Online ISSN: 2249-4626
Print ISSN: 0975-5896

Global Journal

of Science Frontier Research: D

Agriculture and Veterinary

Test Cross Performance

Combining Ability of Maize

Highlights

Coastal Farmers Perception

Contract Farming in Sugarcane

Discovering Thoughts, Inventing Future

VOLUME 15 ISSUE 4 VERSION 1.0

Global Journal of Science Frontier Research: D
Agriculture & Veterinary

Global Journal of Science Frontier Research: D
Agriculture & Veterinary
Volume 15 Issue 4 (Ver. 1.0)

Open Association of Research Society

Incorporation No.: 0423089
License No.: 42125/022010/1186
Registration No.: 430374
Import-Export Code: 1109007027
Employer Identification Number (EIN):
USA Tax ID: 98-0673427

Global Journals Inc.

*(A Delaware USA Incorporation with "Good Standing"; **Reg. Number: 0423089**)*

Sponsors: Open Association of Research Society
Open Scientific Standards

Publisher's Headquarters office

Global Journals Headquarters
301st Edgewater Place Suite, 100 Edgewater Dr.-Pl,
Wakefield MASSACHUSETTS, Pin: 01880,
United States of America
USA Toll Free: +001-888-839-7392
USA Toll Free Fax: +001-888-839-7392

Offset Typesetting

Global Journals Incorporated
2nd, Lansdowne, Lansdowne Rd., Croydon-Surrey,
Pin: CR9 2ER, United Kingdom

Packaging & Continental Dispatching

Global Journals
E-3130 Sudama Nagar, Near Gopur Square,
Indore, M.P., Pin:452009, India

Find a correspondence nodal officer near you

To find nodal officer of your country, please email us at *local@globaljournals.org*

eContacts

Press Inquiries: *press@globaljournals.org*
Investor Inquiries: *investors@globaljournals.org*
Technical Support: *technology@globaljournals.org*
Media & Releases: *media@globaljournals.org*

Pricing (Including by Air Parcel Charges):

For Authors:
22 USD (B/W) & 50 USD (Color)
Yearly Subscription (Personal & Institutional):
200 USD (B/W) & 250 USD (Color)

Integrated Editorial Board
(Computer Science, Engineering, Medical, Management, Natural Science, Social Science)

Dr. Bart Lambrecht
Director of Research in Accounting and FinanceProfessor of Finance
Lancaster University Management School
BA (Antwerp); MPhil, MA, PhD (Cambridge)

Dr. Carlos García Pont
Associate Professor of Marketing
IESE Business School, University of Navarra
Doctor of Philosophy (Management), Massachusetts Institute of Technology (MIT)
Master in Business Administration, IESE, University of Navarra
Degree in Industrial Engineering, Universitat Politècnica de Catalunya

Dr. Fotini Labropulu
Mathematics - Luther College
University of ReginaPh.D., M.Sc. in Mathematics
B.A. (Honors) in Mathematics
University of Windso

Dr. Lynn Lim
Reader in Business and Marketing
Roehampton University, London
BCom, PGDip, MBA (Distinction), PhD, FHEA

Dr. Mihaly Mezei
ASSOCIATE PROFESSOR
Department of Structural and Chemical Biology, Mount Sinai School of Medical Center
Ph.D., Etvs Lornd University
Postdoctoral Training,
New York University

Dr. Söhnke M. Bartram
Department of Accounting and FinanceLancaster University Management SchoolPh.D. (WHU Koblenz)
MBA/BBA (University of Saarbrücken)

Dr. Miguel Angel Ariño
Professor of Decision Sciences
IESE Business School
Barcelona, Spain (Universidad de Navarra)
CEIBS (China Europe International Business School).
Beijing, Shanghai and Shenzhen
Ph.D. in Mathematics
University of Barcelona
BA in Mathematics (Licenciatura)
University of Barcelona

Philip G. Moscoso
Technology and Operations Management
IESE Business School, University of Navarra
Ph.D in Industrial Engineering and Management, ETH Zurich
M.Sc. in Chemical Engineering, ETH Zurich

Dr. Sanjay Dixit, M.D.
Director, EP Laboratories, Philadelphia VA Medical Center
Cardiovascular Medicine - Cardiac Arrhythmia
Univ of Penn School of Medicine

Dr. Han-Xiang Deng
MD., Ph.D
Associate Professor and Research
Department Division of Neuromuscular Medicine
Davee Department of Neurology and Clinical NeuroscienceNorthwestern University
Feinberg School of Medicine

Dr. Pina C. Sanelli
Associate Professor of Public Health
Weill Cornell Medical College
Associate Attending Radiologist
NewYork-Presbyterian Hospital
MRI, MRA, CT, and CTA
Neuroradiology and Diagnostic Radiology
M.D., State University of New York at Buffalo,School of Medicine and Biomedical Sciences

Dr. Roberto Sanchez
Associate Professor
Department of Structural and Chemical Biology
Mount Sinai School of Medicine
Ph.D., The Rockefeller University

Dr. Wen-Yih Sun
Professor of Earth and Atmospheric SciencesPurdue University Director
National Center for Typhoon and Flooding Research, Taiwan
University Chair Professor
Department of Atmospheric Sciences, National Central University, Chung-Li, TaiwanUniversity Chair Professor
Institute of Environmental Engineering, National Chiao Tung University, Hsin-chu, Taiwan.Ph.D., MS The University of Chicago, Geophysical Sciences
BS National Taiwan University, Atmospheric Sciences
Associate Professor of Radiology

Dr. Michael R. Rudnick
M.D., FACP
Associate Professor of Medicine
Chief, Renal Electrolyte and Hypertension Division (PMC)
Penn Medicine, University of Pennsylvania
Presbyterian Medical Center, Philadelphia
Nephrology and Internal Medicine
Certified by the American Board of Internal Medicine

Dr. Bassey Benjamin Esu
B.Sc. Marketing; MBA Marketing; Ph.D Marketing
Lecturer, Department of Marketing, University of Calabar
Tourism Consultant, Cross River State Tourism Development Department
Co-ordinator , Sustainable Tourism Initiative, Calabar, Nigeria

Dr. Aziz M. Barbar, Ph.D.
IEEE Senior Member
Chairperson, Department of Computer Science
AUST - American University of Science & Technology
Alfred Naccash Avenue – Ashrafieh

President Editor (HON.)

Chief Author (HON.)

Dr. R.K. Dixit
M.Sc., Ph.D., FICCT
Chief Author, India
Email: authorind@computerresearch.org

Dean & Editor-in-Chief (HON.)

Contents of the Issue

Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 15 Issue 4 Version 1.0 Year 2015
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Test Cross Performance and Combining Ability of Maize (*Zea Mays L.*) Inbred Lines at Bako, Western Ethiopia

By Girma C. Hosana, Sentayehu Alamerew, Berhanu Tadesse & Temesgen Menamo

Jimma University, Ethiopia

Abstract- Information on combining ability and heterotic grouping for newly developed inbred lines is of paramount importance to design future breeding strategies for the development of hybrid and synthetic varieties. The objectives of the present study were to examine combining ability and to determine heterotic groups of the inbred lines for grain yield and other desirable traits. Twenty five inbred lines were used for the formation of the experimental crosses using line x tester mating design. The resulting 50 F1 crosses plus two standard checks (BH540 and BH543) were evaluated at Bako, Western Ethiopia in 2012 main cropping season. The entries were arranged in alpha lattice design with three replications.

Keywords: *SCA, GCA, hetrotic group.*

GJSFR-D Classification : *FOR Code: 820401*

Strictly as per the compliance and regulations of :

Test Cross Performance and Combining Ability of Maize (*Zea Mays L.*) Inbred Lines at Bako, Western Ethiopia

Girma C. Hosana [α], Sentayehu Alamerew [σ], Berhanu Tadesse [ρ] & Temesgen Menamo [ω]

Abstract- Information on combining ability and heterotic grouping for newly developed inbred lines is of paramount importance to design future breeding strategies for the development of hybrid and synthetic varieties. The objectives of the present study were to examine combining ability and to determine heterotic groups of the inbred lines for grain yield and other desirable traits. Twenty five inbred lines were used for the formation of the experimental crosses using line x tester mating design. The resulting 50 F1 crosses plus two standard checks (BH540 and BH543) were evaluated at Bako, Western Ethiopia in 2012 main cropping season. The entries were arranged in alpha lattice design with three replications. Data on grain yield, other agronomic traits and disease reactions were recorded under field condition. The highest grain yield was recorded from L24 x T1 (CML312/CML442) (9.97 t ha-1). The analysis due to mean squares for crosses was highly significant for all traits except for plant aspect, ear per plant, and number of plants per plot, and thousand kernel weights indicating the existence of genetic variability for all traits. GCA of line was significant for grain yield, agronomic traits and disease severity index. The mean square due to SCA for line by tester combinations were also significant for grain yield, stalk lodging, root lodging, ear rot, husk cover, maturity date, 50% silking day, and Turcicum leaf blight. Significant GCA and SCA effects were indicative of the importance of both additive and non additive gene effects in the control of the traits. However, in all traits, the proportion of GCA sum of square was higher than SCA sum of squares indicating the preponderance of additive gene effects in the control of all traits. Based on the SCA of crosses, the two testers used in this study successfully classified nine out of 25 tested inbred lines into two heterotic groups, A and B: six inbred lines belong to heterotic group A, while the remaining three belong to heterotic group B. These two group can be maximized hetrosis by crossing inbred lines belonging to different heterotic groups/unrelated strains.

Keywords: SCA, GCA, hetrotic group.

I. Introduction

Maize (*Zea mays* L.; 2n =20) is an important cereal crop of the world, belonging to the tribe Maydeae of the grass family *Poaceae.* It has great worldwide significance as human food, animal feed and as a source of hundreds of industrial products. Apart from the manufacture of mixed feed, maize products include maize starch, maltodextrins, maize oil syrups of the large milling industry, and well-known products of the fermentation and distilling industries (Troyer 2004).

As the cultivation of early maize spread to different geographical regions from Mexico and Central America, where maize is widely believed to have originated, there was a rapid evolution of many races adapted to a wide variety growing conditions. It was introduced to West Africa in the early 1500s by Portuguese traders and then to Ethiopia during the 1600s and 1700s (*Dowsell et al. 1996*).

