is found that the percentage of total area is 1% for each of the crop when using CropWatv8.0. This is because CropWatv8.0 does not take in value less than 1 during the development of cropping pattern. This ensures the yield of more production for the other crops. Rice is cultivated in most of the area followed by Potato, Maize, wheat etc.

Crop name	Planting date	Harvesting date	% area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Aush	15/03	01/08	7												
Amon	05/6	22/10	25												
Boro	25/10	02/04	50												
Wheat	20/11	07/06	2												
Maize (R)	15/11	19/03	6												
Maize (k)	15/03	17/07	2												
Potato	05/08	12/12	15												
Peas	05/11	24/03	1												
Groundnut	05/10	11/02	1												
Peeper	05/01	02/08	1												
Cabbage	05/08	16/01	1												
Tomato 1	15/10	12/04	1												
Tomato 2	15/04	11/10	1												
Bean	05/06	22/09	1												
Sugarcane	25/09	10/08	1												
Watermelon	01/10	09/03	1												
Banana	05/08	29/08	1												
Tobacco	05/08	22/11	2												

Figure 3.5: Cropping Pattern of Rangpur

Based on planting and harvesting date and total percentage of area that the crops are cultivated, cropping pattern for Dinajpur shown in figure 3.6 is prepared using CropWatv8.0. Rice is cultivated in most of the area followed by Potato, wheat, Maize etc.

Crop name	Planting date	Harvesting date	% area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Aush	15/03	01/08	3												
Amon	05/6	22/10	45												
Boro	25/10	02/04	35												
Wheat	20/11	07/06	9												
Maize (R)	15/11	19/03	6												
Maize (k)	15/03	17/07	2												
Potato	05/08	12/12	14												
Peas	05/11	24/03	1												
Groundnut	05/10	11/02	1												
Peeper	05/01	02/08	1												
Cabbage	05/08	16/01	1												
Tomato 1	15/10	12/04	1												
Tomato 2	15/04	11/10	1												
Bean	05/06	22/09	1												
Sugarcane	25/09	10/08	1												
Watermelon	01/10	09/03	1												
Banana	05/08	29/08	1												
Tobacco	05/08	22/11	1												

Figure 3.6: Cropping Pattern of Dinajpur

The following figure shows the cropping pattern of Saidpur based on the Planting and Harvesting date and the percentage of total area that each of the crop occupied. The above figure gives an idea about the total area that a crop is cultivated. Rice is cultivated in most of the area followed by Potato, wheat, Maize etc.

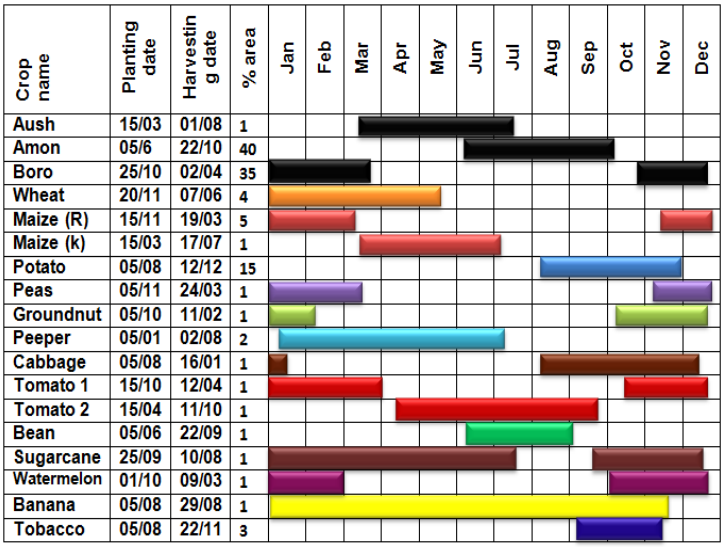

Figure 3.7: Cropping Pattern of Saidpur

IV. Conclusions

Based on the present study the following conclusion can be drawn:

- This study mainly estimates the CWR and IWR for some selected crops as well as developing cropping pattern for the study area using CROPWATv8.0
- IWR is very low from June to September due to higher rainfall intensity in these months and from month October to May a considerable amount of water is required for irrigation.
- Total IWR for Rangpur, Dinajpur and Saidpur are 644714, 1004745, and 47474 million liters or 41.43 cusec, 66.73 cusec and 3.09 cusec respectively.
- Since the climatological conditions of Rangpur, Dinajpur and Saidpur are more or less same hence planting and harvesting date for various crops are kept same while developing cropping pattern.
- The maximum water requires for Rice crops, Wheat, Peeper, Sugarcane and Banana are comparatively higher than the other crops.

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Farmers' Production Constraints, Knowledge of *Striga* and Preferred Traits of Pearl Millet in Jigawa State, Nigeria

By Maryam A. Dawud, Ignatius I. Angarawai, Pangarayi B. Tongoona, Kwadwo Ofori, John S. Y. Eleblu & Beatrice E. Ifie

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Abstract- A participatory rural appraisal was performed in order to identify farmers' pearl millet production constraints, preferred varietal traits and their knowledge about Striga hermonthica. This was conducted in Dutse (Madobi and Kudai), Birninkudu (Kantoga and Kafingana) and Kiyawa (Karfawa and Shuwarin) local governments of Jigawa state Nigeria. Questionnaires and focus group discussion were used to gather information from 143 respondents. Results shows that the five most important traits selected were resistance to Striga infestation, resistance to downy mildew, tolerance to shattering, good quality local beverage, and tolerance to lodging. The major constraints to production across all the districts were low soil fertility, Striga, downy mildew, and high labour costs. Farmers had a good knowledge about Striga and their control methods across the locations were hand-pulling and or hoe weeding.

Keywords: *pearl millet, production constraints, farmers' preferred traits, striga hermonthica.*

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Farmers' Production Constraints, Knowledge of *Striga* and Preferred Traits of Pearl Millet in Jigawa State, Nigeria

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Abstract- A participatory rural appraisal was performed in order to identify farmers' pearl millet production constraints, preferred varietal traits and their knowledge about Striga hermonthica. This was conducted in Dutse (Madobi and Kudai), Birninkudu (Kantoga and Kafingana) and Kiyawa (Karfawa and Shuwarin) local governments of Jigawa state Nigeria. Questionnaires and focus group discussion were used to gather information from 143 respondents. Results shows that the five most important traits selected were resistance to Striga infestation, resistance to downy mildew, tolerance to shattering, good quality local beverage, and tolerance to lodging. The major constraints to production across all the districts were low soil fertility, Striga, downy mildew, and high labour costs. Farmers had a good knowledge about Striga and their control methods across the locations were hand-pulling and or hoe weeding.

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I. Introduction

Pearl millet provides food for over 40 million people in northern Nigeria. It is very important to the nation's agricultural sector because of its high degree of adaptation to stress environments such as severe drought, poor soils and high temperature making it a great relief to life in the Sahel (Rai & Kumar, 1994).

The grain is used primarily for human consumption because of its high level of fat and protein (the protein content varies between 10.9 to 16.9%) (Okoh et al., 1985) and its digestibility is better than that of sorghum (Rooney & McDonough, 1987). In Nigeria from 1992 to 1994, 3.3 million tons of millet was used directly as food, 1.2 million tons for seed, beer, and only 0.1 million tons were used as livestock feed (Obilana, 2003).

According to DIIVA Project report 2010, some improved cultivars were released in Nigeria but adoption by the small-scale farmers are low, with only 24% using improved varieties and 75% local varieties. Kidoido et al. (2002) suggests a number of reasons for low adoption of improved varieties and principal among them is the failure of breeders to involve and incorporate farmers' concerns in their cultivars development.

Participatory rural appraisals have been used in developing countries to make use of rural community's knowledge in agricultural research. A participatory rural appraisal enables local communities to analyze their own conditions, plan and make decisions (Chambers, 1994). Interestingly, farmers are increasingly participating in agricultural research as scientists and development workers become more aware of the philosophy of 'farmer first' and its effectiveness. Before engaging any successful and sustainable breeding programme, it is necessary to document the end-users' perceptions regarding preferences and constraints affecting the crop. However, little is known about farmers' production constraints, their preferred pearl millet varietal traits and perception of *S. hermonthica*, although a number of studies have attempted to include farmers in participatory approaches to breeding of pearl millet in Nigeria. A survey conducted by Dugje et al. (2006) in Yobe state Nigeria, indicated that farmers rated *Striga* infestation as the most important production constraint coupled with low soil fertility. The use of pearl millet varieties that are able to resist these conditions would increase yield in farmers' field and subsequently improve livelihood in Jigawa state. Emechebe et al. (2004) conducted PRA to identify farmers' perception of *Striga* problem and its control in Nigeria. Also, Coulibaly et al. (2017) conducted a PRA study to identify groundnut production constraints in Niger.

Adoption rates of improved technologies in developing countries is low, therefore, it is essential to identify and incorporate farmers' varietal preferences in breeding programmes and document and recommend solutions to production constraints in order to increase the acceptability of new and improved varieties.

Therefore the objectives of this research were to:

i) Assess farmers' pearl millet preferred traits
ii) determine farmers' production constraints in pearl millet, and
iii) Assess farmers' knowledge on *Striga hermonthica* in pearl millet

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II. Methodology

a) Study area

This study was conducted in six villages comprising two each from three local government areas (LGA) of Jigawa State in Nigeria. The villages were Madobi and Kudai from Dutse LGA (11°46'39''N and 9°20'03''E), Karfawa and Shuwarin in Kiyawa LGA (11°47'05''N and 9°36'30''E) and Kafingana and Kantoga in Birninkudu LGA (12°59'53''N and 8°54'35''E). Dutse and Birninkudu are located in the southern region while Kiyawa is located in the south eastern region of Jigawa state. The regions are characterized by monomodal average annual rainfall of 743, 734 and 820mm for Dutse, Kiyawa and Birninkudu respectively.

b) Selection of Study Sites and Sampling Method

A preparatory survey was conducted in Jigawa state to identify and select the villages were pearl millet is largely cultivated, farmer groups and individual farmers. A multi-stage sampling procedure was used to select the sites for the study that represented diverse ecological and socio-economic environments in the pearl millet growing areas of Jigawa State. The first stage included purposive selection of three LGA from the state based on the potentials for pearl millet production. The second stage involved random selection of two villages from each of the LGAs. The last stage involved random sampling of 23 to 24 pearl millet farmers from each of the selected villages, to give a total of 143 farmers which constituted the sample size for the study (Table 1). A survey was further conducted with individual farmers.

Table 1: PRA sites and number of farmers interviewed

Villages	Local governments	No. of farmers (survey)	No. of farmers (FGD)	
			Males	Females
Madobi	Dutse	15	4	5
Kudai	Dutse	15	6	3
Karfawa	Kiyawa	15	5	4
Shuwarin	Kiyawa	15	6	3
Kafingana	Birninkudu	15	6	2
Kantoga	Birninkudu	15	4	5

c) Data Collection and Analysis

The PRA techniques used were focus group discussion (FGD), matrix ranking and individual interviews. At each site of the PRA, the local extension officer led contact with the groups, introduced groups and facilitated the discussion in the local dialect. The study was divided into two components: i) focus group discussions were conducted to reveal the preferred varietal traits, production constraints and knowledge on *S. hermonthica*, and ii) a survey was also conducted with individual farmers to confirm the PRA findings.

The discussions were to determine the pearl millet trait preferences, main constraints to pearl millet production, assess their knowledge on *Striga* and their coping mechanism. Farmers were seated in a semi-circle to facilitate identification of key points raised by each farmer and also ensure full participation by all the participants. The FGDs was conducted using a checklist and the trait preferences and production constraints were subsequently ranked using the pair-wise ranking method. A semi-structured questionnaire was used for the survey to supplement the findings from the FGDs. The survey focused particularly on pearl millet farmers who grew the crop every year. Participants were encouraged to express their views and disagree with one another on issues if there is need. The order in which topics were covered was flexible but generally the sessions started with more general issues and slowly moved into more specific ones. Towards the end, a few probing questions were asked to get in-depth information or to clarify earlier responses. Data generated were coded and analysed using SPSS computer package (version 20).

III. Results

a) Farmers' Preferred Traits in Pearl millet

Striga resistant in pearl millet was ranked the most important trait to be improved across all the districts (ranked 1) except at Kafingana where it was ranked 4th most preferred, followed by tolerance to shattering as the second most important trait to be improved in Kudai, Kafingana and Shuwarin (Table 2). Downy mildew resistance is the most important trait to be improved in Kafingana (ranked 1). Although early maturity is an important trait for improvement in most crops, all farmers reported that they preferred late maturing varieties (early/medium maturity ranked from 10-13 across villages). High grain yield had a low ranking (8 to 10) across villages.

Table 2: Farmers' preferred traits ranked according to importance

Variety characteristics	Dutse		Birninkudu		Kiyawa	
	Madobi	Kudai	Kafingana	Kantoga	Karfawa	Shuwarin
Maturity (Early/medium)	11	11	11	13	13	10
Yield (high)	10	8	8	8	10	8
Plant height (medium)	12	10	11	11	14	13
Panicle length (medium)	13	12	10	12	12	12
Panicle size	11	8	9	10	11	10
Grain size (bold)	8	9	9	9	9	8
Grain color (grey)	8	7	7	7	7	7
Thresh ability	9	10	7	9	9	11
Grain hardness	7	6	6	5	7	7
Taste	6	7	5	5	7	4
Storability	6	5	5	4	8	5
Panicle compactness	5	6	6	6	7	6
Panicle bristle	14	13	11	14	6	*
Downy mildew Resistance	5	4	1	3	5	2
Striga Resistance	1	1	4	1	1	1
Tolerance to lodging	3	3	3	2	2	3
Tolerance to shattering	4	2	2	3	4	2
Tillering ability	2	3	11	2	4	8
Quality local beverage	4	6	2	5	3	4

**denotes characteristic not reported*

b) Constraints to Pearl millet Production

Table 3 shows the constraints to pearl millet production in Jigawa state. Land shortage was the most important constraint to farmers in Madobi (ranked 1) and Kafingana (ranked 1)(Table 3). Theft, lack of improved seeds, and lack of access to extension agents were the most important constraints to farmers in Kantoga (ranked 1), Kudai (ranked 1) and Karfawa (ranked 1) respectively. Also lack of capital was the most important production constraints to famers in Kudai and Shuwarin (both ranked 1). The major constraint reported across the three local governments was low soil fertility (ranked 2 across villages). Other constraints that occurred across all the villages were: *Striga* infestation and downy mildew disease, such that the farmers were helpless thinking there is no solution to the problems. The other constraints were site specific such as high labour cost and high rainfall.

Table 3: Identification of pearl millet production constraints

	Dutse		Birninkudu		Kiyawa	
	Madobi	Kudai	Kafingana	Kantoga	Karfawa	Shuwarin
Low soil fertility	2	2	2	2	3	3
Striga	3	3	5	3	4	2
Downy mildew	5	5	4	5	6	7
High labor cost	5	4	5	6	7	-
Land shortage	1	-	1	7	-	5
Theft	6	-	6	1	-	8
Lack of improved seeds	-	1	2	2	-	-
Lack of capital	-	1	-	-	2	1
Lack of access to extension agents	-	5	-	4	1	4
High rainfall	-	-	2	5	8	6

- denotes constraint not reported

c) Farmers' knowledge about Striga in Pearl millet

Seventy-nine percent of the respondents reported that *Striga* has been a menace in their fields for more than 20 years and that all the cereals they grow were attacked in varying degrees by *S. hermonthica* (Table 4). Most of the farmers reported that, *Striga* damage is more severe when 'maiwa type' millet is heading (42%) or at flowering stage (39%) as the most severe. Farmers also revealed that they grow two types of maiwa millet; long panicle type taking more days (late maturing) to mature and short panicle type taking fewer days to mature (relatively early maturing).

The majority of the farmers (77%) reported that the short panicle type is more resistant to *Striga* infestation than the long panicle type while 12% of the respondents revealed that both the two types of maiwa millet are resistant/tolerant to *Striga*. Most of the farmers hand-pull *Striga* (79%) as their control strategy with few of them using weeding and urea fertilizer application (7%) or addition of urea fertilizer only (4%) to suppress *Striga*. A greater percentage of the farmers use their own saved seeds (80%) without any form of seed treatment (79%). All the respondents (100%) wanted to have 'maiwa type' millet cultivar that is resistant to *S. hermonthica.*

Table 4: Assessing farmers' knowledge of *S. hermonthica* and control strategy

Questions	Response	Percentage
For how long is *Striga* a problem in your field?	- Less than 20yrs	21
	- More than 20yrs	79
At what growth stage is *Striga* a problem?	- Seedling	18
	- Heading	42
	- Flowering	39
	- Maturity	1
Among the varieties you grow which is most resistant/ tolerant?	- Long panicle	2
	- Short panicle	77
	- Both	12
	- None is resistant	9
How do you control *Striga*?	-Handpulling/hoe weeding	79
	- Use of urea	4
	- Weeding and urea app.	7
What is your source of seed?	- Other farmers	9
	- Own saved seed	80
	- Market	4
	- Agro dealers	7
Do you treat your seed before sowing?	- Yes	21
	- No	79
Would you like to have *Striga* resistance cultivar?	- Yes	100
	- No	0

IV. Discussion

a) Farmers' trait Preferences in Pearl Millet

Most farmers rated *Striga* resistance as the most important trait of preference. This is in line with Dugje et al. (2006) in which farmers in Yobe State rated *Striga* as most important constraint and were willing to have resistant cultivars. Farmers in the study area reported that they preferred medium to late maturing cultivars as they are associated with delayed flowering while it is still raining to avoid washing off of pollen that result in poor seed setting and ergot disease thereby minimizing crop loss through disease escape especially if sowing was done at the right time (Thakur et al., 2011; Miedaner & Geiger, 2015; Lubadde et al., 2016). Another factor for the preference of long duration cultivars was because of lack of short duration cultivars available in the study area that is resistant to ergot disease.

As for plant height, farmers preferred medium plant (1 ± 0.2 m) heights because of ease of harvesting as also observed by Owere et al. (2014) in finger millet, and reduced lodging which occurs in taller plants.

Grey grain colour and bold seeds are obvious market parameters that producers concentrate on in order to get better market acceptance, and makes good local beverage and good taste. This is in line with Achot et al. (2014) in sorghum and pearl millet. This probably indicates that the main use of pearl millet in the study areas is for food. All the farmers however, concurred that there was need for improvement in the current cultivars.

b) Pearl Millet Production Constraints in Selected Districts of Jigawa State Nigeria

In all the villages, farmers identified low soil fertility as the leading constraint to pearl millet production. Their soil is so poor that most crops do not give appreciable yield without heavy fertilization. This is

one of the reasons why most of them adopt *maiwa* millet cultivation since it grows relatively well even is in poor soils. This finding is consistent with earlier studies carried out by Ibrahim et al. (2015) in pearl millet production.

The major biotic stresses reported across all the districts were *Striga hermonthica* infestation and downy mildew disease, such that farmers were helpless thinking there is no solution to the problems. This study revealed the persistence of *Striga* infestation in pearl millet production which has shown an increasing trend both in terms of incidence and severity over the years as evidenced by farmers' responses and susceptibility of cultivars which were otherwise initially resistant. In Shuwarin, Madobi, Kudai and Kantoga, the prevalence was reported to be exceptionally higher compared to that observed in Karfawa and Kafingana. The increase in prevalence over the years could be due to emergence of new biotypes, recycling of infested seeds and volunteer crops. The other constraints depended on the farmers from the different villages. This finding is line with Lubadde et al. (2016) in which farmers from different sites sometimes have different production constraints.

c) Farmers' Knowledge of Striga hermonthica

Each ethnic group designated *Striga* with a precise name. The names are associated with the effect it has on crops ranging from witchcraft, fire and killer. This showed that farmers had awareness of this pest. They went further to highlight the symptoms of infested millet plants and linked *Striga* infestation to low soil fertility. Farmers revealed two varieties of *maiwa* millet and that the two varieties together with the other cereals were attacked in varying degrees by *Striga hermonthica.* On the occurrence of *Striga* infestation, farmers in all locations reported that symptoms were on the increase over the years as also observed by Emechebe et al. (2004) and pointed out the most susceptible and tolerant cultivars. Most farmers reported that *Striga* attack is more severe when millet is either heading or flowering. Farmers agreed that the short panicle *maiwa* millet is more tolerant than the longer one. They also reported that, some of the short panicle varieties which were very tolerant were now showing more symptoms of *Striga* damage than in earlier years.

Farmers in the six villages attributed *Striga* damage to two stages of *Striga* development, as also pointed out by Emechebe et al. (2004) namely underground *Striga* and aboveground *Striga*. They emphatically stated that underground *Striga* does more damage to crops than aboveground *Striga*. However, farmers in the six villages had different views about the factors that were responsible for the increasing incidence and severity of *Striga* damage. For example, farmers in Madobi strongly believed that lack of capital was the primary factor that aggravated *Striga* damage as also observed by Atera et al. (2012) in maize. According to them, lack of capital directly or indirectly results in continuous cereal cropping (due to limited land availability), lack of fertilizer and poor soil fertility. On the other hand, Kafingana farmers considered poor soil fertility (due to continuous cropping and soil erosion) and *Striga* dissemination, on hooves and dung of migrating cattle, as the principal factors that exacerbate the *Striga* problem.

V. Conclusion

The most preferred traits by farmers were resistance to *Striga*, tolerance to shattering and good quality local beverage. Low soil fertility was the major constraint to pearl millet production followed by the *Striga* as the leading biotic constraint. Farmers had awareness on *Striga* menace and would consider testing new *Striga* control options that will enhance soil fertility and prevent dissemination of *Striga* seeds. This calls for more research and adequate extension services to manage this parasite in order to meet farmers demand and improve food security.

VI. Acknowledgement

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Adoption of Improved Dairy Cows and Implications for Household Food Security: Evidence in Central Highland of Ethiopia

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Abstract- Crop-livestock production is the main livelihood strategy for rural households of Ethiopia. However, it is constrained by low level of adoption for agricultural technologies. The objectives of this study are, therefore: analyzing adoption of dairy cow technology and examining the contribution of the technology to household food security. The study is conducted in Gudo Beret watershed, North Shewa, Ethiopia. Primary and secondary data were collected from different sources. In the watershed, 211 respondents were selected through systematic random sampling. Expert consultation, household interview, key informants, focused groups, and personal observation were the main data collection methods. Descriptive statistics, inferential tests, multivariate tools, and econometric models have used for data analysis.

Keywords: *adoption, dairy cow, food security, logit model.*

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Wuletaw Mekuria [α], Workneh Negatu [σ] & Kindu Mekonnen [ρ]

Abstract- Crop-livestock production is the main livelihood strategy for rural households of Ethiopia. However, it is constrained by low level of adoption for agricultural technologies. The objectives of this study are, therefore: analyzing adoption of dairy cow technology and examining the contribution of the technology to household food security. The study is conducted in Gudo Beret watershed, North Shewa, Ethiopia. Primary and secondary data were collected from different sources. In the watershed, 211 respondents were selected through systematic random sampling. Expert consultation, household interview, key informants, focused groups, and personal observation were the main data collection methods. Descriptive statistics, inferential tests, multivariate tools, and econometric models have used for data analysis. The results showed that the rate of adoption for improved dairy cows is low and slow in terms of proportion of households and size of cows, respectively. Binary Logit model indicated that hired labor, social responsibility, and livestock size influenced the adoption of improved dairy cows significantly and positively while land holding size affected the technology significantly and negatively. Production of improved dairy cows contributes for household food security. Although the correlation of improved dairy cows and food security is positive, it is very low and insignificant.

Keywords: adoption, dairy cow, food security, logit model.

I. Introduction

About 80% of the population in Ethiopia is dependent on rain-fed agriculture (World Bank, 2013). In the highlands of the country, the dominant agricultural activity is crop and livestock (mixed) farming system (Belay *et al*., 2012). The contribution of crops and livestock to the national growth domestic product is 27.4% and 7.9%, respectively (NPC, 2016). The total livestock population is estimated to be 53.99 cattle, 25.98 sheep, 21.8 goats, 1.91 horses, 6.75 donkeys, 0.35 mules, 0.92 camels, 50.38 chickens, and 5.2 beehives in million numbers (CSA, 2014). Adoption of agricultural technologies is required to enhance agricultural productivity and sustain agriculture in developing countries. Sustainable agriculture is a function of wise management of natural resources and orientation of institutional and technological changes (Titus and Adefisayo, 2012). Livestock production serves as a means of food security (Iiyama *et al.*, 2007a; Messay, 2010). Households with large herd sizes have better chance to ensure food security at household level (Arega, 2012; Mesfin, 2014).

Many countries in Sub-Saharan Africa (SSA), including Ethiopia, could not produce adequate food for the rising population and exhibited large rates of malnutrition (Herrero *et al.,* 2012). In spite of the percentage of the population living below the poverty line has declined from 45.5% in 1995/96 to 29.6% in 2010/11(WFP, 2014), undernourishment remained high (35%) between 2012 and 2014 (FAO, IFAD and WFP, 2014). Soil and pasture degradation is the potential threats of crop-livestock system as long as increasing pressure over the land and growing demand for income, food, and feed. Crop and livestock productivity is limited and attributed by low level of adoption for agricultural technologies (IFPRI, 2011). Although a number of improved livestock breeds have increased, its productivity is low (NPC, 2016).

Plenty of evidences confirmed that several problems are getting worse in the highlands of Ethiopia. These include malnutrition, declining of productivity, excessive land fragmentation, and land degradation (Demese *et al.,* 2010; IFAD, 2013; Nigussie *et al.,* 2015). Climate change is also expected to exacerbate situations by increasing water stress, soil erosion, soil acidity, landslides, feed shortage, and incidence of animal diseases (Tongul and Hobson, 2013). Although various technological interventions have been introduced to the study area, land degradation, feed scarcity, and population density are adversely affecting the landscape situation (Kuria *et al*., 2014). Low considerations and poor management practices of livestock are identified research gaps (Demese *et al*., 2010; EPCC, 2015). The objectives of the study are therefore to analyze determinants of adoption of improved dairy cows and examine the contribution of improved dairy cows to household food security among smallholders.

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II. Methods

a) The study area

The study is conducted in *Gudoberet* watershed of *Basona Worana Woreda*, *North Shewa* zone, *Amhara* national regional state, Ethiopia. It is located between latitudes 9°76' and 9°81' North, and longitudes 39°65' and 39°73' East at a distance of 162 km Northeast of Addis Ababa and 32 km from *Debre Berehan* in the same direction of the town. The watershed covers 2425 ha of land in the upper part of Blue Nile basin in Ethiopia. The catchment lies between an altitude of 2828 and 3700 meters above sea level (masl). Agro-ecology has classified as below 500, 500-1500, 1500-2300, 2300-3200, 3200-3700, and above 3700 masl for *Bereha*, *Kolla*, *Woina Dega*, *Dega,* high *Dega*, and *Wurch,* respectively (MoA, 2016). About 1074 ha of land in the watershed lies in the high *Dega*[1] agro ecology while the remaining 1351 ha lies in *Dega,* agro ecology.

b) Data and sampling procedures

This study is designed to be field survey in quantitative and qualitative approaches. The study watershed is selected purposively in consultation of agricultural experts that have the knowledge of the study area and preliminary diagnostic field assessments. The selected watershed is delineated and demarcated with the help of topographic map, Geographic Positioning System (GPS) and Geographic Information System (GIS). The sample size is determined after the study population who are living in the study watershed is listed. Finally, respondents are selected within the sampling frame of the study population using the following formula derived from Yamane (1967) in Israel (2013).

$$n = \frac{N}{1+N(e)^2} \Rightarrow n = \frac{447}{1+447(.05)^2} \approx 211$$

Where: *n* is the required sample size. *N* is the study population in the watershed, *e* is an acceptance error at a given precision rate. In the watershed, 19 small villages (5 at high *Dega* and 14 at *Dega* agro-ecologies) are identified. A total sample size of 211 respondents (155 in *Dega* and 56 in high *Dega*) are applied for the study through systematic random sampling in probability proportional to size.

c) Methods of data collection and analysis

i. *Methods of data collection*

Both qualitative and quantitative data types are collected from primary and secondary sources. Four data collectors and one facilitator are selected, trained, and they have collected data through interview. Moreover, preliminary field survey, expert consultation, and key informant interview are carried out. On top of this, one focused group discussion, and personal observation are used. Socioeconomic, institutional, demographic, and biophysical data are collected through direct household survey.

ii. *Methods of data analysis*

Descriptive statistics and inferential tests are employed in this study. The socioeconomic and other determinants of adopters are explained both in quantitative and quantitative terms. The rate of adoption is calculated in terms of dairy cow technology users and number of dairy cow breeds. Several studies have used different types of econometric models for dairy technology. Ordinary least square, Probit, Logit, and Tobit are the most commonly used models for adoption studies. Explanatory variables are derived from the theory of innovation diffusion and other empirical studies. In this study Binary Logit model is used. The model helps to describe the relationship between the outcome variable and a set of explanatory variables. Binary Logit is preferred to others because it gives standard result for discrete choice estimation (Gujarati, 2003; Greene, 2007, p.588).

$$Logit(P_i) = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + ... + \beta_n X_{ni} + e_i \quad (1)$$

Where: $P_{(i)}$ is the probability that the i^{th} value of the dependent variable, X is the i^{th} value of the independent variable, e_i is the "error" variability of the dependent variable not explained by the independent variable; n is the number of independent variables.

$$Odds = \frac{P_i}{1-P_i} \quad (2)$$

Odds ratio is the way to present the probability of an event. The odds of an event happening (adoption of crossbred dairy cow) indicates the probability of that event will happen divided by the probability of that event will not happen. Thus, the Logit (Natural log of odds) of the unknown binomial probabilities are modeled as a linear function of the X_i:

$$Logit(P_i) = Ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \sum_{j=1}^{n} \beta_j X_{ji} \quad (3)$$

The Logit model assumes that underlying stimulus index *Logit* (P_i) is a random variable, which predicts the probability of crossbred dairy adoption. P_i is the probability of adopting crossbred dairy cows, while $(1\text{-}P_i)$ is the probability not adopting the technology.