Cereals are the major crops produced in the country and they constitute the largest share of domestic food production. In 2011/12 main cropping season, cereals were cultivated on 9.6 million hectares producing 188.1 million Qt of food grains (CSA 2012). This represented 79.34% and 86.05% of the total area and production of food grains in the country, respectively. Among cereals, maize ranked second to *tef* in area coverage, and first in total production and productivity. Although it is one of the strategic crops for the achievement of food security in the country, more than 90% of the production is handled by small-scale farmers under rain-fed growing condition (CSA 2012).

Maize constitutes a major food source for the majority of the Ethiopian population, being the second most important cereal crop in area and first in total production in Ethiopia (CSA 2012).The per capital consumption of maize of maize in Ethiopia is about 60kg per annum; however, the level of consumption varies from place to place. In major maize producing areas, maize is staple food, and in other areas it is used in mixtures with other food grains (Mosisa et al. 2011).

Since 1952 maize research has been ongoing at different capacities to generate and recommend improved technologies for maize production. With the dissemination and utilization of improved maize technologies by the farmers, the national average yield has been increasing starting in late 1990s. Even though, the current average national maize yield of Ethiopia, 2.95 tones ha-1 (CSA 2012), is better than the national yield of many African countries; it is still low compared to that of the world, China, and that of United States with average annual yield of 5.1, 5.6, and 9.7 tones ha-1, respectively(FAOSTAT 2008). This is due mainly due to

Author α σ ω: Jimma University College of Agriculture and Veterinary Medicine, P.O.Box:307, Jimma, Ethiopia.
e-mail: temesgen2008@hotmail.com
Author ρ: Bako Agricultural Research Centre, Bako, Ethiopia.

the poor adoption of improved technologies by the predominantly small scale maize farmers', shortage of high yielding varieties, biotic and abiotic stresses (Mosisa *et al*. 2011). This indicates the need to develop high yielding maize varieties that perform well under both stress and non-stress conditions. In order to achieve this, potentially suitable parents and superior combinations must be identified.

During the early stages of maize breeding in Ethiopia, the main focus was the development of open pollinated varieties (OPVs) (Benti *et al.* 1993; Kebede et al. 1993). This was mainly due to the assumption that small-scale farmers did not have the skill required to manage hybrid maize (Gebre *et al.* 2002), unavailability of improved germplasm locally for hybrid development, lack of experience in hybrid development and absence of seed producers. Later, the high yield realized on the state farms with hybrids imported from Kenya, Zimbabwe and Malawi in the early 1980s together with high yield potential recorded from some experimental hybrids in the research centers convinced the breeders to go for wide development and testing of maize hybrids locally. This led to a shift in the breeding strategy from development of only OPVs to development of both hybrids and OPVs in the early 1980s, today, both hybrids and OPVs of different maturity groups are the main focus of the national maize research strategy, particularly for the mid-altitude and highland sub-humid maize growing areas of Ethiopia (Mosisa et al. 2011).

Development and release of maize varieties have been an eminent phenomenon in breeding programs mainly to accommodate a range of weather conditions, varying disease prevalence, and volume and distribution of rainfall. The main focus in this case is to come up with more advanced varieties than the existing ones in many aspects (Mosisa *et al.* 2011). Maize improvement involves formation, evaluation, selection, and recombination of genetically variable families or inbred lines (Pixley et al. 2006). Test cross performance of experimental lines is the prime selection criterion in hybrid breeding of maize (Mihaljevic *et al*. 2005). With a common tester, differences among the crosses are generally assumed to arise from genetic variability among the S0 plants or inbred lines crossed on to it (Genter and Alexander 1965). The superior individual lines identified after crossing with a tester can be inbred for potential use as a cross pollinated cultivar or as a parent of synthetic or hybrid cultivar (Fehr 1987). This could be achieved through ecological based development of superior inbred lines and identification of their best hybrid combinations.

Different methods of inbreeding are employed for the development of inbred lines, ear-to-row being the common method of inbred line development. The resulting inbred lines are used in the hybrid breeding program or for the development of synthetic (OPV) varieties. For such use, information on the performance of the inbred lines, both per se and cross, is very crucial. Usually, the inbred lines are evaluated for their per se performance, a yield potential, resistance to major foliar diseases and flowering characteristics. At Bako National Maize Research Program, Ethiopia, the first cross performance of the materials (early test cross) is done when the inbred lines reach the S3 stage. At this stage, the inbred lines are crossed to the common testers of known heterotic groups (A and B) and the resulting test cross progenies are evaluated in multi-location trials. Finally, inbred lines with good cross performance are selected for further advancement and classified into heterotic group for further use in the breeding program.

In maize breeding program, analysis of general combining ability (GCA), specific combining ability and heterosis would help to identify best inbred lines for hybrid development and hybrid combinations for better specific combining ability. Combining ability is an effective tool which gives useful genetic information for the choice of parents in terms of their performance in series of crosses (Sprague and Tatum 1942). The development of populations with high combining abilities has a fundamental role in the efficient use of heterosis (Vasal *et al.* 1992). Therefore, germplasm evaluation is a decisive aspect in maize breeding programs.

Line x tester is useful in deciding the relative ability of female and male lines to produce desirable hybrid combinations (Kempthorne 1957). It also provides information on genetic components and enables the breeder to choose appropriate breeding methods for hybrid variety or cultivar development programmes. Information on combining ability effects helps the breeder in choosing the parents with high general combining ability and hybrids with high specific combining.

So far, combining ability effects in maize and heterotic classification of inbred lines has been extensively studied in Ethiopia for different sets of new inbred lines developed/introduced and adapted at different times(Nigussie and Zelleke 2001; Bayisa *et al.* 2005; Dagne *et al.* 2007; CIMMYT-Zimbabwe 2008; Worku *et al.* 2008). It is always mandatory for any breeding program to generate such information for any new batch of inbred lines generated or received outside of the program. Understanding the relative importance of general (GCA) and specific combing ability effects for different traits for newly developed inbred lines is of paramount importance to design future breeding strategies for the development of hybrid and/or synthetic varieties. The heterotic classification will also assist in determining the relationship existing among the different inbred lines.

Currently, at Bako National Maize Research Center there are a number of new batches of inbred lines generated through different methods of inbred line development. So far, little or no information is available

on these particular set of new inbred lines on their specific and general combing ability effects. Furthermore, these inbred lines are not grouped into the known heterotic groups. Therefore, keeping in view the above this study was conducted with two objectives: a) to estimate the general and Specific combining ability (GCA) of the new inbred lines of crosses for grain yield and other agronomic traits using Line x Tester mating design; and b) to classify the new inbred lines into different heterotic groups for future use in the breeding program.

II. Materials and Methods

a) Description of Experimental Sites

The study was conducted at Bako Agricultural Research Centre, Western Ethiopia, in 2012 main cropping season. The centre is located 250 kilometres west of Addis Ababa. The locations represent sub-humid and mid-altitude maize growing mega-environments of sub-Saharan Africa (White *et al*. 2001).The site lies between 9°06' N latitude and 37°09' E longitude at an altitude of 1650 m.a.s.l. The soil of the centre is reddish brown clay (nitosol) with pH of 6.0 and 5.9 for top soil (0 – 30cm) and sub-soil (30 – 60cm), respectively. The total precipitation during the growing season (May to November 2012) was 828.5 mm, and the mean minimum and maximum temperatures were 14.4.1°C and 26.8.0°C, respectively. The long term total annual rainfall is 1245 mm, with mean, minimum and maximum temperatures of 13.5°C and 28°C, respectively.

b) Experimental Materials

The experiment consisted of 52 maize crosses (including 50 test crosses formed by crossing 25 inbred lines to two testers in line x tester mating design in 2011) and two standard checks (BH543 and BH540). The inbred lines were developed at Bako Agricultural Research Center from available germplasm using ear-to-row and backcross inbred line development approaches. The two testers used; CML312/CML442 (Tester 1) and CML395/CML202 (Tester 2) are single crosses and obtained from CIMMYT. They are developed from commercial CIMMYT Maize Lines (CMLs) of known heterotic groups; viz. CML312 and CML442 are heterotic group A while CML395 and CML202 are heterotic group B. These single cross testers are commonly used by CIMMYT and many other national maize research programs in Africa (Dagne *et al*. 2008).

The most important stresses against which the inbred parents of the testers were selected include diseases (grey leaf spot, leaf rust and turcicum leaf blight), low nitrogen, high density and drought. The lines x tester crosses were made at Bako Agricultural Research Center during the off-season of 2011/12. BH543 and BH540 are commercial maize hybrids released for the mid-altitude and sub-humid maize agro-ecology of Ethiopia. BH543 is a three way-cross commercial hybrid released by Bako National Maize Research Project in 2005. It is a medium maturing hybrid that takes about 145 days for grain maturity at Bako and similar environments. The hybrid is a high yielding, tolerant/resistance to major maize diseases known in the country and well adapted to mid-altitude environments (1000-1700 m.a.s.l) receiving high rainfall. The other check BH540 is a popular single cross commercial hybrid released by the same center in 1995. It is a medium maturing hybrid that matures in about 140 days at the adaptation areas of BH543.

c) Experimental Design and Field Management

A total of 52 entries, the 50 three way crosses plus two hybrid checks adapted to the mid-altitude agro ecology of Ethiopia were planted using alpha lattice (0, 1) design (Patterson and Williams 1976) with four plots per an incomplete block and 13 incomplete blocks in each three replicates. Each entry was placed in a two-row plot of 5.1 m long and 0.75 m apart with 0.3 m between plants.

Trial was hand planted with two seeds per hill, which was later be thinned to one seed per hill to get a total plant population of 44, 444 per hectare. Planting was done in the rainy season the 4th of June, 2012 after reliable moisture level of soil attained to ensure good germination and seedling development. All agronomic practices were done as per the recommendation for Bako research centre.

d) Statistical analysis and procedures

Data Collected and analysis of Variance: Data were recorded on seventy different traits included: Days to 50% taselling, Days to 50% silking, Days to 50% maturity, Ear rot percent, Husk covers percent, Grain yield, Ear height, Plant height, Disease score, Number of ears per plant, Ear aspect, Ear length, Ear diameter, Stalk lodging percent, Root lodging percent, Number of rows per ear and Number of kernels per row. Disease score and Ear aspect, were recorded visually and scale (1-5). Analysis of variance for all parameters studied was computed using the PROC MIXED procedure and test for significance differences among the genotypes was performed using SAS software (SAS 2008).