[1] 3200 masl is a cut-off point between *Dega* and high *Dega* agro ecologies (MoA, 2016).

$$\text{Probability of adoption, } P_i = \left(\frac{1}{1+e^{-Logit(p_i)}}\right) = \left(\frac{e^{Logit(P_i)}}{1+e^{Logit(P_i)}}\right) = \left(\frac{e^{z}}{1+e^{z}}\right) \quad (4)$$

Where Z is cumulative function, $\beta_1 + \beta_2 X_i$ that ranges from $-\infty$ to $+\infty$, while P_i ranges between 0 and 1. The maximum likelihood estimation approach is used to estimate the equation. SPSS Version 20 software is employed to compute estimates.

III. Results and Discussion

a) Dairy cows production in the study watershed

Almost 74.6% of the cattle population was indigenous breeds while 25.4% was improved breeds. The total livestock population of sample households was 3327 (841.1 TLU). Of the total size, the highest number was for sheep, while the highest size in TLU was oxen. Big animals had large body size and high TLU equivalent. Sheep, chicken, and oxen were the three most common livestock types in number while oxen, sheep, donkey, and cow were high populations in TLU. About 16.1% of households owned improved dairy cows of which 13.7% and 2.4% of households owned 1 and 2 improved dairy cows per household, respectively.

Agriculture is said to be sustainable once adequate agricultural inputs and technologies are available to the farming system. Smallholders, development agents, agricultural experts, and previous empirical studies were consulted in technology selection for the study of adoption. Crossbred cows were selected for this study, which had direct implication for household food security. Cows were the second population (23.2%) in cattle husbandry after oxen in the study watershed. About, 60.2% of households owned cows. Households have introduced the technology since 1998. The size of local and crossbred cows was 1.21 and 1.15 per household respectively, 1.19 in average. Gryseels (1988) reported that 80% of households had an average of 1.5 cows per household in the 1980s near to *Debre Berehan*. It implied that the number of households and the size of cows per household in the 1980s around *Debre Berehan* were higher than the study watershed.

b) Characteristics of dairy cattle households

Table 1: Descriptive results of explanatory variables between adopters and non-adopters

Variables	Adopter (N=34) Mean	Non-adopter (N=177) Mean	t-value/χ^2	Sig. value
Age of household heads in years	42.74 (11.76)	44.04 (11.48)	-2.540**	0.023
Total household size in AE	4.53 (1.61)	3.81 (1.51)	-2.512**	0.013
Farming experience in years	24.50 (12.08)	25.31 (12.41)	0.359	0.721
Hired labor in number	0.23 (0.43)	0.07 (0.26)	-2.118**	0.041
Household labor in number	2.91 (1.02)	2.86 (1.38)	-0.232	0.818
Total land holding in ha	1.41 (0.57)	1.32 (0.58)	-0.829	0.411
Farm income ('000 ETB)	6.16 (6.44)	3.45 (39.19)	-2.370**	0.023
Manure applied in kg	119.26 (70.03)	81.27 (73.58)	-2.873***	0.006
Total livestock in TLU	6.44 (3.00)	3.52 (2.39)	-5.352***	0.000
Non-farm income ('000 ETB)	1.19 (2.47)	0.89 (1.76)	-0.661	0.513
Fertilizer applied in kg	94.85 (73.02)	54.83 (59.37)	-3.010***	0.004
Irrigation land in ha	0.025 (0.07)	0.029 (0.06)	0.261	0.795
Market distance in minutes	25.29 (24.16)	17.10 (18.98)	-1.499	0.141
Road distance in minutes	25.29 (24.16)	17.10 (18.98)	-1.868*	0.069
Kebele distance in minutes	34.20 (27.46)	26.83 (24.92)	-1.455	0.122
Contact of DAs	1.50 (1.05)	1.05 (1.06)	-1.189	0.241
Sex of household head+			5.150**	0.023
Educational status+			5.272**	0.022
Land tenure security+			2.369	0.124
Social status of household head+			13.277***	0.000
Membership in cooperatives+			0.074	0.786
Slope class+			0.007	0.934
Access to credit+			0.042	0.838

, **, * indicates 10%, 5% and 1% significant level respectively.*

Figures in parenthesis refer to std. dev; '+' refers to discrete variables. The mean values for adopters and non-adopters are computed using independent t-test for continuous variables and χ^2 for discrete variables.

i. *Demographic characteristics*

The mean ages of adopters and non-adopters were 42.74±2.01 and 44.04±0.93 years, respectively. There was a significance difference in age between adopters and non-adopters at t-value of -0.254 (p=0.023). The average household size of adopters and non-adopters was 4.53±0.28 and 3.81±0.11, respectively. The average number of years of farming experience for adopters was 24.5±2.07, whereas that of non-adopters was 25.31±0.93. The female heads distribution among adopter and non-adopter groups was 14.7% and 34.5%, respectively. Majority of adopters (38.2%) and non-adopters (43.5%) have had read and write educational status. The χ^2-test result indicates sex and educational level of household heads were significant at 5% probability level. About 50% of adopters and 20.3% non-adopters had social status. Social status was also significant at 1% probability level (Table 1).

ii. *Socio-economic characteristics*

The mean of hired-labor for adopters and non-adopters was 0.23±0.07 and 0.07±0.01, respectively and significant at t-value of -2.118 (p=0.041). The size of household labor for adopters (1.41±0.17) was greater than that of non-adopters (1.32±0.10). The mean farmland size of adopters was 1.41±0.09, while for non-adopters was 1.32 ±0.04. The farm and non-farm household income was better for adopters than their counter parts. It was estimated to be 6.16±1.10 and 3.45±0.29 of farm income for adopters and non-adopters, respectively; while 1.19±0.42 and 0.89±0.13 of non-farm income for adopters and non-adopters, in thousand values. The mean value of farm-income was significant at t-value -2.37 (p=0.023). Households for crop production apply inorganic and organic fertilizers. In average, adopters and non-adopters have applied 119.26 ±12.01 and 81.27±5.53 kg of manure, respectively, while 94.85 ±12.52 kg of inorganic fertilizer was supplied by adopters and 54.83±4.46 kg by non-adopters. The mean difference among adopters and non-adopters was significant both for organic and inorganic fertilizers. Adopters owned more livestock than non-adopters. The mean livestock size for adopters was 6.44±0.51 and 3.52±0.18 for non-adopters which is statistically significant at t-value of -5.352 (p=0.000). Adopters and non-adopters had almost the same size of irrigation lands, 0.02 ha in average.

iii. *Institutional, topographic, and infrastructural characteristics*

The average frequency contact of development agents with adopters for extension service was 1.5±0.18 while for non-adopters was 1.05±0.07 days per month. Households in the watershed travel to the nearest market, asphalt road and the centre of the *Kebele* for various purposes. The nearest market and *Kebele* centre had almost the same average distance among adopter and non-adopter groups, respectively. Although non-adopters travelled less hours in average than adopters, it was statistically insignificant (P-value >0.10). Households travelled to the nearest asphalt road within few minutes compared to the distance to the nearest market and *Kebele* centre. The mean time taken to the nearest road was 25.29±4.14 and 17.10±1.42 minutes for adopters and non-adopters, respectively. Households who reside close to the market, *Kebele* centre and asphalt road were non-adopters who engaged mainly in non-farm activities compared to adopters.

c) *Rate of adoption for improved dairy cows*

The rate of adoption for improved dairy cows was computed in two ways: (i) the ratio of number of crossbred dairy cows to the total number of cows (Adeogun *et al*., 2008). Thus, the rate of adoption was estimated to be 25.8%. (ii) The relative speed with which members of a social system adopts an innovation. In this scenario, adoption rate refers the number of individuals who adopt new technology within a specified period (Roger, 2003). The number of households who adopt crossbred dairy cows to the total number of farmers who own local and crossbred cows was 26.8%, 1.6% per year. In both scenarios, the rate of adoption was low and slow as well. Bikal *et al* (2015) stated that the level of technology adoption was calculated as the total score obtained by households to the maximum possible score then categorized into low, medium, and high. Adopters, in the study watershed, did not have well-designed strategy and defined packages for crossbred cows. Moreover, all adopters except five of them owned only one crossbred cow.

d) *Determinants of adoption of improved dairy cows*

A number of factors influence households' decision either to adopt or reject a new technology. VIF and χ^2 were used to test multicollinearity for continuous and discrete explanatory variables, respectively. There was no multcollinearity among discrete explanatory variables in χ^2–test so that all discrete variables were entered in Logit model for analysis. However, age, farming experience, market distance, and centre of the *Kebele* were multicollinear in VIF value of greater than 10. Some hypothesized variables such as access to crossbred cows, veterinary service, and training were not included in model, because only smallholders who held crossbreds were accessible to improved dairy breeds and veterinary services. All non-adopters respond that they were not accessible to crossbred technology. In addition, only a single person in a year have participated in training on crossbred dairy technology. Thus, age, farming experience, *Kebele* and market distance, access to crossbreds, veterinary services, and trainings are excluded in the model.

Table 2: Descriptions of variables specified in the model

Variables	Measurements and descriptions
Dependent variable (Y_i)	Adoption of crossbred dairy cows which takes the value of 1 if a household is adopting and 0, otherwise.
Independent variables	
Sex (X_1)	Sex of the household head, 1 if a farmer is male and 0, otherwise
Household size (X_2)	Number of household members in households in AE
Education (X_3)	Educational level, 1 if a household head is literate and 0, otherwise
Hired labor (X_4)	Number of wage labor in households
Household labor (X_5)	Number of active labor force in households
Land (X_6)	Total size of land in ha
Farm income (X_7)	Total annual gross on-farm income measured in ETB
Organic fertilizer (X_8)	Amount of manure used in qt
Non-farm income (X_9)	Total annual gross non-farm income in ETB
Fertilizer (X_{10})	Amount of inorganic fertilizer used in kg
Irrigation land (X_{11})	Size of irrigation land in ha
Cooperative (X_{12})	Membership in cooperatives; 1 if a farmer is a member and 0, otherwise
Land tenure (X_{13})	Tenure security; 1 if land is secured to a farmer and, 0 otherwise
Road (X_{14})	Distance between resident and the nearest asphalt road in minutes
Slope (X_{15})	Topography of farmlands, 1 if it is gentle slope and 0, otherwise
DAs contact (X_{16})	Frequency of contact of DAs with household per month
Credit (X_{17})	Access to credit; 1 if a farmer is accessible and, 0 otherwise
Social status (X_{18})	Social position; 1 if a farmers has position and, 0 otherwise
Livestock (X_{19})	Total size of livestock in TLU

Source: Survey data (2016)

The Omnibus test of Goodness of fit in Chi-square indicated the null hypothesis has determined that the step was justified. When the step is to add a variable (s), the inclusion is justified if the significance of the step is less than 0.05. Had the step been to drop variable (s) from the equation, then the exclusion would have been justified if the significance of the change were more than 0.10. Therefore, the likelihood ratio of Chi-square of 63.12 with a p-value of 0.000 shows that outcome model as a whole fitted significantly. The overall model was significant and good fit.

Table 3: Result of maximum likelihood estimates in Binary Logit model

Variables	β	S.E.	Wald	Significance	$Exp(\beta)$
Sex	0.462	0.671	0.475	0.491	1.588
Household size	0.307	0.219	1.973	0.160	1.360
Education	0.285	0.264	1.168	0.280	1.330
Hired labor	1.806**	0.793	5.195	0.023	6.088
Household labor	-0.471	0.311	2.292	0.130	0.624
Land holding	-1.242**	0.575	4.658	0.031	0.289
On-farm income	0.000	0.000	0.823	0.364	1.000
Organic fertilizer	-0.003	0.005	0.324	0.569	0.997
Non-farm income	0.000	0.000	0.137	0.712	1.000
Inorganic fertilize	0.005	0.004	1.164	0.281	1.005
Irrigation	0.761	3.665	0.043	0.836	2.140
Coop member	-0.092	0.559	0.027	0.869	0.912
Land tenure	0.044	0.609	0.005	0.942	1.045
Road distance	-0.004	0.015	0.077	0.781	0.996
Slope	0.078	0.173	0.205	0.651	1.081
DA's contact	-0.427	0.298	2.046	0.153	0.653
Access to credit	-0.078	0.608	0.016	0.898	0.925
Social position	1.344**	0.596	5.091	0.024	3.834
Livestock holding	0.525***	0.151	12.019	0.001	1.690
Intercept	-4.190	1.342	9.745	0.002	0.015

*Source: Model output of SPSS version 20; ** and *** 5% and 1% indicates significance level*

Note: Wald = $(B/SE)^2$ and odds ratio in terms of log of odds i.e. ln [exp (B)] = B

The purpose of beta coefficients in the above table is to describe the direction of relationships and its significance. Among nineteen explanatory variables, hired labor, land holding, social position, and livestock were significant variables. Hired labor, social position, and livestock had positive relationships with adoption of

dairy cow technology while land holding had negative relationships with the technology. The probabilities of changes for explanatory variables on the dependent variable are presented in Table 4.