Combining ability analysis: Line x tester analysis was done for traits that showed statistically significant differences among crosses using the adjusted means based on the method described by Kempthorne (1957). General combining ability (GCA) and specific combining ability effects for grain yield and other agronomic traits were calculated using line x tester model using SAS software.

Classification of the inbred lines into different heterotic group: Classifying maize inbred lines into heterotic groups is the initial step in maize breeding program

which would provide maximum exploitation of heterosis. Systematic studies on classifying inbred lines into heterotic groups have been reported (Vasal et al. 1992). Melchinger (1999) proposed that when large number of inbred lines is available and proven testers exist, the performance of the lines in test crosses with proven testers can be used as a main criterion for grouping of lines. Vasal *et al. (1992*) used this approach in evaluating the performance of test crosses of 92 tropical and 88 subtropical maize lines using two dent and two flint line testers. On the basis of ANOVA and SCA effect for grain yield of the testcrosses was used to classify the inbred 25 lines into two heterotic groups. An inbred line that expressed negative SCA effects when crossed to a certain tester implied that the inbred line belongs to the same heterotic group with the tester. On the other hand, if the same line manifests positive SCA effect with the same tester, it is classified into opposite heterotic group (Vasal *et al. 1992*).

III. Results and Discussions

a) Analysis of Variance

Analysis of variance showed highly significant differences (P<0.01) among tested materials for all the traits except for number of plants, number of ear per plant, plant aspect and thousand kernel weight (Table 1). The existence of highly significant differences for all traits indicates the presence of inherent variation among the materials, which makes selection possible. In support of the present finding, earlier studies reported significant differences among genotypes for Grain yield tons per hectare (YLDT) and YLDT related traits in different sets of maize genotypes (Tuna 2004; Dagne *et al.* 2007; Nepir 2007).

In addition, highly significant differences were observed among entries for grey leaf spot (GLSSID) and Turcicum leaf blight (TLBSID), indicating the variable reaction of the tested genotypes against the two diseases. The use of inbred lines from diverse sources of germplasm for generation of the crosses might have contributed to the significant difference observed among crosses for most of the traits considered. Similarly, Worku et al. (2008) and Legesse et al. (2009) reported significance difference in the genotypes they tested in combining ability study of maize inbred lines.

Table 1 : Mean squares of genotype and error for grain yield and other related traits in 25x2 lines by tester cross of maize at Bako (2012/13)

So.var	DF	DT	DS	MD	PH	EH	NP	PA
Rep	2	14.54**	9.31**	128.58**	1021.43**	535.55**	0.04	0.64
B(Rep)	36	1.14	2.21**	2.11	128.22**	72.41*	1.22	0.12
ENTRY	51	2.14**	2.33**	3.33**	301.68**	304.63**	1.37	0.12
ERROR	66	0.76	0.67**	1.30441	110.65**	63.79**	0.95	0.09
So.var	DF	ERP	ERP+	HCP	HCP+	TLBSID	TLBSID+	EL
Rep	2	0.61	0	0.5	0.0002	2.56	0.0003	1.99*
B(Rep)	36	1.90*	0.001	2.58*	0.001	204.94*	0.0246*	1.67*
ENTRY	51	6.20**	0..013	67.66**	0.036**	264.37**	0.0309**	3.55**
ERROR	66	1.16	0.001	1.92	0.0009	120.86	0.0143	1.47
So.var	DF	SLP	SLT+	RLP	RLP+	EA	YLDT	
Rep	2	3.33*	0.001	4.12*	0.002*	0.03	2.93**	
B(Rep)	36	2.66*	0.001	2.35*	0.001*	0.06*	0.31*	
ENTRY	51	50.31**	0.026**	23.78**	0.012**	0.31**	1.63**	
ERROR	66	2.19	0.001	2.88	0.001	0.07	0.38	
So.var	DF	GLSSID	GLSSID+	NEP	ED	NRE	TKW	
Rep	2	4863.56**	0.59**	0.06	0.002	0.03*	10932.7	
B(Rep)	36	246.79	0.03	1.12	0.066**	0.76	3306.61	
ENTRY	51	549.36**	0.07**	1.23	0.052**	1.31**	3804.59	
ERROR	66	175.91	0.02	0.87	0.027	0.51	3751.84	

+Traits with transformed data

**=significant at 0.05 probability level, **=significant at 0.01 probability level*

DT=day of 50% tassiling, DS=days of 50% silking, MD =Maturity date, PH=Plant height, EH=Ear height, NP=number of plant per plot, PA=Plant aspect, ERP= ear rot percent, HCP=husk cover percent, TLBSID=Turcicum leaf blight severity index, EL=Ear length; SLP=stalk lodging percent, RLP= root lodging percent, EA=Ear aspect, YLDT=Grain yield tones per hectare, GLSSID=Gray leaf spot severity index, NEP= number ear per plot, ED=Ear diameter, NRE=Number of kernel rows per ear, TKW=Thousand kernel weight

b) Mean performance of crosses and checks

Grain yield (YLDT): The mean grain yield (YLDT) for genotypes tested under this experiment ranged from 6.8 t ha-1 (L1xT1) to 9.97 t ha-1 (L24xT1) with a mean value of 8.23 t ha-1 (Appendix 1). Among the crosses, 33 crosses showed significantly higher yield than the hybrid check BH540 and 26 crosses revealed significantly higher yield than the check hybrid BH 543. The best 11

crosses with yield advantages of 25% over the best check hybrid were L24xT1, L22xT1, L19xT2, L18xT1, L24xT2, L2xT2, L18xT2, L17xT1 L20xT1, L21xT1 and L22xT2.

Fifty percent tasseling(TD) and silking days(SD): The number of days to 50% tasseling ranged from 79.00 days (L3xT1) to 82.67 days (L24xT1) with overall mean of 81.04 days (table 2). Cross L24xT1 was late in tasseling and scored the longest day and became the highest yielder (9.97 t/ha) which could be due to high photosynthetic product accumulation during the longer growing period. The trait days to 50 percent silking showed a similar variation pattern with days to tasseling and ranged from 81 days (L7xT1, L8xT2 and L3xT1) to 84.67 days (L24xT1 and L17xT2). Crosses L3xT1, L7xT1 and L8xT2 had similar silking dates with that of hybrid check BH540. The rest 47 crosses revealed significantly higher days to silking as compared to hybrid check BH540. Crosses L3xT1, L7xT1 and L8xT2 were significantly earlier in silking than the check hybrid BH543.

Maturity days (MD): The days to maturity ranged from 147.67 (L6xT2 and L15xT2) to 153.33 days (L22xT1). Crosses L6xT2, L15xT2, L6xT1, L9xT2, and L8xT1 were earlier and showed similar maturity date to that of the check hybrid BH540. Twenty seven crosses showed significantly late maturity date when compared to the check hybrid BH540 while 23 crosses had similar maturity date as that of BH-540. Six crosses viz., L17xT1, L18xT2, L21xT1, L22xT2, L22xT1 and L24xT2 showed significantly late maturity date than hybrid check BH543 while L6xT1, L6xT2 andL15xT2 were significantly earlier than BH543 (Table 4). From the tested crosses, 41 crosses had similar maturity dates with hybrid check BH543. In this study, crosses with late maturity dates showed long days to tassling as well as long days to silking day with longer anthesis silking interval and this might contributed to the late maturing of the crosses, while on contrary crosses with earlier anthesis and silking with shorter anthesis silking interval showed earlier maturity. Late maturing crosses could be used in breeding programs for the development of genotypes and better performing hybrids could be released for areas receiving sufficient precipitation for more than 155 days. Early maturing crosses also could be used for the development of early maturing varieties.

Plant Height (PH): The mean value for plant height ranged from 252.67 cm (L5xT1) to 299.33 cm (L17xT1) and the mean PH was 274.26 cm. Twenty five crosses exhibited significantly higher plant height than check hybrid BH543, while 15 crosses had similar plant height to BH543. From the tested crosses, 13 crosses were significantly taller than the check hybrid BH-540 while 37 crosses exhibited similar plant height to BH-540. In this study, crosses that showed significantly higher plant height gave higher grain yield, which could be attributed to high photosynthetic products accumulation during long period for grain filling. Crosses L21xT1, L2xT2, L19xT2, and L20xT1 were in the range of high yielding crosses with intermediate height which is desirable in this particular trait.

Ear height (EH): L11xT1 was the cross with the lowest EH (126.33 cm) while L20xT2 had manifested the highest ear height (174.33cm). The mean EH for all genotypes was 145.33 cm. Among all the tested genotypes, 13 crosses exhibited significantly higher ear placement than the check hybrid BH540 while crosses L11xT1, L8xT1, L6xT1 and L9xT2 showed significantly lower ear height. Fourteen crosses showed significantly higher ear height than check hybrid BH543, while only L11xT1 cross showed significantly lower ear height. Crosses L2xT2 and L21xT1, which were among the top grain yielding hybrids, showed intermediate ear height. Plant and ear heights are the major concern to plant breeders since plants with increased ear and plant heights are vulnerable to lodging and hence yield reduction. Therefore, the variability existed in the tested crosses could help in the improvement of these traits. But it is evident that farmers use the maize Stover for different alternative uses like fire wood, fencing and livestock feed. In particular, farmers in crop-livestock mixed farming systems use the maize stover as animal feed and they usually prefer taller plants than shorter one to get large biomass. While trying to respond to the needs of farmers, care should be taken not to introduce taller varieties that are susceptible to lodging into the farming system where lodging is prevalent due to the occurrence of heavy wind.

Stalk lodging Percentage (SLP): L20xT1, L4xT2, L7xT2, L23xT1, L4xT1 and L19xT1 were crosses that manifested no stalk lodging (0%) while L15xT2 was most affected by stalk lodging (26.28%). The overall mean for this trait was 4.38%. Nine crosses showed significantly higher percentage of lodging to both hybrid checks, while 7 crosses exhibited significantly lower percent lodging. Among the tested crosses, six crosses scored 0% stalk lodging, which is a desirable feature that have been contributed either by the line or tester or due to the expression of hybrid vigor. The standard checks BH540 and BH543 exhibited stalk lodging percentage of 4.20 and 4.17, respectively.

Root lodging percentage (RLP): The mean for root lodging was 4.56% with minimum and maximum values of 0.0% (L21xT1) and 19.79% (L25xT1), respectively. Hybrid L25xT1 showed significantly higher root lodging to check hybrid BH540 and BH543. Among tested crosses, 49 showed significantly lower root lodging to BH540 and 43 crosses revealed significantly lower root lodging to BH543. L24xT1, L4xT1, L5xT2 and L2xT1 showed low percent root lodging next to L21xT1. The check hybrids, BH540 (11.69%) and BH543 (9.38%)

exhibited higher percent lodging next to cross L25xT1 (19.79%).

Ear aspect (EA): it is the visual evaluation of harvested ears for general performance with regard to diseases and uniformity. Ear aspect was scored on 1-5 scale and the mean values ranged from 1.33 for L18xT2, L19xT2, and L22xT1 to 2.5 for L9xT1 with overall mean of 2.08. Crosses L18xT2, L19xT2, L22xT1, L22xt2, L21xT2, L24XT2, L23xT2, L24xT1 and L19xT1 showed significantly lower score (1.33 to 1.5). They exhibited significantly lower score for trait crosses is in the desirable direction which implied these crosses showed clean, uniform, large and well filled ears and could be promoted to the next stage of trial evaluation if they are high yielding and have performed well in other traits. However, the check hybrids BH540 and BH543 showed intermediate score of 2.5 and 2.17, respectively.

Ear rot percentage(ERP): Mean ER value ranged from 0.0% for L18T2, L22xT2, L21xT2, L17xT2, L20xT1, L16xT2, L7xT2, L23xT1, L6xT1 and L19xT1 to 6.22% for L4XT2 with the overall mean of 2.27%. Among the tested crosses, 21 showed significantly higher ear rot percent to the hybrid BH540 while 4 crosses were significantly higher in ear rot percent to hybrid check BH543. In addition, 33 crosses showed significantly lower score as compared to BH543. These shows there are promising materials that are less affected by ear rot as compared to the standard checks. Based on their yield and overall performance, these materials could be advanced to advanced stages of trials to confirm their performance across locations and years.

Husk cover percentage (HCP): Poor husk cover, increases the susceptibility of genotypes for ear rot and field infestation of weevil before harvest. Generally, materials with good husk cover could promote to the next stages of trial evaluation. In the current study, mean values for husk cover ranged from 0.0% (L10xT1, L10xT2, L11xT1, L25xT2, L24xT2, L1xT2, L18xT2 and L2xT2) to 24.16% (L3xT2). The mean value for husk cover was 5.19%. Four crosses scored significantly higher percent while 46 crosses showed significantly lower husk cover percent to hybrid BH540. Among the tested crosses, 23 exhibited higher score while 27 crosses showed significantly lower husk cover percent when compared to check hybrid BH543. In this experiment, entries that manifested the highest husk cover percentages are the ones that showed the highest score for ear rot.

Turcicum leaf blight severity index (TLBSI): The mean values scored for TLBSI ranged from 20% for L13xT2 to 72% for L17xT1 with mean value of 35.82% severity index. The level of infection varies from slight to sever leaf infection and none of the entries showed complete resistant to *Turcicum* leaf blight. The low severity was recorded for L13xT2, L10xT1, L8xT1, L4xT1, L6xT1, and L9xT1 with severity percent of 20, 21.33, 22.67, 22.67, 24.00 and 25.33, respectively. From the tested crosses 16 crosses showed significantly higher leaf infection when compared to hybrid check BH540 while 24 crosses exhibited similar in reaction to TLBSI. BH-543 showed severe index (61.33%) while, BH-540 showed moderate severity index (22.67%). The highest index for BH543 is because of the susceptibility of one of its parents for *turcicum* leaf blight. As a result of that, this variety is also affected by this disease when grown in trurcicum hot spot areas. There is a need for proper positioning of this variety in order to avoid the growing of it in areas where the occurrence of the disease is high.

Gray leaf spot severity index (GLSSI): Mean value of GLSSI ranged from 20% for L18xT2 to 78.67% for L16xT1. Over all mean value for the trait was 35.24%. Among the tested crosses, 10 crosses showed significantly higher severity index percent due to grey leaf spot when compared to hybrid check BH540. The only cross showed significantly higher GLSSI was L16xT1while 15 crosses revealed significantly lower GLSSI when compared to BH543. Crosses L18xT2, L22xT2, L25xT1, L21xT1, L7xT2, L5xT2 and L11xT2 revealed relatively low leaf infection and could be used in the development of resistant genotypes against grey leaf spot. Check hybrid BH543 (45.33%) exhibited high leaf infection above the overall mean (35.24%). Therefore, care should be exercised not to grow this variety in areas where the incidence of occurrence of both *Turcicum* leaf blight and gray leaf spot is high.

Ear length (EL): Of all the genotypes tested, L19xT2 attained the maximum ear length (21.3 cm) while L1xT2 was genotypes with shortest ear length (16.6 cm). The overall man for all the genotypes evaluated was18.62 cm. Among all crosses, 16 showed significantly higher ear length as compared to BH540. Among the tested crosses, L19xT2, L19xT1, L20xT1 and L24xT2 showed significantly higher ear length compared to BH543 while L1xT2and L25xT2 exhibited lower ear length. Crosses L19xT1, L24xT2, L20xT1 and L19xT2 were crosses with the best ear length and are among the 11 best crosses with larger ear length.

Ear diameter(ED): L25xT2 manifested the highest ear diameter (5.17cm) of all the genotypes studied. On the other hand, L14xT2 has shown the least ear diameter of 4.47cm. The average ear diameter for all the genotypes included in this study was 4.79 cm. L25xT2, L3xT2, L25xT1, L17xT2 and L18xT2 showed significantly higher ear diameter than BH540 while 13 crosses exhibited higher ear diameter than BH543.

Number of kernels row per ear (NKRE): NKRE was a significant difference between crosses. It varies from 13.07 to 16.67 with average 14.46. The minimum NKRE was recorded from L14xT2 cross and the maximum was from L23xT2 cross.

Number of kernel per row (NKR): The number of kernels per row ranged from 36.60 (L25xT2) to 47.00 (L20xT2) and had mean value of 41.24 for the trait. Out of 50 crosses tested, 21 showed significantly higher number of kernels per rows when compared with BH540 while 9 crosses showed significantly higher NKR when compared with BH543. The two check hybrids, BH540 and BH543 showed 38.07 and 39.73 kernels per row which was below the overall mean (41.24) of tested genotypes.

A number of crosses showed better performances for more than one trait as compared to the best hybrid check used in the study. Therefore, crosses that had high grain yield could be used in the breeding program to improve the grain yield and other traits of interest. Similarly, hybrids that were late in anthesis and silking, longer in ear and plant heights could be used as sources of genes for development of late maturing and longer statured varieties. In agreement with the present results, investigators in their studies identified experimental varieties performing better than the best check for most yield and related traits (Nepir 2007; Wegary et al. 2010).

Table 2 : Mean Minimum, Maximum, CV (%) and F-test values of grain yield and related traits evaluated

Traits	MEAN	MIN	MAX	CV (%)	LSD (5%)	F-test
TD	81.04	78.67	82.67	1.08	1.43	**
SD	82.60	79.67	84.67	0.99	1.34	**
MD	150.22	147.67	153.33	0.76	1.86	**
PH(cm)	274.26	252.67	299.33	3.84	17.15	**
EH(cm)	145.33	126.33	174.33	5.50	13.02	**
SLP (%)	4.38	0.00	26.28	33.77	2.41	**
RLP (%)	4.56	0.00	19.79	37.25	2.77	**
EA(scale)	2.08	1.33	2.5	12.77	0.43	**
ERP (%)	2.27	0.00	6.23	47.32	1.75	**
HCP (%)	5.19	0.00	24.16	26.67	2.26	**
YLDT(tones)	8.23	6.80	9.97	7.50	1.01	**
TLBSI	35.82	20.00	72.00	30.69	17.92	**
GLSSI	35.24	20.00	78.67	37.63	21.62	**
EL(cm)	18.62	16.60	21.30	6.51	1.98	**
ED(cm)	4.79	4.47	5.17	3.40	0.27	**
NKRE	14.46	13.07	16.67	4.95	1.17	**
NKR	41.24	36.60	47.60	5.12	3.44	**

Traits	MEAN	MIN	MAX	CV (%)	LSD (5%)	F-test
TD	81.04	78.67	82.67	1.08	1.43	**
SD	82.60	79.67	84.67	0.99	1.34	**
MD	150.22	147.67	153.33	0.76	1.86	**
PH(cm)	274.26	252.67	299.33	3.84	17.15	**
EH(cm)	145.33	126.33	174.33	5.50	13.02	**
SLP (%)	4.38	0.00	26.28	33.77	2.41	**
RLP (%)	4.56	0.00	19.79	37.25	2.77	**
EA(scale)	2.08	1.33	2.5	12.77	0.43	**
ERP (%)	2.27	0.00	6.23	47.32	1.75	**
HCP (%)	5.19	0.00	24.16	26.67	2.26	**
YLDT(tones)	8.23	6.80	9.97	7.50	1.01	**
TLBSI	35.82	20.00	72.00	30.69	17.92	**
GLSSI	35.24	20.00	78.67	37.63	21.62	**
EL(cm)	18.62	16.60	21.30	6.51	1.98	**
ED(cm)	4.79	4.47	5.17	3.40	0.27	**
NKRE	14.46	13.07	16.67	4.95	1.17	**
NKR	41.24	36.60	47.60	5.12	3.44	**

**=significant at 0.05 probability level **=significant at 0.01 probability level a Figures in parenthesis were transformed values.*

TD=50% Tasseling days, SD=50% silking days MD =Maturity day, PH=Plant height, EH=Ear height, SLP=stalk lodging percent, RLP= root lodging percent, EA=Ear aspect, ERP= ear rot percent, HCP=husk cover percent, TLBSI=Turcicum leaf blight severity index, GLSSI=Gray leaf spot severity index, YLDT=Grain yield tones per hectare, EL=Ear length, ED=Ear diameter, NKRE=Number of kernel rows per ear, NKR=Number of kernels per row

c) *Combining Ability*

The mean squares due to crosses were partitioned into lines, testers and line by tester mean squares using the line by tester procedure (Singh and Chaudhary 1979; Dabholkar 1999). As a result, mean squares due to GCA of lines and tester, and SCA of crosses were determined (Table 3). The analysis indicated that both additive and non-additive gene effects were involved in the control of most of these traits. However, the proportion of GCA sum of squares was higher than that of SCA for all traits. This showed the greater contribution of the additive gene effects to genetic variability of the traits than the non-additive genetic variance in the crosses.