Table 4: Binary Logit model result for marginal effects using Stata Version 11.9

	Delta-method					
	dy/dx	Std. Err.	z	p>|z|	[95% conf.	Interval]
Sex	0.0352	0.0495	0.71	0.478	-0.0620	0.1323
Household size	0.0233	0.0163	1.43	0.153	-0.0087	0.0553
Education	0.0217	0.0202	1.07	0.285	-0.0181	0.0614
Hired labor	0.1372	0.0625	2.19	0.028	0.0146	0.2598
Household labor	-0.0358	0.0231	-1.55	0.122	-0.0812	0.0096
Land holding	-0.0941	0.0435	-2.16	0.031	-0.1795	-0.0087
On-farm income	0.0000	0.0000	0.91	0.364	-0.0000	0.0000
Organic manure	-0.0002	0.0004	-0.57	0.569	-0.0009	0.0005
Non-farm income	-0.0000	0.0000	-0.38	0.707	-0.0000	0.0000
Inorganic fertilizer	0.0004	0.0003	1.09	0.277	-0.0003	0.0010
Irrigation	0.0589	0.2760	0.21	0.831	-0.4820	0.5999
Coop member	-0.0071	0.0425	-0.17	0.868	-0.0904	0.0763
Land tenure	0.0033	0.0461	0.07	0.943	-0.0872	0.0939
Road distance	-0.0003	0.0011	-0.28	0.780	-0.0025	0.0018
Slope	0.0059	0.0132	0.45	0.653	-0.0199	0.0319
DA's contact	-0.0324	0.0223	-1.45	0.146	-0.0761	0.0113
Credit access	-0.0058	0.0462	-0.13	0.900	-0.0964	0.0847
Social position	0.1021	0.0475	2.15	0.032	0.0090	0.1952
Livestock	0.0398	0.0125	3.18	0.001	0.0152	0.0644

Source: Model result

i. *Hired-labor*

The result of descriptive statistics showed that the mean difference of hired-labor for adopters was greater than non-adopter and statistically significant at 5% significant level. The result of Logit model was also statistically significant at 5% (p=0.023) showing a positive relationship with adoption of dairy cows at coefficients value of 1.806. The odds ratio of 6.088 for hired-labor implied that, for each unit increment in hired-labor while fixing the values of other independent variables, the likelihood of crossbred dairy adoption increases by fivefold. As hired-labor increases by one, adoption of crossbred dairy cows increases by 13.7%.

ii. *Land holding size*

Land size influenced adoption of crossbred dairy cows. The result of descriptive statistics showed that the mean difference of total land holding size for adopters was greater than non-adopter. The result of Logit model was statistically significant at 5% (p=0.031) showing a negative relationship with adoption of crossbred dairy cows at a negative coefficient of -1.242. As land size increases by one ha, the probability of adoption of crossbred dairy cow declines by 28.9% holding all other variables are constant. As land size increases by one ha, adoption of crossbred dairy cow declines by 9.4%. The possible reason for negative relationship between land holding and adoption of dairy cows could be as households involved in crop production, the adoption of improved dairy cows held less attention. Another probable reason, in many studies, grazing lands and farmlands have contrasted trends, as cropland and livestock size increases; rangeland decreases (McIntire *et al.,* 1992; Iiyama *et al.,* 2007b; IFAD, 2010). In the study of Tesfaye *et al* (2001), farm size has negative relationships with adoption of inorganic fertilizer. Nevertheless, farmland has positive relationship with adoption of improved wheat varieties and sustainable soil management practices (Tesfaye *et al*., 2001; Bikal *et al*., 2015).

iii. *Social responsibility*

Results in χ^2-test showed that social status of household heads was significant at 1% probability level. This variable was also statistically significant in Logit model at 5% (p=0.024) showing a positive relationship between social status and adoption of dairy cows at a coefficient value of 1.344. The odds ratio of 3.834 for social responsibility implied that, a household played a part in socials responsibility while fixing the value of other independent variables, the odds of adoption in crossbred dairy increased by almost threefold. As a household has social responsibility, adoption increases by 10.2%. This result is consistence with the finding of Silva *et al* (2011) studied on mobile phone adoption in six countries of Asia. Social network is an important determinant of technology adoption (Bandiera and Rasul, 2006).

iv. *Livestock size*

According to t-test, the mean difference of livestock size for adopters was greater than non-adopter and statistically significant at 1% significant level. It was also statistically significant in Logit model at 1% (p=0.001) showing a positive relationship between livestock size and adoption of crossbred dairy cows. As

expected, livestock increases the odds of adoption, with 1.69. Keeping other things constant, each TLU increased in livestock, the likelihood of crossbred dairy cow have increased by 69%. As livestock increases by one TLU, adoption of crossbred dairy cow increases by 4%. This result is consistence with the study of Bikal *et al* (2015) but in contrast with the finding of Oyekale (2013) that showed the relationship between number of cattle and adoption of improved dairy cattle has correlated negatively and significantly.

e) Implications of improved dairy cows for household food security

Sample households have quantified the amount of food that could satisfy their family's food requirement. An equation is adapted from FAO-WFP (2009) to compute the amount of net available food using the household food balance sheet model. Various studies have used the mean daily per capita food energy value 2100 kcal as a minimum threshold daily energy requirement (FAO-WFP, 2009; WFP, 2009; Demese *et al*., 2010; Messay, 2010; Arega, 2012; Aziz *et al.,*2016). Thus, in this study, the mean daily energy requirement of 2100 kcal /AE /day was used as the lower limit of food secure households. Households less than 2100 calories were food deprived groups and exposed to undernourishment (WFP, 2009). This cut-off point was the mean per capita energy requirement for the normal population distribution of a developing country (WFP, 2009).

$$HNAF = (OP + FP + R/G + FA) - (PHL + SR + GS + TO)$$ (Arega, 2012)

Where: HNAF is household net available food, *OP* is own production, *FP* is food purchased, *R/G* is remittance or gift, *FA* is food aid, *PHL* is post harvest loss, *SR* is seed reserve , *GS* is amount of grain sold, and *TO* is transfer to others. The equation enables to calculate dietary energy supply.

The supply side of the equation indicated that sample households produced a total amount of 3826.54 qt. Similarly, 124.25 qt was purchased, and 1.80 qt was obtained through transfer. There was no food obtained through aid. Thus, a total amount of 3952.59 qt of food was supplied. The expenditure side of the equation in the same food balance sheet showed food disposals such as 289.56 qt of food was lost due to several reasons, 552.7 qt of seed was reserved, 429.22 qt of food items were sold, and 9.42 qt of food was given to others. Hence, about 1280.9 qt of food was the annual expenditure of households. Consequently, the total amount net dietary energy supply was 2671.7 qt. The total dietary energy supply was divided by number of persons (i.e. 267170 kg ÷ 832.77 persons=320.8 kg/AE/year). Approximately, 225 kg of cereal is equivalent with 2100 kcal (Guyu, 2015). The second method of calculation was in terms of calories. Food secure, marginally insecure, moderately insecure, and severely insecure households were categorized with a value of greater than 2100, 1800-2100, 1500-1800, and less than 1500 kcal, respectively. This type of food insecurity classification was adapted from FAO-WFP (2009).

Table 5: Households' distribution in terms of per capita food consumption (kcal/AE/day)

Food security status	Proportion of households (%)
Food secure	58.8
Mildly food insecure	6.6
Moderately food insecure	7.1
Severely food insecure	27.5

Source: Survey result (2016)

Crops and animal products were the source of dietary energy supply for 58.8% food secure, 6.6% marginally insecure, 7.1%, moderately insecure and 27.5% severely insecure households. Hence, 58.8% households could attain the minimum food requirements. Households with less than the minimum food requirement were accounted for 41.2%, of which 27.5% are severely food insecure (Table 5). Probably, they were unable to meet their minimum food requirement over extended periods. This result is in agreement with the study of Mesfin (2014) who stated that the proportion of food insecure people in *Amhara* region is 42.5%, which is higher than the national average, 33.6%.

IV. Conclusions

In the study watershed, about 28.9% of household-heads were females. Sample household-heads had an average age of 43.8 with a range of 23 to 82 years. The average family size of sample households was 4.54 a minimum of 1 and a maximum 10 persons per household, with 64.3% of active labor force. About 79.2% of household-heads were literate and 25% of heads were leaders in different socio-economic and political responsibilities. Human and livestock population density was estimated to be 85.4 persons per sq.km and 4.18 TLU per ha, respectively. About 92.4% of smallholders have reared livestock.

More than 70% of the topography had steep landscapes with approximately 22.2% of low fertile soils. The average landholding size was 1.34 ha while the average livestock size was 4.0 TLU per household. Almost, 18.4% smallholders have used 0.06 to 0.25 ha of irrigable lands per household. Nearly, 17.5% and 12.3% of households have rented-in and rented-out lands, respectively. Sales from crop and livestock products accounted for 66.3% of the total annual cash income. Just about 83.9% of households have gained average annual cash income of 3892.6 ETB from on-farm activities and 37.4% households have obtained 944.8 ETB from non-farm activities. Thus, the total annual income of households was estimated to be 4832.7 ETB per household. Livestock have contributed for 37.5% of annual cash income and 2.65% of food calories. Most recently, the annual growth of livestock population was 5.5%. The average productivity of a cow was 1.3 and 2.5 liters of milk per day per cow for local and improved breeds, respectively.

Nearly 26.8% of the cattle population was dairy cows that have been kept by 60.2% of households. However, adoption rate for dairy cattle technology was low and slow because 25.8% of cows were improved breeds while 26.8% of households who reared cows have adopted improved dairy breeds. Adopters had better socio-economic characteristics than non-adopters do. High social responsibilities, more number of family sizes, high amounts of on-farm income, agricultural inputs (such as organic and inorganic fertilizers), high livestock population, and better frequency of extension service were some of the characteristics of adopters. Nevertheless, the mean age of adopters was less than non-adopters. Moreover, the number of literate people for adopters was less than their counterparts. The size of irrigation lands and distance of infrastructures were almost similar for adopters and non-adopters. Binary Logit showed that hired labor, social status, and livestock size have influenced positively and significantly the adoption of dairy cow technology, while land holding size has affected the technology significantly but negatively.

About 41.2% of households were food insecure in food availability aspect of food security. Adoption of improved dairy cows has important implications for household food security. The mean daily per capita was estimated to be 2960.63 and 3084.73 kcal/AE/day for non-adopters and adopters, respectively. Household food security per capita and improved dairy cows have positive relationships but in very low correlation coefficient (0.016). Thus, food security per capita in kcal is insignificant (p=0.766) between adopters and non-adopters with t-values (-0.299). Therefore, the production of improved dairy cows should be supported with dairy packages.

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Striga Resistance in Cereal Crops: Recent Progress and Future Prospects. A Review

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Abstract- Production of cereal crops such as sorghum, maize, rice and millet is threatened by Striga hermonthica (Del.) Benth and Striga asiatica (L.) Kuntze in sub-Saharan Africa and India. Varying levels of resistance have been identified and exploited in the breeding programmes of several crops. Considerable efforts have been invested in breeding for Striga resistance in cereals and significant progress has been made in the development of improved selection methods. However, the level of protection achieved to date is incomplete especially for orphan crops such as pearl millet. Resistance is mainly determined by the coexistence of several mechanisms controlled by multigenic and quantitative systems. Efficient control of the parasite requires a better understanding of the interaction and their associated resistance mechanisms at the histological, genetic and molecular levels. Application of postgenomic technologies and the use of model plants should improve the understanding of the plant–parasitic plant interaction and drive not only breeding programmes through either marker-assisted selection (MAS) or transgenesis but also the development of alternative methods to control the parasite.

Keywords: *striga spp., resistance, cereals, recent progress, potential prospects.*

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Keywords: striga spp., resistance, cereals, recent progress, potential prospects.

I. Introduction

Parasitic plants are a major threat to today's agriculture and provide an intriguing case of pathogenesis between species of relatively close evolutionary ancestry. Almost all crop species are potential hosts for parasitic plants, but severe disease outbreaks are usually restricted to certain host–pathogen combinations (Spallek et al., 2013). The evolutionary strategy of exchanging autotrophy for dependence on host plants (parasitism) may seem odd, but it has proven to be evolutionarily successful for several plant species. Plant parasitism has arisen at least 12 times independently, generating more than 4000 parasitic dicotyledonous plant species (Westwood et al., 2010). Although some parasitic plants are still photosynthetically active (hemiparasitic), others are not, and depend entirely on a host (holoparasitic). The establishment of parasitism is essential for holoparasites and several hemiparasites such as *Striga* spp., and therefore these species are called obligate parasites (Parker, 2009).

The genus *Striga* consists of obligate hemiparasitic root parasites, some of which are serious agricultural pests (Parker, 2009).They are a major biotic constraint and a serious threat to subsistence cereal crops (Pearl millet, finger millet, sorghum, maize and upland rice) grown in sub-Saharan Africa and India ((Rispail et al., 2007; Teka, 2014). In *Striga*-prone regions, *S. hermonthica* (Del.) Benth. and*S. asiatica*(L.) Kuntze are the most economically important weeds (Ejeta, 2007; Atera et al., 2011) that infect sorghum [*Sorghum bicolor* (L.)Moench], maize [*Zea mays* (L.)], upland rice [*Oryza sativa* (L.)] and pearl millet [*Cenchrus americanus* (L.) Morrone]. *Striga* spp. are now often identified as the greatest biological constraint to food production, and have been estimated to infest some 64% of the total cereal production area in West Africa (Figure 1) (Gressel et al., 2004; Ejeta, 2007; Parker, 2012), and are continuing to expand. Infection of crops can result in grain yield losses, of 20-80% in Africa but up to 100% in worst situations, and as consequence, have a significant negative impact on food security in these regions (Gurney, Press, & Scholes, 2002).

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Figure 1: *Striga* affects millions of smallholder farmers in sub-Saharan Africa(Mignouna et al., 2013)

Infested area and level are likely to increase in the near future because of continued increase in cereal monoculture in some parts of Africa that has led to reduced soil fertility coupled with high moisture stress, and the weed has consequently been described as an indicator of low soil fertility (Oswald, 2005;Teka, 2014). Agronomic control of *Striga* aimed at limiting *Striga* seed production, but as each *Striga* plant sets tens of thousands of seeds that can live for so many years, control appears very difficult (Kountche, 2013). Genetic control of *Striga*, where possible, is widely considered to be the most practical and economically feasible method for long-term control of *Striga* (Ejeta, 2007; Hearne, 2009; Yoder & Scholes, 2010).

Many scientists (Haussmann et al., 2001; Omanya et al., 2004; Gurney et al., 2003; Cissoko et al., 2011; Jamil et al., 2011) in the past have made intense investigation, to characterize the mechanisms and inheritance of resistance to *Striga* spp. in some major cereal crops such as sorghum, rice, and maize. This was followed by the development of molecular markers associated with *Striga* resistance and quantitative trait loci (QTL) in sorghum and their introgression into elite varieties (Haussmann et al., 2004;Gurney et al., 2006; Satish et al., 2012; Mutengwa et al., 2005; Rispail et al., 2007). However, despite these efforts, precise, validated information on the inheritance of resistance to *Striga* is still lacking in cultivated pearl millet (Kountche, 2013). Some scientists report the presence of resistance to *Striga* in cultivated pearl millet (Ramaiah, 1987), but these reports were questioned by other authors (Chisi & Esele, 1997). So far, Wilson et al. (2000, 2004) reported the presence of partial quantitative resistance to *S. hermonthica* in wild pearl millet relatives originating from Africa.. Kountche (2013) also stressed that, progress in genetic, genomic and physiological characterization of *Striga* resistance mechanisms is essential for the sustained improvement of pearl millet, which is the least studied major cereal crop cultivated in Africa.

This paper presents the latest information on breeding for resistance to *Striga* in cereal crops and future prospects.