The mean squares due to GCA of line and SCA of line x tester were significant ($P<0.01$) and ($P<0.05$) respectively for grain yield (YLDT). However, mean square due to GCA of tester showed non-significant difference for grain yield. Significant GCA and SCA mean squares implied the importance of additive and non-additive gene actions in governing grain yield. In the analysis, significant GCA and SCA mean squares were observed for grain yield (table 3). In agreement with the present study, Nepir (2007) using line x tester analysis of QPM versions of early generation highland maize inbred lines and reported significant GCA mean squares due to lines at Holeta. Dagne et al. (2007) and Abakemal et al. (2011) reported the importance of both additive and non-additive gene actions in governing grain yield in maize. Legesse et al. (2009) reported significant GCA mean squares due to lines and testers and significant SCA mean squares for grain yield. On the contrary, Pswarayi and Vivek (2008) using diallel analysis among CIMMYT's early maturing maize germplsam reported significant GCA mean squares and non-significant SCA mean squares for grain yield. On the contrary, Asefa *et al.* (2008) found non-significant GCA effects for grain yield in line by tester study of transition highland inbred lines at Kulumsa. Worku *et al.* (2008) reported the mean squares due to GCA effects for grain yield to be more important than SCA effects under high-N conditions. *Legesse et al.* (2009) also found significant GCA mean squares of lines and testers and significant SCA mean squares for grain yield. Tamirat *et al.* (2014) reported that GCA Mean squares were significant, but SCA mean squares were non-significant for all traits what they were studied.

The mean square due to GCA of line and tester was significant ($P<0.01$) for GLSSI. The mean square due to SCA was significant ($P<0.05$) for TLBSI. However, GCA of line and tester and SCA for GLSSI were not significant. Similarly, Dagne *et al.* (2007) observed highly significant GCA and SCA effects for GLSSI in maize inbred lines. The contribution of GCA effects were higher than SCA effects for GLSSI in the present study as GCA contributed 80.28% and SCA contributed 19.72% of the cross sum of squares. Worku *et al.* (2008) also reported higher proportion of GCA effect as compared to SCA for GLSSI. Legesse *et al.* (2009) found highly significant SCA mean squares for GLSSI. From the results of this finding, GLSSI tolerant varieties could be developed from inbred lines having desirable GCA effects.

The mean squares due to GCA of lines for PH showed highly significant differences ($P<0.01$). However, mean square of GCA of testers and SCA of line x tester did not showed significant differences. EH the mean square due to GCA of line was highly significant differences ($P<0.01$) and GCA of tester showed significant differences ($P<0.05$) among genotypes. Similar results were reported by Leta *et al*. (1998) in Ethiopian maize composites who observed a highly significant GCA effects for both PH and EH while the SCA effect was non-significant. Worku *et al.* (2008) reported high mean square due to GCA and SCA effects under high-N.

In this study, GCA mean squares of line explained 91.29% of the variation for EH. The proportional contribution of GCA for the total variation was higher indicating the importance of additive gene effects than the non additive (table 4). Similarly, Worku *et al.* (2008) also observed higher proportion of GCA sum of squares than SCA sum squares for secondary traits (ear height and plant height) in large number of (635) CIMMYT tropical mid altitude inbred lines evaluated under contrasting nitrogen (both low and high nitrogen) environments. The highly significant ($p<0.05$) GCA observed for PH in the present study was in accordance with the findings of Sughroue and Hallauer,(1997), Dagne *et al.* (2007), and Amiruzzaman *et al.* (2010).

The mean square of GCA of line and tester for ERP did not showed significant differences. However, the mean square due to SCA of line by tester showed highly significant ($P<0.01$) differences. Non additive gene effects were found to be important for the control of ERP as manifested by a highly significant SCA effects. Worku *et al.* (2008) also observed higher proportion of GCA mean squares for ERP than SCA.

The mean square estimates due to GCA of lines for ED and EL showed highly significant differences ($P<0.01$) and significant differences ($P<0.05$) for tester ED. The result of the present study is in line with the findings of Dagne *et al.* (2007). In the present study, GCA accounted for about 81.10% of the total sum of squares for ED. This indicated the greater contribution of additive genetic portion for the total variation observed in the crosses for this trait. Several investigators reported the importance of both additive and non-additive gene effects in the inheritance of ED. Dange *et al.* (2007), Assefa *et al.* (2008) and Abdel-Moneam et al. (2009) observed highly significant GCA and SCA for ED and EL. On the contrary, Ojo *et al.* (2007) reported a non significant GCA and SCA effect for ED and EL.

Estimate of GCA effects of line and tester for NKRE revealed a highly significant ($p<0.01$) mean square and non-significant SCA effects (Table 6). The proportional contribution of line GCA sum of squares to the cross sum of squares was higher (83.07%), indicating the higher share of additive gene effects to the total variation observed in crosses for NKRE in this particular set of cross combinations. Several workers reported a significant GCA effects for the traits (Dagne *et al.* 2007; Abdel-Moneam *et al.* 2009; Amiruzzaman *et al.* 2010). Similar to the present study, Bayisa, (2005) and Dange *et al.* (2007) reported a significant GCA and non significant SCA effect for NKRE.

The mean squares due to GCA of line and SCA for SD showed highly significant differences ($P<0.01$) and non-significant difference for tester. The present finding is in agreement with the findings of Assefa *et al.* (2008). Many other authors also reported (Abebe 1983; Mulatu *et al.* 1993; Beyene 1998) reported the importance of both additive and non-additive gene effects for the control of the trait. TD or SD, the greatest share of variability observed in crosses was contributed by the GCA of lines which accounted, 70.60% for TD and 77.00 for SD of the total sum of squares. Similar to the current result, Mosisa *et al.* (2008) observed higher proportion of GCA for most of the secondary traits they studied including TD and SD.

The mean square of GCA of lines for TD) revealed significant differences ($P<0.05$). However, tester did not revealed significant differences. Mean square of GCA of line contributed 70.30% of the total sum of square. The SCA effects due to line x tester showed non- significant differences. Similarly, Wagary (2002), Bayissa (2005) Tuna (2004) and Bhatnagar *et al.* (2004) reported significance differences of mean squares due to GCA of anthesis days.

The mean square of GCA of line for maturity date (MD) showed highly significant ($P<0.01$) and showed non-significant for tester GCA effects. The mean square due to SCA of line x tester showed significant ($P<0.05$). The present finding is in agreement with the findings of Legesse *et al.* (Legesse *et al.* 2009). Many other authors also reported (Abebe 1983; Kebede *et al.* 1993; Beyene 1998; Nigusie 1999; Nigussie and Zelleke 2001) the importance of both additive and non-additive gene effects for the control of the trait. In preset study, the greatest share of variability observed in crosses was contributed by the GCA of lines which accounted, 78.7% of the total sum of squares.

The mean square of GCA of line for HCP revealed highly significant ($P<0.01$). However, GCA of tester was not significant. The mea square due to SCA for line by tester showed highly significant differences ($P<0.01$). This result is consistence with the findings of Worku *et al.* (2008) who reported the significances of GCA mean squares for secondary trait. The proportional contribution of lines GCA to the cross mean of squares was higher indicating the higher share of additive gene effects to the total variation observed in crosses for HCP in this particular set of cross combinations.

Estimate of GCA effect of line for SLP was highly significant ($p<0.01$). However, GCA of tester was not significant. The mean square of SCA due to line x tester showed highly significant ($p<0.01$). The finding is in accordance with the findings of various workers. Bhatnagar *et al.* (2004) reported the predominance of additive gene action for root lodging and the predominance of both additive and non additive gene action for stalk lodging. In this study, sum of squares explained 78.1% of the variation for SLP.

The mean square of SCA due to line x tester for RLP showed highly significant ($p<0.01$). However, GCA of line and tester did not showed significant differences. The result of present study is in agreement with Bhatnagar *et al.* (2004) who reported the predominance of additive gene action for root lodging and the predominance of both additive and non additive gene action for stalk lodging.

The estimate of GCA effects of line for NKR revealed highly significant differences (*P<0.01*). However, mean square due to GCA of tester and SCA of line x tester did not show significant differences. The present result was in agreement with Dange *et al.* (2007) who reported a non significant SCA effect for NKR in their study for heterosis and combining ability for grain yield and its components in selected maize inbred lines. Similarly, ear length showed highly significant mean square due to GCA of lines (*P<0.01*). The present study is in line with the findings of Wagary (2002) and Dagne *et al.* (2007).

The Mean square due to GCA of line for ear aspect revealed highly significant differences (*P<0.01*). However GCA of tester and SCA of line x tester did not show significant differences.

Table 3 : Mean square for GCA of lines, testers and SCA of line x tester for 17 characters in 25 x 2 line by tester crosses evaluated at Bako (2012/13)

	DF	MF	FF	MD	PH	EH	EA
Rep	2	14.54**	9.31**	128.58**	1021.43**	535.56**	0.030
Block (Rep)	36	1.140	1.46**	2.11*	128.22**	72.410	0.063
Entry	51	2.14**	2.33**	3.33**	301.68**	304.63**	0.31**
Cross	49	0.59**	1**	1.86**	146.93**	155.5**	0.14**
GCA line	24	0.85*	1.57**	2.99**	247.42**	284.33**	0.23**
GCA tester	1	0.180	0.020	0.020	15.300	132.29*	0.110
SCA (L x T)	24	0.350	0.48**	0.81*	51.910	27.640	0.040
Check	1	13.50**	10.670	8.17*	140.167	13.500	0.167
Cross vs. Check	1	4.813	15.898	6.896	862.450	108.000	0.390
Pooled error Entry	66	0.765	0.671	1.304	110.654	63.791	0.071
Pooled Error Crosses	62	0.250	0.220	0.450	38.230	22.080	0.020
Pooled error checks	2	0.500	0.667	0.167	76.167	6.500	0.042
	DF	SLP	SLP+	RLP	RLP+	ERP	ERP+
Rep	2	3.334	0.001	4.122	0.002	0.612	0.000
Block (Rep)	36	2.659	0.001	2.352	0.001	1.90*	0.00*
Entry	51	50.31**	0.03**	23.79**	0.01**	7.00**	0.01**
Cross	49	21.65**	0.01**	9.33**	0**	3.32**	0.01**
GCA line	24	34.53**	0.02**	9.870	0.00	3.950	0.010
GCA tester	1	10.520	0.000	0.350	0.00	0.330	0.000
SCA (L x T)	24	9.24**	0.01**	9.17**	0**	2.82**	0.01**
Check	1	0.002	0.000	8.050	0.003	6.30**	0.01**
Cross vs. Check	1	0.238	0.004	223.131	0.101	0.187	0.001
Pooled error Entry	66	2.189	0.001	2.879	0.001	1.159	0.001
Pooled Error Crosses	62	0.760	0.000	0.890	0.000	0.410	0.000
Pooled error checks	2	0.002	0.000	2.014	0.001	0.047	0.000

*0.05 probability level **=significant at 0.01 probability level , MF=male flowering, FF=female flowering, MD =Maturity date, PH=Plant height, EH=Ear height, EA=Ear aspect, SLP=stalk lodging percent, RLP= root lodging percent, ERP= ear rot percent*

Continuo table

	DF	HCP	HCP+	YLDT	TLBSID	TLBSID+	NKR
Rep	2	0.503	0.000	2.93**	2.564	0.000	4.185
Block (Rep)	36	2.577	0.001	0.309	204.94*	0.02*	3.687
Entry	51	67.66**	0.04**	1.63**	264.37**	0.03**	14.62**
Cross	49	28.91**	0.02**	0.64**	106.84**	0.01**	6.05**
GCA line	24	46.34**	0.02**	1.13**	139.170	0.020	10.55**
GCA tester	1	5.000	0.000	0.010	205.400	0.020	3.420
SCA (L x T)	24	12.49**	0.01**	0.23*	70.4*	0.01*	1.650
Check	1	206.15**	0.08**	0.240	2242.667	0.277	4.167
Cross vs. Check	1	47.401	0.031	9.393	238.281	0.031	34.085
Pooled error Entry	66	1.920	0.001	0.381	120.865	0.014	4.465
Pooled Error Crosses	62	0.670	0.000	0.130	37.530	0.000	1.470
Pooled error checks	2	1.186	0.000	0.020	514.667	0.069	11.247
	DF	GLSSID	GLSSID+	EL	ED	NKRE	
Rep	2	4863.56**	0.59**	1.989	0.002	2.37*	
Block (Rep)	36	246.789	0.030	1.670	0.07**	0.759	
Entry	51	549.36**	0.07**	3.55**	0.05**	1.31**	
Cross	49	214.28**	0.03**	1.49**	0.02**	0.5**	
GCA line	24	270.8**	0.03**	2.61**	0.03**	0.77**	
GCA tester	1	1930.07**	0.24**	0.000	0.04*	1.8**	
SCA (L x T)	24	86.270	0.010	0.450	0.010	0.170	
Check	1	560.667	0.077	4.507	0.042	2.667	
Cross vs. Check	1	1.117	0.000	3.234	0.070	3.309	

Pooled error Entry	66	175.906	0.021	1.470	0.027	0.513
Pooled Error Crosses	62	55.090	0.010	0.490	0.010	0.170
Pooled error checks	2	1260.66	0.158	1.322	0.207	0.187

**= significant at 0.05 probability level **=significant at 0.01 probability level, HCP=husk cover percent, YLDT= Grain yield tones per hectare, TLBSID=Turcicum leaf blight severity index, NKR=Number of kernels per row, GLSSID=Gray leaf spot severity index, EL=Ear length, ED=Ear diameter, NKRE=Number of kernel rows per ear,*

i *General combining ability estimates*

Grain yield: The GCA estimates of parental lines ranged from -1.39 to 1.42 for grain yield. The female parent, L24 was the best general combiner for GY with a highly significant (*P<0.01*) and positive GCA effect of 1.42 t ha-1 followed by L22 and L18 with GCA effect of 1.20 and 1.11 t ha-1, respectively (table 4). In addition, L2, L17, L19, L20, L21, L22 and L24 had highly significant (*P<0.01*) positive GCA effects of 0.88 and 0.81, respectively. These inbred lines are desirable parents for hybrid development as well as for inclusion in the breeding programs, as the lines may contribute favorable alleles in the synthesis of new varieties. Parental lines L1, L4, L6, L7, L8, L9, L10, L11, L12 and L25 showed significantly negative GCA effects to the undesirable direction. Among the testers (males), none of them showed significant GCA effects for grain yield per hectare. Result of the current study are in accordance with the findings of Amiruzzaman *et al.* (2010), Legesse *et al*.(2009), Nepir (2007), Tuna (2004) and Dagne *et al*. (2007) who reported significant positive and negative GCA effects for grain yield.

Fifty percent silking and tassling days: The GCA estimates of parental lines ranged from -1.66 to 1.84 for silking days. The female parent L24, L17, L22, L2, L20, were the best general combiners for SD with high and significant difference (*P<0.01*). L24 and L17 had high positive GCA effect of 1.84 days respectively. These inbred lines had the tendency to increase late maturity On the other hand, L7, L8, L9, L11, L13, L18, L19 and L25 showed highly significant GCA effects. Hence, the inbred lies had contributed to earliness in maturity in their crosses as these lines showed negative and highly significant negative GCA effects of -1.16 days, -1.66 and -1.16, respectively. Similarly, Gudeta (2007) and Wagary (2010) reported significant positive and negative GCA effects for silking in their combining ability study.

The GCA estimates of parental lines ranged from -1.06 to 1.44 for Tasseling days. The female parents L24, L16, L1, L2, L10, L12, L15, L17, L20, L21 and L22 revealed significant and positive GCA effects contributed to late maturity. Lines L3, L25, L19, L8, L6, L7 and L18 showed significant and negative GCA effects contributed to early maturity and were best combiners for early maturity as they showed the tendency to increase early flowering. None of the testers showed significant GCA effects for both silking and tasseling. Result of the current study are in accordance with the findings of Nepir (2007) and Dagne (2007) who reported significant positive and negative GCA effects for anthesis in their combining ability study.

The GCA estimates of lines ranged from -2.34 to 2.66 days for maturity date (MD) . L22 showed highly significant positive GCA effect of 2.66 days. In addition, L17, L18, L19, L24 showed highly significant (*P<0.01*) GCA of 1.16 whereas, L6, L8, L11, L14 and L15 revealed highly significant GCA effects in the negative direction. The female line (L6) could be used in breeding program for the introgression of gene for early maturing. Testers showed non-significant effects to MD. The result of this study is in accordance with Legesse (2009) who found desirable GCA effects for physiological maturity in combining ability of highland transition maize inbred line.

Table 4 : Estimates of general combining ability (GCA) effect of lines and tester for grain yield and agronomic traits in 25x2 line by tester crosses evaluated at Bako(2012/13)

Lines	TD	SD	MD	PH	EH	SLP	EA
1	0.44*	0.34	-0.34	-7.23**	-4.99*	3.3**	0.34**
2	0.44*	0.84**	0.16	-0.73	0.51	1.12**	0.18**
3	-1.06**	-0.66**	0.16	-11.56**	-8.83**	-3.33**	0.34**
4	-0.06	-0.16	-0.84**	-5.39*	-11.16**	-4.39**	0.09
5	-0.06	-0.16	-0.34	-16.56**	-9.33**	-2.84**	0.01
6	-0.56**	-0.16	-2.34**	-13.39**	-15.33**	-2.4**	0.26**
7	-0.56**	-1.16**	-0.84**	-14.56**	-12.66**	-0.71*	-0.24**
8	-1.06**	-1.66**	-1.34**	-3.06	-12.16**	-0.87*	0.43**
9	-0.06	-0.66**	-0.84**	-9.39**	-12.49**	0.14	0.26**
10	0.44*	0.34	0.16	2.61	0.84	2.8**	0.26**
11	-0.06	-0.66**	-1.34**	-11.06**	-14.99**	-0.93**	0.34**
12	0.44*	0.34	-0.84**	5.27*	-3.16	0.07	0.26**
13	-0.06	-1.16**	-0.34	-5.9*	1.51	7.21**	0.09
14	-0.06	-0.16	-1.34**	-8.06**	-5.83**	1.21**	0.34**

	15	0.44*	-0.16	-1.34**	12.94**	9.67**	15.97**	0.09
	16	0.94**	0.34	0.66*	2.77	-3.32	0.65	0.18**
	17	0.44*	1.84**	1.16**	21.27**	14.01**	-0.87*	-0.16**
	18	-0.56**	-0.66**	1.66**	17.44**	21.84**	-1.87**	-0.41**
	19	-1.06**	-0.66**	1.16**	0.61	5.51**	-3.87**	-0.66**
	20	0.44*	0.84**	0.66*	12.11**	20.51**	-2.81**	-0.07
	21	0.44*	0.34	2.16**	-9.9**	-4.33*	-0.9*	-0.49**
	22	0.44*	1.34**	2.66**	14.94**	11.01**	-1.42**	-0.66**
	23	-0.06	0.34	0.66*	11.77**	20.51**	-1.34**	-0.32**
	24	1.44**	1.84**	1.16**	13.94**	17.67**	-1.86**	-0.57**
	25	-1.06**	-0.66**	-0.34	1.11	-4.99*	-2.02**	0.09
	SE[1]	0.20	0.19	0.27	2.47	1.88	0.35	0.06
	SEd	0.29	0.27	0.39	3.57	2.71	0.50	0.08
Tester	1	-0.06	0.02	-0.02	0.55	-1.63**	-0.46**	0.05**
	2	0.06	-0.02	0.02	-0.55	1.63**	0.46**	-0.05**
	SE[2]	1	1	1	1	1	1	1
	SEd	0.08	0.08	0.11	1.01	0.77	0.14	0.02

1GCA lines standard error. 2 GCA testers standard error.