II. Striga Biology and Life Cycle

'*Striga*' is the Latin word for 'witch'. Witchweed, Mukarram (Shuwa Arab), Maakasha or wuta wuta (Hausa) and other common names for *Striga* often refer to the word 'witch', fire or killer presumably because plants diseased by *Striga* display stunted growth and an overall drought-like phenotype long before *Striga* plants appear. *Striga* species are annual plants and most of their life cycle occurs underground (figure 2) (Spallek et al., 2013). *Striga* plants are highly reproductive (10 000 to 200 000 seeds) and can remain dormant in the soil for more than 20 years before germination (Parker & Riches, 1993). Germination is linked to the presence of a nearby host, because the endosperm of *Striga* seeds can sustain it survival only for the first 3–7 days (Berner et al., 1995). Within that time, *Striga* must successfully establish a parasitic relationship with the host plant or otherwise die. This aspect was successfully exploited during *S. asiatica* eradication programme in the USA, when 'suicide germination' was induced by fuming farmland with ethylene to trigger *Striga* germination in

the absence of host plants (Parker, 2009).These *Striga* seeds germinates only in response to specific chemicals, most commonly strigolactones, which are apocarotenoid signaling molecules (Matusova et al., 2005). The germination of *Striga* depends on the perception of germination stimulants released by host roots. In order to be responsive to germination stimulants, *Striga* seeds must go through a phase of moisture and high temperatures for 7–14 days, called 'conditioning'. If, during that time, no germination stimulant is perceived, *Striga* seeds fall into a secondary dormancy. Strigolactones are certainly the best studied and extremely potent inducers of *Striga* germination (Spallek et al., 2013). The signals are then released by the host plant roots into the rhizosphere (Bouwmeester et al., 2003;Yoneyama et al., 2010; Xie et al., 2010). The concentration of stimulant required to initiate *Striga* seed germination ranges from 10-10 to 10-16 mole m^{-3} (Hearne, 2009). When the appropriate concentration is achieved, each *Striga* seedling establishes a sticky radicle which, in response to haustorial initiation factors derived from the host roots (such as quinone), forms the haustorium. In contact with a host root, the haustorial cells undergo a remarkable differentiation processes to form a wedge-shaped group of cells that penetrates the host root cortex and endodermis to establish parasite-host xylem–xylem connections (Figure 2) (Albrecht et al., 1999; Dorr, 1997). This allows the direct transfer of water, carbohydrates and nutrients from the host plant to the parasite, drastically reducing host plant growth and yield (Parker & Riches, 1993; Van, 2006). Subsequently, *Striga* grows upwards and adventitious roots are produced, emerges above the ground and flowers to produce seeds (Spallek et al., 2013).

In many cases, *S. hermonthica* seeds collected from one cereal host can infect other cereal species, although there is evidence for some interspecies specificity, particularly with respect to the reciprocal infectivity of populations of *S. hermonthica* collected from sorghum and pearl millet (Vasudeva & Musselman, 1987). Perhaps, genetic variation is likely to be maintained within populations (ecotypes) from generation to generation, especially in *S. hermonthica* (Bharatha et al., 1990). More recently, the presence of genetic variation for host range specificity within *S. hermonthica* populations have been reported by Huang et al.(2011). The dual phase life-cycle of parasitic weed and its mode of action make it difficult to control (Kountche, 2013). Furthermore, host plant resistance to *Striga* involves physiological and genetic mechanisms and requires a thorough understanding of the biophysical processes of the host-parasite interaction (Figure 2).

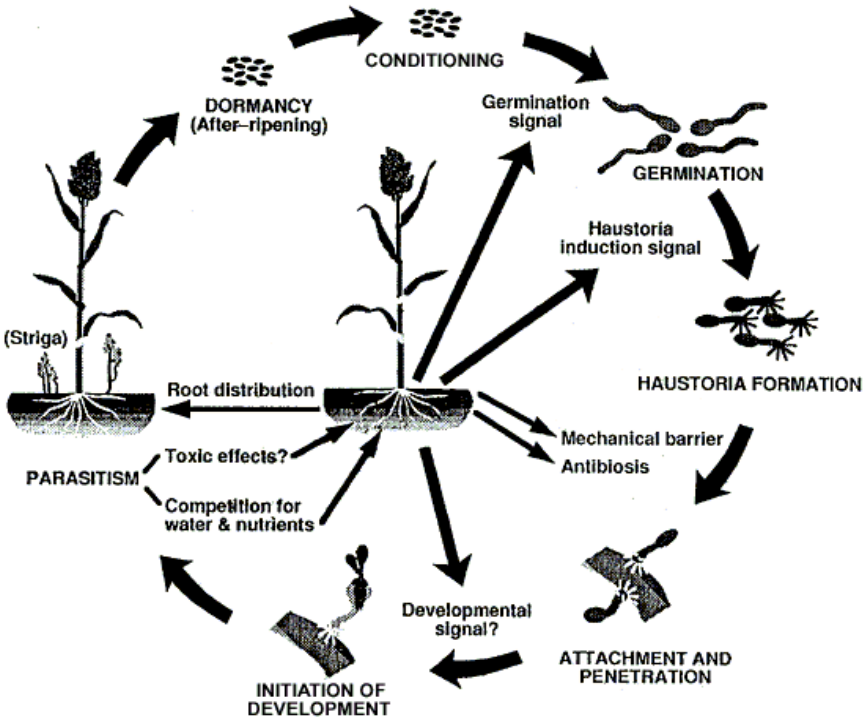

Figure 2: Stages in *Striga*life-cycle and its interaction with the host plant(Ejeta & Butler, 1993)

III. Striga Control Methods

Research aimed at *Striga* control has been carried for a long time and a wide range of technologies have been developed (Atera et al., 2011). Despite efforts made to control the *Striga* problem, it has persisted and increased in magnitude prompting to research aimed at preventing infestation. Many potential *Striga* control

methods have been applied, ranging from agricultural practices to biological control (Joel, 2000). According to Haussmann et al.(2000) *Striga* control strategies can be broadly classified into three major categories that have different impacts on a *Striga* population: (1) reduction of the *Striga* seed bank; (2) limitation of *Striga* seed production; and (3) reduction/prevention of *Striga* seed dissemination to uninfested fields. Also, Strategies may be directed to the alternative management options of *Striga* control, containment, or eradication (Ejeta & Gressel, 2007). Although, control of *Striga* could be slow but is feasible. The severity of *Striga* damage and infestation can be reduced with well-managed practices and measures that fit the local knowledge, economy, as well as labor capacities, and practiced for several seasons. Four independent *Striga* control approaches that have been widely investigated and developed have been outlined by Ejeta and Gressel (2007); cultural, chemical, genetic, and biological options. Some of these control options aim to improve soil fertility, through the use of organic and inorganic fertilizers, while others directly affect the parasite (Rector, 2009). So far the various control options available to farmers include; the use of cultural and mechanical practices such as hand-pulling, crop rotation, trap-cropping, intercropping, appropriate improvement of soil fertility, soil and water management, tillage and planting methods (Hess & Dodo, 2004; Jamil et al., 2011) biological control using the insect *Smicronix* spp or pathogenic fungus *Fusarium oxysporum* as a mycoherbicide (Marley et al., 2005; Zahran et al., 2008; Rebeka et al., 2013) application of chemicals using pre-emergence and post emergence herbicides (Kanampiu et al., 2003) and host plant resistance (sorghum, rice and maize) (Parker & Riches, 1993; Haussmann et al., 2000; Gurney et al., 2006;Hearne, 2009; Teka, 2014). The fact that symptoms of *Striga* damage on the host appears before *Striga* emerge above the ground illustrates how ineffective the control of the parasite by hand weeding or application of herbicide is likely to be. Therefore, control methods that affect *Striga* germination and attachment to the host are expected to be more effective because they prevent the host from *Striga* parasitism. Nevertheless, former techniques are important because they could avoid the reproduction of *Striga* thereby reducing the seed bank. Elzein et al. (2010) reported *Fusarium oxysporum* is highly effective in hindering germination, growth and development of *Striga*. Also, the fodder crop legume, *Desmodium uncinatum* is highly effective in controlling *Striga* as reported by Khan et al.(2008), as it attract the parasite thereby preventing the host from *Striga* attack. In general, only a few of these control measures have been widely adopted or commercialized. Low adoption of the control practices are as a result of limited knowledge of the problem, its biology, the lack of labor or resources to make the needed investment, an uncertainty of potential control, and a return to investment, and an unwillingness to make the long-term investments (Joel et al., 2007). Considering the challenges to a successful control of the parasitic weed so far, it is generally believed that no single method of control can provide an effective and economically feasible solution. Therefore, the most practicable, comprehensive and sustainable way to deal with this parasitic weed is integrated control approach which is essential, ideal and useful to small-scale farmers, in order to achieve sustainable crop production (Teka, 2014; Ejeta, 2007)). Therefore, control strategies should be geared towards individual cropping systems, local needs and preferences to help adapt and optimize control strategies to different agro-ecosystems. Oswald (2005) suggested first containment, sanitation as a measure to prevent Striga damage and finally eradication, as a means to eradicate the soil *Striga* seed bank. According to FAO(2016) and Khan et al.(2008) the "push pull" system of integrated pest management inhibit *Striga* growth and does not need high levels of external inputs. Also, farmers have adapted "push pull" to allow intercropping with beans and report that their maize yields have increased three to four times. In northern Nigeria, some farmers control *Striga* by applying organic and inorganic fertilizer and crop rotation (Dugje et al., 2006). Ibrahim et al. (2014) also suggested the use of cover crops such as *Mucuna* spp. as an intercrop to reduce *Striga* infestation. The potential use of sesame as a trap-crop in integrated control of *Striga* in pearl millet was reported by Hess & Dodo (2004). Also, Midega et al. (2013) reported significant decrease in *Striga* count when *desmodium* was used as an intercrop to control *Striga* in maize. Integrated *Striga* management package combining a mycoherbicide based on *F. oxysporum* isolate and host plant resistance has been demonstrated on farmers' fields as effective *Striga* control approach (Yonli et al., 2012; Teshome, 2013; Teka, 2014). All these facts demonstrate the need for integrated *Striga* control as an effective tool in addition, reduce the environmental impact of individual control strategy. It has generally been accepted that, *Striga* can be controlled if a wide range of individual control methods are brought together as a program of integrated *Striga* control (ISC), to serve a range of bio-physical and socio-economic environments (Ellis-Jones et al., 2004; Douthwaite et al., 2007; Harker & O'Donovan, 2013). According to Atera et al. (2011) the major objective of ISC is to reduce *Striga* densities in the soil thereby avoiding new *Striga* plants from emerging in the subsequent seasons. Moreover, integrating genetic resistance with other technologies is the smartest option possible both for effectiveness of control as well as for increasing durability of resistance genes (Ejeta, 2007; Cissoko et al., 2011). In recent years, efforts have been undertaken to elucidate the molecular characterization of the host plant – parasite interaction and host resistance through expression analysis of the genes,

proteins and metabolites involved in these processes (Rispail et al., 2007; Aly, 2012). Recent discovery of a new class of plant hormones, strigolactones by Yoneyama et al. (2010) not only controlled branching but also play a role in attracting *Arbuscular mycorrhizal fungi* (AMF).Strigolactones are certainly the best studied and extremely potent inducers of *Striga* germination (Xie et al., 2010; Kohlen et al., 2011).

An RNA interference (RNAi) technology was recently investigated as a genetic tool for enhancing host resistance against parasitic weeds (Yoder et al., 2009). The development of herbicide-resistant crops is an alternative approach to the control of parasitic weeds (Gressel, 2009). However, these approaches use genetically modified organisms and may thus not be easily adopted by farmers and (Kountche, 2013), in addition, may be associated with problems in the field (gene flow, coexistence with local varieties). The foregoing shows that *Striga* is not a new problem on cereals in Africa; some early work was done and much is now being done to understand biology of the interaction and its control.

IV. Approaches used for Striga Resistance Breeding

Considerable efforts have been invested in breeding for *Striga* resistance in cereals and significant progress has been made in the development of improved selection methods. Haussmann et al., (2000) reported an improved field testing method for *Striga* resistance. More recently, Kountche et al. (2013) used phenotypic recurrent selection to breed for *Striga* resistance under field conditions and this resulted in significant improvement in *Striga* resistance in cultivated pearl millet and the development of the first pearl millet *Striga*-resistant experimental varieties. However, multi-location field screening for *Striga* resistance resulted in significant genotype ×environment (G×E) interactions for *Striga* resistance traits in sorghum, maize and pearl millet trials (Haussmann et al., 2001; Badu-Apraku et al., 2010). These results suggest that there is need to select for specific adaptation in *Striga* resistance breeding, particularly in the case of contrasting environments where different putative *Striga* ecotypes may exist. The use of laboratory-based assays, on the other hand, has enabled further insights into the interactive biological processes between *Striga* and the roots of host plants during each individual stage of the parasitic process (Ejeta, 2007). The power of the physiology-based breeding approach is that it pushes the limit of what would traditionally be considered good source material for resistance to the parasitic weed (Kountche, 2013). Physiology-based approaches have also threw more light on the specific mechanisms of resistance associated with each source of host genotype (Ejeta & Butler, 1993; Gurney et al., 2006). However, laboratory experiments need to be tested in the field, because laboratory environment is different from field environment. Recently, a number of genes or chromosomal regions that control quantitative traits, quantitative trait loci (QTL), associated with resistance to *Striga* spp. in sorghum (Haussmann et al., 2004; Satish et al., 2012), and rice have been reported (Gurney et al., 2006; Kaewchumnong & Price, 2008). As a result, QTLs have been refined to introgress *Striga* resistance into farmer-preferred sorghum varieties in most parts of African countries (Grenier et al., 2007). Marker assisted-selection techniques for parasitic plant resistance can be used to rapidly accumulate several resistance genes (Rispail et al., 2007). However, marker-assisted backcrossing (MABC) has certain limits for introgressing a quantitative trait (Kountche, 2013). Since markers to be used in MABC are usually identified in biparental mapping populations, this becomes a limitation in exploiting potentially wider range of allelic diversity present in the crop species, and markers may be valid only for the genetic background in which they were identified (Varshney & Dubey, 2009). The limitation of pyramiding quantitative traits with minor effect brought about the use of marker-assisted recurrent selection (MARS) as an indispensable breeding strategy for developing germplasm with durable resistance(Bernardo & Charcosset, 2006). However, the most important point to note in molecular breeding for resistance to *Striga* is the identification of strong associations between genetic markers and the genes that determine resistance to the parasite.

Because of the ability of *Striga* spp., particularly *S. hermonthica*, to break down resistance (Rich & Ejeta, 2008), deliberate stacking of quantitative (polygenic) resistance in addition to the qualitative (monogenic) resistance in the cultivars to be used reduces the likelihood of resistance breakdown. Gene stacking is of upmost importance for durability because multiple mutations would have to accumulate in the parasite population to overcome resistance genes in the host (Rich & Ejeta, 2008). Kountche et al. (2013) reports that, the use of genetically different *Striga*-resistant open-pollinated cultivars, with different resistance alleles, could be a practical alternative to stability of resistance over time.