TD=number of days to 50% tasseling SD= number of days to 50% silking , MD =Maturity date, PH=Plant height, EH=Ear height, SLP=stalk lodging percent, EA=Ear aspect, SLP=stalk lodging percent

Continue Table 4

Lines	HCP	YLDT	GLSSID	EL	ED	NKRE	NKR
1	-4.54**	-1.39**	-7.23*	-1.83**	-0.04	-0.96**	-1.77**
2	-2.59**	0.69**	6.77*	-1.4**	0.07	-0.83**	-0.18
3	17.69**	-0.11	-10.56**	-0.42	0.27**	1.24**	0.17
4	2.58**	-0.61**	-10.56**	-0.05	0.04	0.24	0.93
5	0.55	0.16	-7.89**	-1.08**	-0.01	0.64**	-0.57
6	-0.11	-0.98**	-7.23*	-1.4**	0.01	0.04	-2.98**
7	0.89**	-0.63**	7.44*	0.09	0.02	0.17	-2.03**
8	3.4**	-0.76**	-6.56*	0.2	-0.12**	0.11	-3.47**
9	3.44**	-0.56**	15.44**	-0.18	-0.04	0.18	-1.43**
10	-5.08**	-0.33*	2.77	-0.93**	-0.16**	0.44**	-3.27**
11	-3.12**	-0.86**	-3.23	-0.11	-0.03	0.31	-0.86
12	-1.59**	-0.36*	14.11**	0.85**	-0.08	-0.16	0.94
13	-0.96**	0.01	2.77	0.03	-0.04	-0.49**	0.5
14	5.58**	-0.18	8.11**	-0.33	-0.17**	-0.89**	-0.63
15	-2**	0.02	18.11**	-0.11	-0.11**	-0.46**	1.1*
16	-4.07**	-0.05	29.44**	-1.56**	0.04	-1.03**	-1.86**
17	-3.61**	0.47**	8.1**	1.42**	0.19**	0.11	1.97**
18	-3.12**	1.11**	-13.89**	0.14	0.08	0.11	0.07
19	3.13**	0.81**	-7.9**	2.45**	-0.17**	-0.33	3.24**
20	4.92**	0.42**	2.11	1.62**	-0.04	-0.42*	5.7**
21	-0.55	0.71**	-11.89**	0.32	-0.13**	0.38*	1.47**
22	-2.58**	1.2**	-13.89**	1.68**	0.08	0.31	3.34**
23	-0.6	0.64**	8.11**	0.92**	0.09*	1.51**	0.97
24	-3.57**	1.42**	-8.56**	1.25**	-0.03	0.11	2.1**
25	-4.1**	-0.88**	-13.89**	-1.55**	0.31**	-0.36*	-3.47**
SE[1]	0.33	0.14	2.97	0.28	0.04	0.16	0.48
SEd	0.47	0.21	0.00	0.40	0.56	0.24	0.70
Tester							
1	-0.32**	0.02	6.21**	0	0.03**	0.19**	-0.26*
2	0.32**	-0.02	-6.21**	0	-0.03**	-0.19**	0.26*

SE^2	1	1	1	1	1	1	1
SEd	0.13	0.06	1.21	0.11	0.02	0.07	0.20

1GCA lines standard error. 2 GCA testers standard error.

**=significant at 0.05 probability level **=significant at 0.01 probability level, HCP=husk cover percent, ERP= ear rot percent, GLSSID=Gray leaf spot severity index EA=Ear aspect, YLDT=Grain yield tons per hectare, EL=Ear length, ED=Ear diameter, NKRE=Number of kernel rows per ear, NKR=Number of kernels per row.*

Plant height: The GCA estimate of parental lines ranged from -16.56 to 21.75 cm for plant height (PH). L18, L17, L20, L22, L15, L23, L12, and L24 showed positive and significant GCA effects indicating that these lines significantly contributed to taller plant stature. On the other hand, L5, L6, L3, L11, L9, L1, L4, L9, L14, L21, and L7 showed negative GCA effects, indicating that these lines contributed to reduced plant stature in their crosses. None of the testers showed significant GCA effects for PH. In line with the present study Tuna (2004) and Wagary (2010) found significant positive and negative GCA effects for plant height.

Ear height (EH): The GCA estimate of parental lines ranged from -15.33 to 21.84cm for ear EH. Parental lines: L18, L19, L15, L20, L23, L24, L17 and L22 showed positive and significant GCA effects indicating that these lines significantly contributed to taller plant stature. On contrary, L11, L6, L7, L9, L8, L4, L5, L1, L14 and L3 showed negative GCA effects, indicating that these lines contributed to reduce plant ear height in their crosses. Regarding the testers, T2, showed positive GCA effects for EH, indicating that this tester contributed to increased plant stature whereas T1 depicted negative and significant GCA effects for EH. Similarly, Tuna (2004) and Wegary et al. (2010) found significant positive and negative GCA effects for plant height.

Grey leaf spot severity index (GLSSI): The GCA estimate of parental lines ranged from -13.89 to 29.44 for GLSSI. Parental lines, L18, L22, L25, L21, L3, L4, L24, L5, L6, L1, L8 andL19 and revealed GCA effect of -13.89, -13.89, -13.89, -11.89, -10.56, -10.56, -8.56, -7.9 -7.89, -7.23, -6.56, -7.9 respectively. These inbred line had greater tolerances to GLS as the line had negative significant GCA effects while, L16, L15, L9, L12, L2, L7, L14, L17 and L23, showed positive and significant GCA effects to undesirable direction as these increased the susceptibility of crosses they involved, which was evident from their highly significant positive GCA effect of 29.44, 18.11, 15.44, 14.11, 6.77, 7.44, 8.11, 8.1, 8.11 respectively. The result of this study is in agreement with Menkir (2005), Asefa et al (2008) and Legesse et al. (2009).

Ear length (EL): The GCA estimate of parental lines ranged from -1.83 to 2.45cm for EL. Parental lines, L19, L17, L20, L22, L23, L12, and L24 showed positive a and significant GCA effects to the desirable direction and contribute to increased grain yield in its hybrid combinations. On contrary, L1, L2, L5, L6, L10, L16 and L25 showed negative SCA effects. Similarly, Dagne et al. (2007) reported significant positive and negative GCA effects for this trait.

Ear diameter(ED): The GCA estimate of parental lines ranged from - 0.17 to 0.31cm for ED. Parental lines, L25, L3, L23 and L17 showed positive and significant GCA effects to the desirable direction and contribute to increased grain yield in its hybrid combinations. On contrary, L8, L10, L14, L15, L19 and L21 showed negative and significant GCA effects which is undesirable. The GCA estimate for testers showed that, T1 revealed positive and significant GCA effect While, T2 showed negative significant GCA effect. This result revealed T1 contributed towards the increments of yield in its hybrid combinations. The present study is in agreement with Dagne et al. (2007), and Nepir (2007), who reported significance positive and negative GCA effects for ear diameter.

Number of kernels row per ear (NKRE): The GCA estimate of parental lines ranged from -1.03 to 1.51 for NKRE. Parental lines L23, L3, L5 and L10 revealed positive and significant GCA effects to the desirable direction and contributed to increased grain yield in its hybrid combinations. L1, L2, L13, L14, L15, L16, L20 and L25 showed negative and significant GCA effects. The GCA estimate for testers showed that, T1 revealed positive and significant GCA effect While, T2 showed negative significant GCA effect.T1contributed towards the increments of yield in its hybrid combinations. Similar results were found by Dagne et al. (2007), Tuna (2004) and Nigusie (1999).

Number of Kernels per row (NKR): The GCA estimate of parental lines ranged from -3.47 to 3.34 for NKR. Parental line, L22, L19, L17, L24, L20, L21 and L15 showed positive and significant GCA effects to the desirable direction and contributed to increased grain yield in its hybrid combinations .On the other hand, L1, L6, L7, L8, L9, L10, L16 and L25 revealed negative and significant GCA effects. The GCA estimate for testers showed that, T1 revealed negative and significant GCA effect While, T2 showed high and positive significant GCA effect. This result revealed T2 contributed towards the increments of yield in its hybrid combinations. The current result is in agreement with Dagne et al. (2007) and Nepir (2007).

Stalk lodging percent (SLP): The GCA estimate of parental lines ranged from -4.39 to 15.97 for SLP. Parental lines, L15, L13, L14, L1, L2, and L10 showed positive and significant GCA effects to the undesirable and vulnerable effect. On the other hand parental lines,

L3, L4, L5, L6, L7, L8, L11, L17, L18, L19, L20, L21, L22, L23, L24 and L25 revealed negative and significant GCA effects which is to the desirable direction and could be used in breeding program for the development of stalk lodging tolerant improved maize varieties. Regarding testers, T1 showed high and negative GCA effect which is desirable while, T2 showed positive and GCA effect which contributed towards loading. The current result agrees with Bhatnagar et al. (2004) who found significant differences among GCA effects for the same trait.

Ear aspect (EA): The GCA estimate of parental lines ranged from -0.66 to 0.43 for EA. Parental lines, L8, L1, L3, L11, L9, L12, L2, L6, L10, L16 and L14 showed high and positive significant GCA effects to the undesirable direction. On the other hand, L7, L19, L22, L24, L23, L21, L18 and L17 revealed a high and negative GCA effect which is to the desirable direction with good ear character that could be used in breeding programs for trait.