V. Research Achievements

Significant advances have been made on *Striga* control research in Africa from 1940s onwards (Andrews, 1947; Ejeta, 2007) and, in the last 20 years these efforts have been increased and considerable resources have been invested in developing control options (Oswald, 2005; Khan et al., 2010; Midega et al., 2013). Several organizations have been involved in conducting *Striga* control research in Africa. These includes; International Maize and Wheat Improvement

Centre (CIMMYT) (Odhiambo & Ransom, 1993)); International Centre of Insect Physiology and Ecology (ICIPE) (Khan et al., 2008); International Crops Research Institute for the Semi-Arid-Tropics (ICRISAT) (Haussmann et al., 2001); Integrated soil fertility management program in sub-Saharan Arica by IITA, IFDC and IPNI (Vanlauwe et al., 2015); African Agricultural Technology Foundation (AATF) and International Institute of Tropical Agriculture (IITA) (Manyong, 2008). Other institutions from advanced countries mostly from Europe (The UK and The Netherlands), USA and Canada have also been involved in conducting research on *Striga* (Andersson & Halvarsson, 2011). Recently, a four-year project *Achieving sustainable Striga control for poor farmers in Africa* (April 2011-March 2015) reported by Oluoch et al.(2014), also known as the Integrated *Striga* Management Project (ISMA), was conducted to improve the livelihoods of over 25 million small-holder farmers in northern Nigeria (15 million) and western Kenya (10 million) in the long term. Sustainability, which is one of the key aspects of the project, focuses on stakeholder involvement and feedback mechanisms. Project activities have been positioned within national programs (IITA, CIMMYT, ICIPE, Institute of Agricultural Research, Ahmadu Bello University, Nigeria, Bauchi State Agriculture Development Programme (BSADP), AATF) and local project sites to assure end users' access to technical information, technologies, and experience. More than 10 herbicide and *Striga* resistant maize hybrids and OPVs have been developed and promising materials have been identified for further testing and potential release in the two countries. These institutions have recommended control options to farmers in Nigeria geared towards reducing infestation and damage. The options include: the use of resistant crop varieties, intercropping of cereals and legumes, crop rotation, use of trap crops that stimulate suicidal germination such as *desmodium*, and application of manure and nitrogenous fertilizer.

Research on the parasitic weed, have been going on for so long that it would be wrong to suggest that there has been little progress in their control. From the aforementioned studies, dedicated work leading to useful *Striga* control strategies have been done on at least local basis.

VI. Next Generation *Striga* Research

A thorough knowledge of the molecular bases of resistance to *Striga* is essential to provide the fundamental information necessary to drive not only crop improvement but also the development of alternative control methods.

In recent years, efforts have been undertaken to elucidate the molecular events underlying *Striga* infections using next generation and conventional sequencing technology (Yoshida et al., 2010). For example, comparative studies on repetitive regions in five *Striga* species generated a total of about 2200 Sanger sequence reads and about 10 000 454 reads (Estep et al., 2012). Partially assembled and identified repeats were most similar to the most closely related plant species. Overall, the authors came to the conclusion that the analysed *Striga* genomes have a rather typically complex angiosperm genome. Estimated haploid genome sizes range from 615 Mb for *S. asiatica* and 1425 Mb for *S. hermonthica* suggesting several polyploidization events.

No evidence of large transfers of repetitive DNA regions from the hostgenomes was observed, which is in contrast with the observed HGT events between monocot genes and *S. hermonthica* (Yoshida,et al., 2010), and favours the hypothesis that HGT events originate from mRNA species rather than from large pieces of genomic DNA.

Until recently, genomic resources associated with resistance to parasitic weeds due to RNA interference were rare. This new strategy has great potential for the control of parasitic plants (Jennifer, 2012). Thanks to the great progress made in the Parasitic Plant Genome Project' (http://ppgp.huck.psu.edu/) (Westwood et al., 2012), genetic resistance based on silencing of a target gene in the host plant is now feasible (Yoder et al., 2009).

Nevertheless, there is still a need for further research into the mechanisms involved in the translocation and regulation of the macromolecules involved in host- parasite interactions (Aly, 2012).

Moreover, comparative genomics can point to important resistance genes and signaling pathways in pearl millet as they were discovered in other *Striga*- host cereal crops (Michelmore, 2000; Rispail et al., 2007). Alignment of the high-density pearl millet genetic map currently under development will thus enable exploitation of comparable grass resources for the identification of potential *Striga* resistance genes in pearl millet (Devos & Gale, 2000; Kountche, 2013).

Next-generation sequencing technology has led to an increase in available transcriptional data for *S. hermonthica* and related species. For example, Wickett et al.(2011) analysed sequence data obtained from Illumina short reads of mRNA isolated from above-ground tissue of three Orobanchaceae species: the facultative hemiparasite *T. versicolor*, *S. hermonthica* and *Phelipanche aegyptiaca* (pers.) Pomel. The expression of photosynthesis-related genes was much lower in *S. hermonthica* than in *Triphysaria*, and no expression of these genes was detected in *Phelipanche*. The study also revealed that chlorophyll *a* synthesis gene expression was conserved and detectable in all three species, even in the non photosynthetically active *Ph. aegyptiaca*.

Next-generation sequencing technology will almost certainly provide detailed transcriptional information for *Striga* at different stages of infection and on different hosts, and will allow the simultaneous detection of host and pathogen transcriptomes. So far, host transcriptome data are mainly based on microarray studies or similar methods. Hiraoka et al. (2009) used a suppression subtractive hybridization strategy of mRNA isolated from *Lotus japonicus* to investigate differences when infected with *S. hermonthica* (resistant) or *Ph. aegyptiaca*.

The accumulation of cytotoxic material is also probably the cause of nonhost resistance to *S. hermonthica* in *Tripsacum dactyloides*, a wild relative of maize. In contrast with *Z. mays*, haustoria formation is impaired on *T. dactyloides* plants by an unknown factor. This factor is also able to suppress haustoria formation on *Z. mays*, when *Striga* plants are attached to *T. dactyloides* at the same time (Gurney et al., 2003).In rice, when one susceptible rice variety (IAC 45) and one resistant variety (Nipponbare) were infected with *S. hermonthica* and analysed 2, 4 and 11 days after infection using whole-genome microarrays (Swarbrick et al., 2008), the incompatible interaction between *S. hermonthica* and Nipponbare showed enhanced expression of defence-related genes, such as genes encoding pathogenesis-related (PR) proteins, WRKY transcription factors and pleiotropic ABC transporters, whereas the compatible (susceptible) interaction was characterized by large-scale down-regulation of genes associated with growth regulation, metabolism, biogenesis of cellular components and cell division. Several genes coding for nutrient transporters, enzymes involved in amino acid metabolism, were up-regulated at the same time in the susceptible rice cultivar.

Overall, these data, although sometimes very difficult to compare, draw a common picture, in which *Striga* is actively recognized by resistant plants and triggers a defence-like response. This response appears to be very similar to that observed for other nonhost or race-specific resistance responses to other plant pathogens. It also shows that *Striga* actively manipulates host transcription to foster parasitism by either up-regulating host genes associated with nutrient supply or by down-regulating defence-related genes. It is not known how *Striga* manipulates transcription in host plants. Avirulence gene products are interesting candidates, but difficult to isolate as a result of limited genetic resources in parasitic plants.

VII. Conclusion

Over the years, many researchers have tackled the problems caused by parasitic plants in infested regions. Although advances have been made in the understanding of the interaction, complete solutions remain to be found. The lack of efficient control methods is rooted in the high complexity of the interaction and the nature of the parasite. The detection of partial resistance within genotypes of some crop oriented further development of control methods toward genetic crop improvement. However, the multigenic and quantitative system generally controlling the resistance dramatically slows down breeding. It is now evident that efficient control of the parasite requires a more comprehensive understanding of the molecular bases of the interaction and its transfer to breeders. The few studies targeting the analysis of gene expression and accumulation of proteins and metabolites start to reveal the molecular dialogue involved in resistance. However, it is only a beginning that requires to be further exploited. Application of some of these biotechnological tools has already been initiated to tackle plant parasite problems such as MAS or the 'omic' technology, but to develop resistant crops the inclusion of other tools such as genetic transformation and functional genomics will be needed. The most efficient approach to crop improvement would be the integration of these different tools from fundamental to applied biology. Indeed, a comprehensive understanding of the interaction obtained from molecular studies of the host responses to parasite in model plants – including transcriptomic, proteomic and metabolomic – should provide candidate genes to improve resistance in crops, which will need to be validated through functional analysis. In addition, the better understanding of the interaction and the parasite biology gained by these molecular methods may also allow the development of new methods of control. Although much work remains to be done, the different approaches presented in this review should, in the near future, provide solutions to the problems caused by parasitic plants.

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Quantitative Evaluation of Sesame (*Sesamum indicum* L.) Promising Lines for Adaptability and Seed Yield in Different Agro-Climatic Conditions of Punjab (Pakistan)

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Keywords: *sesame, promising lines, agro-climate, seed yield, Punjab.*

GJSFR-D Classification: *FOR Code: 070199*

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Hafiz Saad Bin Mustafa [α], Muhammad Anwar [σ], Habibur Rehman [ρ], Faisal Saddique [ω] & Muhammad Aftab [¥]

Abstract- Pakistan has become the fourth largest market for cooking oil after China, India and United Arab Emirates and third largest importer of the commodity. Pakistan imports crude and refined cooking oils (palm and palm olein) mainly from Malaysia and Indonesia, while it imports soybean oil from North America and Brazil. The aim of present study was to evaluate best performing sesame genotypes under different climatic conditions of Punjab province. The experiment was conducted in randomized complete block design (RCBD) with three replications at five different agro-climatic locations during Kharif 2016. Experimental material comprised of 10 genotypes with different genetic makeup. The data for seed yield was recorded and Least Significant Difference(LSD) was calculated at 5% probability level. The study showed that there is significant variability among the genotypes for seed yield. Genotypes 10003 and 50022 performed well and showed good stability in seed yield at all five locations. The cultivation of these lines in Punjab province may enhance the local production of good quality edible oil in the country.

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I. Introduction

Sesame (*Sesamum indicum* L.) is enriched oilseed crop with oldest history and belongs to family Pedaliaceae with chromosomal number 2n (26). Pedaliaceae consist of 16 genera and 60 species. Sesame is most important genus of this family. It is self-pollinated crop but sometime cross pollination may occur due to insects. The growth habit of sesame is annual (Peter, 2004). Sesame is originated from Africa, while tropical and sub-tropical regions are best for its cultivation (Saikat *et al.,* 2015).

Sesame is a conventional oilseed crop having branched and single stem varieties. Sesame plant bears deep root system and grows well in water deficit situations (Fazal *et al.,* 2015). Sesame is a short duration crop which completes its cycle within 100-110 days and fit as catch crop in Zaid Kharif season so, wheat can be timely cultivated. Therefore, there is great scope of horizontal expansion of sesame without affecting current area under different crops. Sesame is a very rewarding crop due to its low cost of production and high price (Anwar *et al.,* 2013).

Sesame seed contains more than 50% oil, about 25% proteins and 13.5% carbohydrate. Sesame seeds also possess the essential fatty acids such as linoleic acid and high lignin that comprises of sesaminol sesamin, sesamol and sesamolinol (Fazal*et al.,* 2013). Vitamin B complex is important for cell oxygenation favorably influence on liver cells function also present in sesame(Sarwar and Hussain, 2010). Sesame oil plays a vital role to improve human health. It decreases the Total Serum Cholesterol (TST)and Low Density Lipoprotein (LDL) and increases the antioxidant capacity in hypercholesterolemia patients (Chen et al.,2005). Sesmol is phenolic compound which is present in sesame having anti-mutagenic properties (Kaur and Saini, 2000). It causes antimicrobial effects on Klebsiella sp. (gram negative bacterium) which causes urinary infection in human (Costa *et al.,* 2007).

Edible oil is one of the most important commodities for everyday use which is deplorably facing extreme scarcity in Pakistan. Pakistan has to import 65-70% of its edible oil from the international market annually (Hussain *et al.,* 2017).Sesame is only oilseed crop which is exported by Pakistan. During 2013-14, 37.63 million tons sesame seed worth Rs.7342 million was exported (Federal Bureau of Statistics, 2013-14). According to Pakistan Bureau of statistics 2015-16 total available area for sesame in Pakistan is 80,000 hectares which is 0.96 time less than previous year (83,000 ha) and total production is 32.4 thousand tons which is 0.97 time less than previous year 33.1 thousand tons (2014-15).

The major causes of low seed yield of sesame are the cultivation of poor yielding dehiscent types, yield loss during threshing, lack of agricultural inputs such as improved varieties, fertilizers, pesticides and other agrochemicals, poor management and lack of appropriate breeding program (Olowe *et al.,* 2009;

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Pham *et al.,* 2010). As sesame utilization is increasing day by day therefore, it is essential to develop high yielding sesame cultivars to meet the requirement. The present study was conducted at different agro-climatic zone of Punjab (Pakistan) to evaluate the stability and seed yield performance of different sesame promising strains under different climatic conditions.

II. Material and Method

The presented study was conducted during Kharif (summer season) 2016 to evaluate the stability and seed yield of ten Sesame promising lines under five different Agro-climatic locations of Punjab, Pakistan. All the strains (50022, 40004, 40021, 87008, 40012, 10003, 50011, 70004 and Black Til along with TS-5 as check variety) have different genetic makeup. The experiment was sown in tri replicated randomized complete block design (RCBD) at five location with different agro-climatic conditions viz. Oilseeds Research Institute, Faisalabad, Adaptive Research Farm, Mandi Bahauddin, Oilseeds Research Sub-station, Piplan, Regional Agricultural Research Institute, Bahawalpur, and Oilseeds Research Station, Khanpur. Plot size for each entry was 5m x 1.8m with 45cm Row spacing at all locations. Sowing was done on flats by manual drilling. Nitrogen and phosphorus fertilizer were applied @ 60:60kg/ha at all locations. All recommend agronomic and cultural practices were applied during growing period at all the locations. The data for seed yield per plot for each entry was recorded at all locations.

The mean seed yield was compared by Least Significant Difference (LSD) test to study the significance at 5% probability level by using Statistix 8.1. Data collected were subjected to analysis of variance (ANOVA) for RCBD experiment using the method described by Steel and Torrie (1980). The F-LSD procedure as described by Obi (2001) was used in separating the treatment means. Weather records on rainfall, temperature and relative humidity (Figure 1, Figure 2, Figure 3, Figure 4 and Figure 5)were collected from meteorological department, Govt. of the Punjab (Pakistan) and www.worldweatheronline.com.

III. Result and Discussion

All the promising lines of sesame were developed through pedigree method of plant breeding. These lines were grown in five different agro-climatic conditions to check adaptability and yield stability of these lines. Figure1, Figure2, Figure3, Figure4 and Figure5 showed the mean data for temperature, humidity, rainfall and sunshine hours during the growing period of sesame crop at all five locations viz. Faisalabad, Mandi Bahauddin, Piplan, Bahawalpur and Khanpur. The data showed the existence of variability in temperature, humidity and precipitation pattern at all five locations. Similar experiment was performed by Anwar *et al.,* 2013.

The data presented in Table1 showed the mean seed yield along with least significant difference (LSD) of three replication at all five locations. Large variations were observed among all genotype at five locations for seed yield.

Table 1: Data for mean seed yield and LSD test at five locations

Sr. No.	Variety/ Line	Seed Yield (kg/ha)				
		Faisalabad	Mandi Bahauddin	Piplan	Bahawalpur	Khanpur
1.	50022	841	716	361	666	470
2.	40004	810	603	444	463	211
3.	40021	636	518	269	655	270
4.	87008	774	488	361	407	311
5.	40012	557	492	250	503	425
6.	10003	857	652	794	563	463
7.	50011	819	736	296	381	396
8.	70004	646	549	241	536	380
9.	Black Til	808	685	536	344	311
10.	TS-5 (C)	779	610	241	566	287
	LSD 5%	**122**	**142**	**53**	**267**	**72**

a) Faisalabad

During growing period of sesame (July-Oct.) maximum mean temperature 46°C in June and minimum 37°C in October was observed. While maximum rainfall (28.29mm) was occurred in July and no rainfall was observed in whole month of October. The maximum humidity was measured 36% in August and minimum 16% in October. The maximum sunshine hours was observed in July(155.5 hour) and minimum in October (93 hour). The genotype 10003 produced highest seed

yield (857kg/ha) and minimum yield was harvested from 40012(557kg/ha). The checked varietyTS-5 produced 779kg/ha seed yield in Faisalabad climatic conditions. Five lines(50011, 50022, 40004, 10003 and Black Til) produced higher yield than the check variety TS-5.Three sesame lines (40012, 40021 & 7004) gave significantly lower yield than the check varietyTS-5. Sesame genotype 87008 showed at par yield with check variety.122 LSD was measured at 5% probability level.

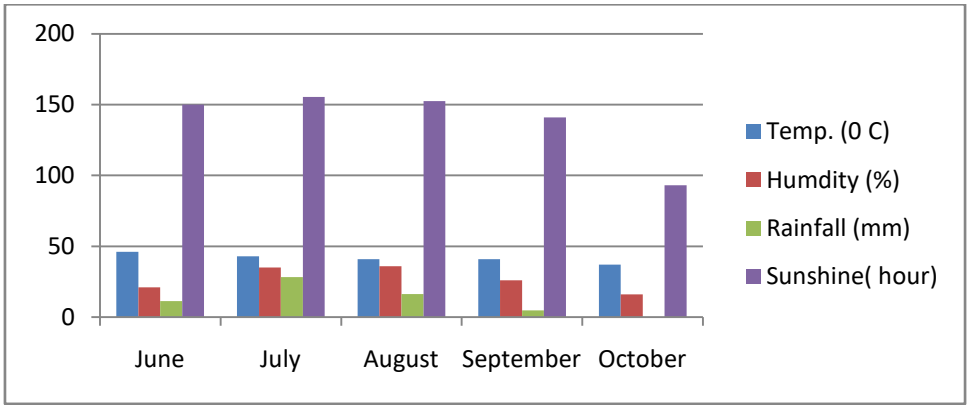

Figure 1: Faisalabad Climatic condition during growing period June – October, 2016

b) Mandi Bahauddin

During growing period of sesame (July-Oct.) maximum mean temperature (43°C) in June and minimum 35 °C in October was observed. While maximum rainfall(56.17mm) was occurred in July and no rainfall occurs in whole month of October. The maximum humidity was measured 39% in August and minimum 15% in October. The maximum sunshine hours was observed in July(155 hour) and minimum in October (93.8hour).The genotype 50011 produced highest seed yield(736kg/ha) and minimum yield was harvested from 87008(488kg/ha). The checked variety TS-5 produced 610kg/ha seed yield in Mandi Bahauddin climatic conditions. Four lines(50011, 50022, 10003and Black Til) produced higher yield than the checked variety TS-5. Four lines (87008, 40012, 40021 & 70004) gave lower yield than the check variety.10003 showed at par seed yield with check variety. 142 LSD was measured at 5% probability level.

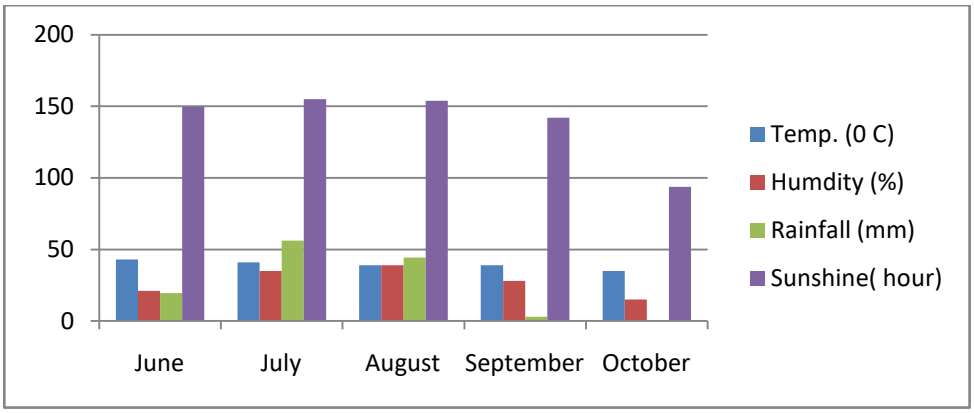

Figure 2: Mandi Bahaudin climatic condition during growing period June – October, 2016

c) Piplan

During growing period of sesame (July-Oct.) maximum mean temperature (45°C) in June and minimum 35°C in October was observed. While maximum rainfall(48.84mm) was occurred in July and no rainfall was observed during whole months of September and October. The maximum humidity was measured 31% in August and minimum 16% in October. The maximum sunshine hours was observed in July and august (155 hour) and minimum in October (93 hour). The genotype 10003 produced highest seed yield(794kg/ha) and minimum yield was harvested from 70004 along with check variety (241kg/ha). The checked variety TS-5 produced lowest seed yield 241kg/ha in Piplan climatic conditions. Sixlines(50022, 40004, 87008, 10003, 50011 and Black Til) produced significantly higher yield than the checked variety TS-5.While three lines (40021, 40012 & 70004) produced at par seed yield than the check variety. 53LSD was measured at 5% probability level.

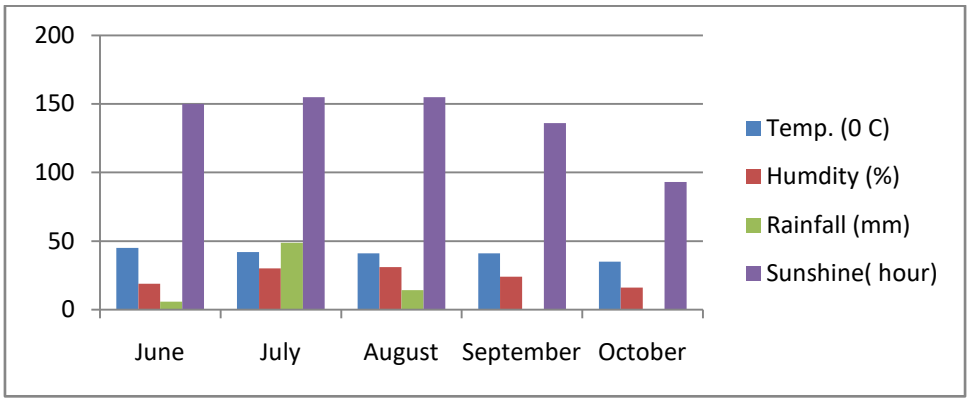

Figure 3: Piplan climatic condition during growing period June – October, 2016

d) Bahawalpur

During growing period of sesame (July-Oct.) maximum mean temperature (44°C) in June and minimum 37°C in October was observed. While maximum rainfall(24.75mm) was occurred in July and no rainfall occurs in whole month of October. The maximum humidity was measured 36% in August and minimum 17% in October. The maximum sunshine hours was observed in July(153.8 hour) and minimum in Sep (93 hour). The genotype 50022 produced highest seed yield (666kg/ha) and minimum yield was harvested from Black Til (344kg/ha). The checked variety TS-5 produced 566kg/ha seed yield in Bahawalpur climatic conditions. Two lines(50022 and 4002l) produced higher yield than the checked variety TS-5.Four lines (40004, 87008, 50011 & Black Til) gave lower yield than the check variety while 40012, 10003 & 70004 showed at par seed yield with check variety. 267 LSD was measured at 5% probability level.

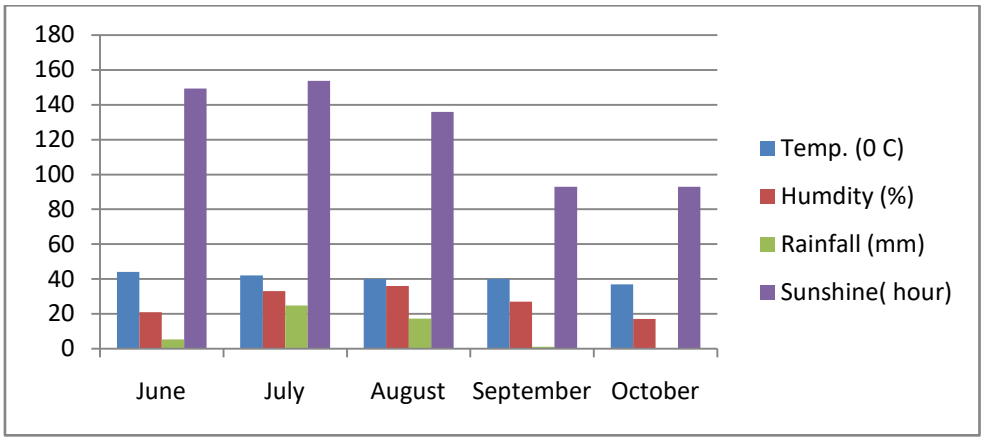

Figure 4: Bahawalpur climatic condition during growing period June – October, 2016

e) Khanpur

During growing period of sesame (July-Oct.) maximum mean temperature (44°C) in June and minimum 37°C in October was observed. While maximum rainfall(10.5mm) was occurred in August and no rainfall was observed in whole month of October. The maximum humidity was measured 36% in August and minimum 19% in October. The maximum sunshine hours was observed in July (153.8 hour) and minimum during September and October (96 hour). The genotype 50022 produced highest seed yield(470kg/ha) and minimum yield was harvested from 40004 (211kg/ha). The checked variety TS-5 produced 287kg/ha seed yield in Khanpur climatic conditions. Five lines(50022, 40012, 10003, 50011, and 70004) produced significantly higher yield than the checked variety TS-5.Genotype 40004 gave significantly lower yield than the check variety. While three sesame lines (40021, 87008 & Black Til) showed at par seed yield with check variety. 72 LSD was measured at 5% probability level.

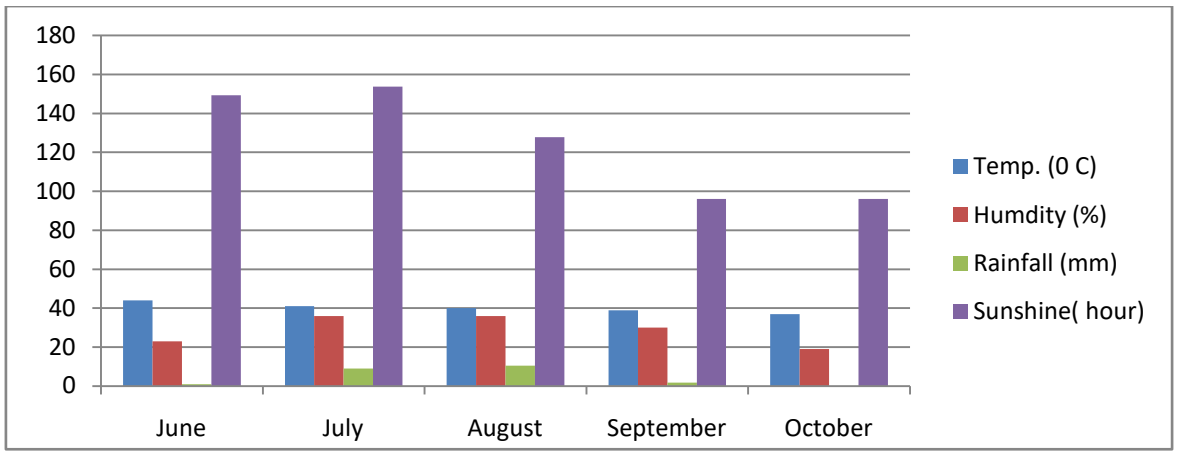

Figure 5: Khanpur climatic condition during growing period June – October, 2016

The data prescribed in Figure6 showed the comparison between seed yield among ten genotypes at all five locations. The data showed that significant variability was found among the 10 sesame accessions for seed yield. Earlier investigations by other researchers also showed significant variation among sesame genotypes inseed yield. (Adebisi *et al.,* 2005;Ehsanullah*et al.,* 2007; Nahar *et al.,* 2008;Parameshwarappa *et al.,* 2009; Pham *et al.,* 2010;).All the sesame lines produced highest yield in Faisalabad climatic condition. Promising lines 10003 and 50022 performed well and showed good stability in seed yield at all five locations. The genotypes 50011 and Black Til also performed well in Faisalabad and Mandi Bahauddin climatic conditions. Genotype 40021 showed good performance only under Bahawalpur climatic conditions. Other genotypes had not shown any significant performance. Other sesame lines produced lower or at par yield with check variety TS-5 so these lines lost their worth for further evaluation. Ogbonna and Ukaan 2012 performed similar experiment on sesame accessions and observed similar results in his material.

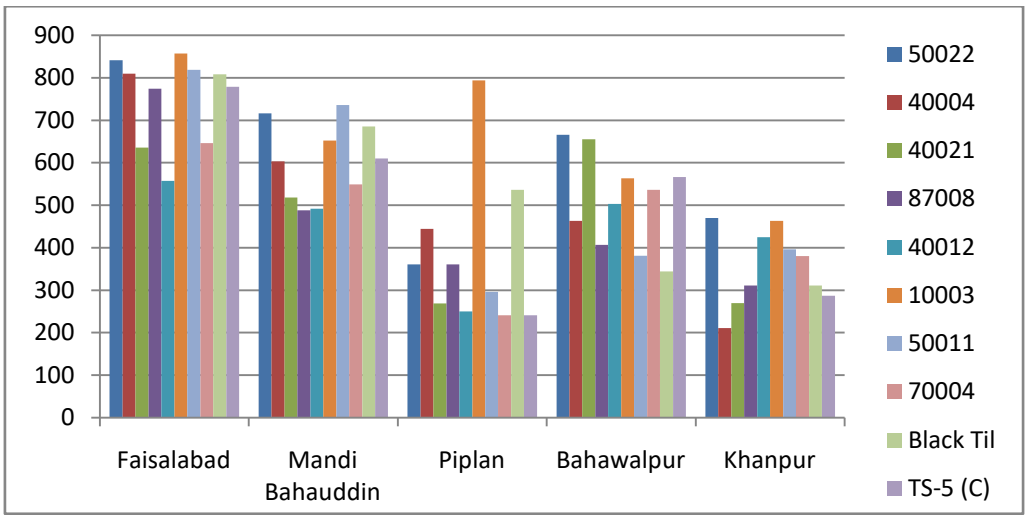

Figure 6: Mean seed yield(kg/ha) at five different Agro-climatic locations of Punjab(Pakistan)

IV. Conclusion

It is concluded that 10003 and 50022 are the overall best performing sesame lines under Punjab climatic conditions. The variety approval case of these lines should be submitted to Punjab Seed Council for general cultivation of these lines in Punjab (Pakistan).The cultivation of these lines in Punjab province may enhance the local production of good quality edible oil in the country which will ultimately reduce the import bill of edible oil.

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FARSS accrediting is an honor. It authenticates your research activities. After recognition as FARSB, you can add 'FARSS' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, and Visiting Card etc.

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We shall provide you intimation regarding launching of e-version of journal of your stream time to time.This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

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As FARSS, you will be given a renowned, secure and free professional email address with 100 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.

The FARSS will be eligible for a free application of standardization of their researches. Standardization of research will be subject to acceptability within stipulated norms as the next step after publishing in a journal. We shall depute a team of specialized research professionals who will render their services for elevating your researches to next higher level, which is worldwide open standardization.

The FARSS member can apply for grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.
Once you are designated as FARSS, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria. After certification of all your credentials by OARS, they will be published on your Fellow Profile link on website https://associationofresearch.org which will be helpful to upgrade the dignity.

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The FARSS is eligible to earn from sales proceeds of his/her researches/reference/review Books or literature, while publishing with Global Journals. The FARSS can decide whether he/she would like to publish his/her research in a closed manner. In this case, whenever readers purchase that individual research paper for reading, maximum 60% of its profit earned as royalty by Global Journals, will be credited to his/her bank account. The entire entitled amount will be credited to his/her bank account exceeding limit of minimum fixed balance. There is no minimum time limit for collection. The FARSS member can decide its price and we can help in making the right decision.

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The "MARSS" is a dignified ornament which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., MARSS or William Walldroff, M.S., MARSS.

MARSS accrediting is an honor. It authenticates your research activities. After becoming MARSS, you can add 'MARSS' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, Visiting Card and Name Plate etc.

The following benefitscan be availed by you only for next three years from the date of certification.

MARSS designated members are entitled to avail a 25% discount while publishing their research papers (of a single author) in Global Journals Inc., if the same is accepted by our Editorial Board and Peer Reviewers. If you are a main author or co-author of a group of authors, you will get discount of 10%.

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We shall provide you intimation regarding launching of e-version of journal of your stream time to time.This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

The MARSS member can apply for approval, grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.

Once you are designated as MARSS, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria.

It is mandatory to read all terms and conditions carefully.

AUXILIARY MEMBERSHIPS

Institutional Fellow of Global Journals Incorporation (USA)-OARS (USA)

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The "FARSC" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSC or William Walldroff, M.S., FARSC.

The IFOARS institution is entitled to form a Board comprised of one Chairperson and three to five board members preferably from different streams. The Board will be recognized as "Institutional Board of Open Association of Research Society"-(IBOARS).

The Institute will be entitled to following benefits:

The IBOARS can initially review research papers of their institute and recommend them to publish with respective journal of Global Journals. It can also review the papers of other institutions after obtaining our consent. The second review will be done by peer reviewer of Global Journals Incorporation (USA) The Board is at liberty to appoint a peer reviewer with the approval of chairperson after consulting us.

The author fees of such paper may be waived off up to 40%.

The Global Journals Incorporation (USA) at its discretion can also refer double blind peer reviewed paper at their end to the board for the verification and to get recommendation for final stage of acceptance of publication.

The IBOARS can organize symposium/seminar/conference in their country on behalf of Global Journals Incorporation (USA)-OARS (USA). The terms and conditions can be discussed separately.

The Board can also play vital role by exploring and giving valuable suggestions regarding the Standards of "Open Association of Research Society, U.S.A (OARS)" so that proper amendment can take place for the benefit of entire research community. We shall provide details of particular standard only on receipt of request from the Board.

The board members can also join us as Individual Fellow with 40% discount on total fees applicable to Individual Fellow. They will be entitled to avail all the benefits as declared. Please visit Individual Fellow-sub menu of GlobalJournals.org to have more relevant details.

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After nomination of your institution as "Institutional Fellow" and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.
The board can also take up the additional allied activities for betterment after our consultation.

The following entitlements are applicable to individual Fellows:

Open Association of Research Society, U.S.A (OARS) By-laws states that an individual Fellow may use the designations as applicable, or the corresponding initials. The Credentials of individual Fellow and Associate designations signify that the individual has gained knowledge of the fundamental concepts. One is magnanimous and proficient in an expertise course covering the professional code of conduct, and follows recognized standards of practice.

Open Association of Research Society (US)/ Global Journals Incorporation (USA), as described in Corporate Statements, are educational, research publishing and professional membership organizations. Achieving our individual Fellow or Associate status is based mainly on meeting stated educational research requirements.

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- The professional accredited with Fellow honor, is entitled to various benefits viz. name, fame, honor, regular flow of income, secured bright future, social status etc.

- In addition to above, if one is single author, then entitled to 40% discount on publishing research paper and can get 10%discount if one is co-author or main author among group of authors.
- The Fellow can organize symposium/seminar/conference on behalf of Global Journals Incorporation (USA) and he/she can also attend the same organized by other institutes on behalf of Global Journals.
- The Fellow can become member of Editorial Board Member after completing 3yrs.
- The Fellow can earn 60% of sales proceeds from the sale of reference/review books/literature/publishing of research paper.
- Fellow can also join as paid peer reviewer and earn 15% remuneration of author charges and can also get an opportunity to join as member of the Editorial Board of Global Journals Incorporation (USA)
- • This individual has learned the basic methods of applying those concepts and techniques to common challenging situations. This individual has further demonstrated an in–depth understanding of the application of suitable techniques to a particular area of research practice.

Note :

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- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.
- In case, the chairperson needs to be replaced then consent of 2/3rd board members are required and they are also required to jointly pass the resolution copy of which should be sent to us. In such case, it will be compulsory to obtain our approval before replacement.
- In case of "Difference of Opinion [if any]" among the Board members, our decision will be final and binding to everyone.

"

Process of submission of Research Paper

The Area or field of specialization may or may not be of any category as mentioned in 'Scope of Journal' menu of the GlobalJournals.org website. There are 37 Research Journal categorized with Six parental Journals GJCST, GJMR, GJRE, GJMBR, GJSFR, GJHSS. For Authors should prefer the mentioned categories. There are three widely used systems UDC, DDC and LCC. The details are available as 'Knowledge Abstract' at Home page. The major advantage of this coding is that, the research work will be exposed to and shared with all over the world as we are being abstracted and indexed worldwide.

The paper should be in proper format. The format can be downloaded from first page of 'Author Guideline' Menu. The Author is expected to follow the general rules as mentioned in this menu. The paper should be written in MS-Word Format (*.DOC,*.DOCX).

The Author can submit the paper either online or offline. The authors should prefer online submission.Online Submission: There are three ways to submit your paper:

(A) (I) First, register yourself using top right corner of Home page then Login. If you are already registered, then login using your username and password.

(II) Choose corresponding Journal.

(III) Click 'Submit Manuscript'. Fill required information and Upload the paper.

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- Font type of all text should be Swis 721 Lt BT.
- Paper Title should be of Font Size 24 with one Column section.
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- Numbering of First Main Headings (Heading 1) must be in Roman Letters, Capital Letter, and Font Size of 10.
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You can use your own standard format also.
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1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

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2) Drafting the paper and revising it critically regarding important academic content.

3) Final approval of the version of the paper to be published.

All authors should have been credited according to their appropriate contribution in research activity and preparing paper. Contributors who do not match the criteria as authors may be mentioned under Acknowledgement.

Acknowledgements: Contributors to the research other than authors credited should be mentioned under acknowledgement. The specifications of the source of funding for the research if appropriate can be included. Suppliers of resources may be mentioned along with address.

Appeal of Decision: The Editorial Board's decision on publication of the paper is final and cannot be appealed elsewhere.

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Manuscript submission is a systematic procedure and little preparation is required beyond having all parts of your manuscript in a given format and a computer with an Internet connection and a Web browser. Full help and instructions are provided on-screen. As an author, you will be prompted for login and manuscript details as Field of Paper and then to upload your manuscript file(s) according to the instructions.

To avoid postal delays, all transaction is preferred by e-mail. A finished manuscript submission is confirmed by e-mail immediately and your paper enters the editorial process with no postal delays. When a conclusion is made about the publication of your paper by our Editorial Board, revisions can be submitted online with the same procedure, with an occasion to view and respond to all comments.

Complete support for both authors and co-author is provided.

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Based on potential and nature, the manuscript can be categorized under the following heads:

Original research paper: Such papers are reports of high-level significant original research work.

Review papers: These are concise, significant but helpful and decisive topics for young researchers.

Research articles: These are handled with small investigation and applications

Research letters: The letters are small and concise comments on previously published matters.

5.STRUCTURE AND FORMAT OF MANUSCRIPT

The recommended size of original research paper is less than seven thousand words, review papers fewer than seven thousands words also.Preparation of research paper or how to write research paper, are major hurdle, while writing manuscript. The research articles and research letters should be fewer than three thousand words, the structure original research paper; sometime review paper should be as follows:

Papers: These are reports of significant research (typically less than 7000 words equivalent, including tables, figures, references), and comprise:

(a)Title should be relevant and commensurate with the theme of the paper.

(b) A brief Summary, "Abstract" (less than 150 words) containing the major results and conclusions.

(c) Up to ten keywords, that precisely identifies the paper's subject, purpose, and focus.

(d) An Introduction, giving necessary background excluding subheadings; objectives must be clearly declared.

(e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition; sources of information must be given and numerical methods must be specified by reference, unless non-standard.

(f) Results should be presented concisely, by well-designed tables and/or figures; the same data may not be used in both; suitable statistical data should be given. All data must be obtained with attention to numerical detail in the planning stage. As reproduced design has been recognized to be important to experiments for a considerable time, the Editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned un-refereed;

(g) Discussion should cover the implications and consequences, not just recapitulating the results; conclusions should be summarizing.

(h) Brief Acknowledgements.

(i) References in the proper form.

Authors should very cautiously consider the preparation of papers to ensure that they communicate efficiently. Papers are much more likely to be accepted, if they are cautiously designed and laid out, contain few or no errors, are summarizing, and be conventional to the approach and instructions. They will in addition, be published with much less delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and to make suggestions to improve briefness.

It is vital, that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

Format

Language: The language of publication is UK English. Authors, for whom English is a second language, must have their manuscript efficiently edited by an English-speaking person before submission to make sure that, the English is of high excellence. It is preferable, that manuscripts should be professionally edited.

Standard Usage, Abbreviations, and Units: Spelling and hyphenation should be conventional to The Concise Oxford English Dictionary. Statistics and measurements should at all times be given in figures, e.g. 16 min, except for when the number begins a sentence. When the number does not refer to a unit of measurement it should be spelt in full unless, it is 160 or greater.

Abbreviations supposed to be used carefully. The abbreviated name or expression is supposed to be cited in full at first usage, followed by the conventional abbreviation in parentheses.

Metric SI units are supposed to generally be used excluding where they conflict with current practice or are confusing. For illustration, 1.4 l rather than 1.4 × 10-3 m3, or 4 mm somewhat than 4 × 10-3 m. Chemical formula and solutions must identify the form used, e.g. anhydrous or hydrated, and the concentration must be in clearly defined units. Common species names should be followed by underlines at the first mention. For following use the generic name should be constricted to a single letter, if it is clear.

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All manuscripts submitted to Global Journals Inc. (US), ought to include:

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Optimizing Abstract for Search Engines

Many researchers searching for information online will use search engines such as Google, Yahoo or similar. By optimizing your paper for search engines, you will amplify the chance of someone finding it. This in turn will make it more likely to be viewed and/or cited in a further work. Global Journals Inc. (US) have compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Key Words

A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy and planning a list of possible keywords and phrases to try.

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

The Editorial Board and Global Journals Inc. (US) recommend that, citation of online-published papers and other material should be done via a DOI (digital object identifier). If an author cites anything, which does not have a DOI, they run the risk of the cited material not being noticeable.

The Editorial Board and Global Journals Inc. (US) recommend the use of a tool such as Reference Manager for reference management and formatting.

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Tables: Tables should be few in number, cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g. Table 4, a self-explanatory caption and be on a separate sheet. Vertical lines should not be used.

Figures: Figures are supposed to be submitted as separate files. Always take in a citation in the text for each figure using Arabic numbers, e.g. Fig. 4. Artwork must be submitted online in electronic form by e-mailing them.

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Even though low quality images are sufficient for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit (or e-mail) EPS (line art) or TIFF (halftone/photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Do not use pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings) in relation to the imitation size. Please give the data for figures in black and white or submit a Color Work Agreement Form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

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6. AFTER ACCEPTANCE

Upon approval of a paper for publication, the manuscript will be forwarded to the dean, who is responsible for the publication of the Global Journals Inc. (US).

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Proofs must be returned to the dean at dean@globaljournals.org within three days of receipt.

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Before start writing a good quality Computer Science Research Paper, let us first understand what is Computer Science Research Paper? So, Computer Science Research Paper is the paper which is written by professionals or scientists who are associated to Computer Science and Information Technology, or doing research study in these areas. If you are novel to this field then you can consult about this field from your supervisor or guide.

TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

4. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

5. Ask your Guides: If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

6. Use of computer is recommended: As you are doing research in the field of Computer Science, then this point is quite obvious.

7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

8. Use the Internet for help: An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

9. Use and get big pictures: Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

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.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

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.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

Please carefully note down following rules and regulation before submitting your Research Paper to Global Journals Inc. (US):

Segment Draft and Final Research Paper: You have to strictly follow the template of research paper. If it is not done your paper may get rejected.

- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.

- Do not give permission to anyone else to "PROOFREAD" your manuscript.

- Methods to avoid Plagiarism is applied by us on every paper, if found guilty, you will be blacklisted by all of our collaborated research groups, your institution will be informed for this and strict legal actions will be taken immediately.)
- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

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Topics	Grades		
	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

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