Husk cover percentage (HCP): The GCA estimate of parental lines ranged from -5.08 to 17.69 for HCP. Parental lines, L3, L20, L19, L14, L9, L8, L7, and L4 showed high and positive significant GCA effects to the undesirable direction contributed to open husks. On the other hand, L10, L1, L16, L25, L24, L22, L18, L17, L11, L12, L13, L15 and L2 revealed negative and significant GCA effect which is to the desirable direction plants with good ear character that could be exploited in breeding programs for unopened husk cover.

ii *Specific combining ability estimates*

Grain yield: Crosses L2xT2, L5xT2, L11xT2, L12xT1, L14xT1, L17xT2, L19xT 1, L20xT2 and L22xT2 (table 5) revealed positive and significant SCA effects for grain yield with SCA values of 0.42, 0.55, 0.47 , 0.37, 0.35, 0.43, 0.63 , 0.41 and 0.43t/ha, indicating that these crosses were good specific combinations for grain yield. Crosses with the higher value of SCA effect also showed higher values of mean grain yield performance, indicating good correspondence between SCA effects and mean grain yield. Hence, such cross combinations could effectively be exploited in hybrid breeding program in maize research. On the other hand, five cross combinations L19xT2, L5xT1, L11xT1, L17xT1, L20xT1, L14xT2, L12xT2, L2xT1 and L22xT1 expressed negative and significant SCA effects for grain yield which is undesirable as these crosses showed a tendency to reduce grain yield performance. The finding of the current study are in agreement with that of Nigussie (1999) who reported significant positive and negative SCA effects for grain yield in 8 x 8 diallel study of drought tolerant maize populations at Melkasa. and Dagne et al. (2007) also reported similar results for grain yield. However, Pswarayi and Vivek (2008) and Jumbo and Carena (2008) reported non-significant positive and negative SCA effects for grain yield which is inconsistent with the present study.

Fifty percent silking: Crosses, L3xT1, L4xT1, L 7xT2, L10xT1, L15xT1, L17xT1, L20xT2, L14xT2, L13xT1, L6xT2, L5xT1, L2xT1 and L18xT1, manifested positive and significant SCA effects for silking. This indicated these crosses were good specific combiners for lateness in female flowering (silking). On the other hand crosses L3 x T2, L4xT2, L7 x T1, L10 x T2, L15 x T2, and L17 x T2, expressed negative and significant SCA effects indicating earliness in flowering (Table 10). These are the best hybrids that could be used for developing early maturing hybrids. This finding agrees with Tuna (Tuna 2004), Nepir (2007) and Wegary et al. (2010) who found positive and negative SCA effects for silking.

Maturity day (MD): The SCA effect for MD ranged from -1.48 to 1.48. Crosses L10xT2, L13xT1 L15xT1, L16xT2 and L20xT1 manifested negative and significant SCA effects indicating that these crosses were good specific combinations for early maturity date. Hence, such cross combinations could effectively be exploited in hybrid breeding program in maize research for reduced maturity dates. On the other hand, cross combinations L5xT2, L10xT1, L13xT2, L15xT2, L16xT1 and L20xT2 expressed positive and significant SCA effects for maturity date which are undesirable as these crosses showed a tendency to increase maturity date.

Table 5 : Estimates of Specific combining abilities of 25 x 2, Line x tester crosses evaluated for yield, agronomic and disease traits at Bako (2012/13)

Entry	CODE	SD	MD	SLP	RLP	ERP	HCP	YLDT	TLBSID
1	L1xT2	-0.02	0.02	-1.13**	-1.03**	-0.51	0.86*	-0.10	0.00
2	L1xT1	0.02	-0.02	1.13**	1.03**	0.51	-0.86*	0.10	2.70
3	L2xT1	0.48*	-0.48	1.96**	-1.06**	1.49**	2.81**	-0.42**	3.97
4	L2xT2	-0.48*	0.48	-1.96**	1.06**	-1.49**	-2.81**	0.42**	-3.97
5	L3xT2	-1.02**	-0.48	0.44	-1.16**	0.93**	-1.07**	0.22	-2.69
6	L3xT1	1.02**	0.48	-0.44	1.16**	-0.93**	1.07**	-0.22	2.69
7	L4xT2	-0.52**	-0.48	0.46	-1.13**	-2.17**	-1.25**	-0.02	-4.03
8	L4xT1	0.52**	0.48	-0.46	1.13**	2.17**	1.25**	0.02	4.03

9	L5xT1	0.48*	-0.98**	-0.01	2.52**	0.45	-2.13**	-0.55**	3.97
10	L5xT2	-0.48*	0.98**	0.01	-2.52**	-0.45	2.13**	0.55**	-3.97
11	L6xT2	0.48*	0.02	0.49	-0.05	-1.23**	0.39	-0.05	-4.03
12	L6xT1	-0.48*	-0.02	-0.49	0.05	1.23**	-0.39	0.05	4.03
13	L7xT1	-0.52**	0.52	4.13**	1.77**	1.88**	0.22	0.1	-1.36
14	L7xT2	0.52**	-0.52	-4.13**	-1.77**	-1.88**	-0.22	-0.1	1.36
15	L8xT2	-0.02	0.02	2.02**	-2.49**	-1.05**	1.85**	0.03	-8.69**
16	L8xT1	0.02	-0.02	-2.02**	2.49**	1.05**	-1.85**	-0.03	8.69**
17	L9xT1	-0.02	0.52	1.93**	-0.57	-0.1	-0.22	0.03	-3.36
18	L9xT2	0.02	-0.52	-1.93**	0.57	0.1	0.22	-0.03	3.36
19	L10xT2	-1.02**	-1.48**	-1.49**	0.41	-0.07	0.32	-0.04	-4.70
20	L10xT1	1.02**	1.48**	1.49**	-0.41	0.07	-0.32	0.04	4.70
21	L11xT2	-0.02	0.02	-0.03	0.45	-1.06**	-1.64**	0.47**	3.30
22	L11xT1	0.02	-0.02	0.03	-0.45	1.06**	1.64**	-0.47**	-3.30
23	L12xT2	-0.02	-0.48	1.91**	0.93*	-0.1	1.82**	-0.37*	-8.03**
24	L12xT1	0.02	0.48	-1.91**	-0.93*	0.1	-1.82**	0.37*	8.03**
25	L13xT1	0.48*	-0.98**	-4.04**	-3.4**	-1.21**	2.29**	-0.23	7.31**
26	L13xT2	-0.48*	0.98**	4.04**	3.4**	1.21**	-2.29**	0.23	-7.31**
27	L14xT2	0.48*	0.02	-1.91**	-1.00*	0.01	-6.05**	-0.35*	1.97
28	L14xT1	-0.48*	-0.02	1.91**	1.00*	-0.01	6.05**	0.35*	-1.97
29	L15xT2	-0.52**	1.02**	-5.47**	0.00	1.51**	2.42**	-0.02	-0.69
30	L15xT1	0.52**	-1.02**	5.47**	0.00	-1.51**	-2.42**	0.02	0.69
31	L16xT1	-0.02	1.02**	-1.52**	-1.54**	-0.59*	0.32	-0.02	2.64
32	L16xT2	0.02	-1.02**	1.52**	1.54**	0.59*	-0.32	0.02	-2.64
33	L17xT2	-0.52**	0.52	2.94**	1.42**	0.96**	0.81*	0.43**	20.64**
34	L17xT1	0.52**	-0.52	-2.94**	-1.42**	-0.96**	-0.81*	-0.43**	-20.64**
35	L18xT1	0.98**	0.02	1.86**	-0.67	0.41	2.28**	0.07	6.64**
36	L18xT2	-0.98**	-0.02	-1.86**	0.67	-0.41	-2.28**	-0.07	-6.64**
37	L19xT2	-0.02	0.52	-0.06	-0.62	-1.63**	-0.78*	-0.63**	0.64
38	L19xT1	0.02	-0.52	0.06	0.62	1.63**	0.78*	0.63**	-0.64
39	L20xT2	0.48*	1.02**	-1.12**	0.36	-0.59*	-7.72**	0.41**	0.64
40	L20xT1	-0.48*	-1.02**	1.12**	-0.36	0.59*	7.72**	-0.41**	-0.64
41	L21xT1	-0.02	0.52	0.92*	-3.14**	1.91**	0.78*	0.07	-3.36
42	L21xT2	0.02	-0.52	-0.92*	3.14**	-1.91**	-0.78*	-0.07	3.36
43	L22xT2	-0.02	0.02	-0.49	2.43**	1.95**	-1.20**	0.43**	-4.03
44	L22xT1	0.02	-0.02	0.49	-2.43**	-1.95**	1.20**	-0.43**	4.03
45	L23xT1	-0.02	0.02	-2.59**	0.88*	-1.58**	1.80**	0.03	0.64
46	L23xT2	0.02	-0.02	2.59**	-0.88*	1.58**	-1.80**	-0.03	-0.64
47	L24xT1	0.48*	-0.48	1.02**	-0.59	0.44	1.83**	0.25	-4.03
48	24xT2	-0.48*	0.48	-1.02**	0.59	-0.44	-1.83**	-0.25	4.03
49	L25xT2	-0.02	0.02	-0.24	7.3**	-0.10	1.30**	0.21	-0.69
50	L25xT1	0.02	-0.02	0.24	-7.3**	0.10	-1.30**	-0.21	0.69
SCASE		0.19	0.27	0.35	0.38	0.26	0.33	0.14	2.45
SEd		0.38	0.55	0.71	0.77	0.52	0.67	0.29	5.00

**=significant at 0.05 probability level, **=significant at 0.01 probability level*

SD=Silking day, MD =Maturity date, SLP=stalk lodging percent, RLP= root lodging percent,

HCP=husk cover percent, ERP= ear rot percent, TLBSID=Turcicum leaf blight severity index, YLDT=Grain yield tones per hectare,

stalk lodging(SLP): Crosses L1xT2, L2xT2, L7xT2, L8xT1, L9xT2, L10xT2, L12xT1, L13xT1, L14xT2, L15xT2, L16xT1, L17xT1, L18xT2, L20xT2, and L23xT1 revealed negative and significant SCA effects for SLP with SCA

values of -1.13, -1.96, -4.13, -2.02, -1.93, -1.49, -1.91, -4.04, -1.91, -5.47, -1.52, -2.94, -1.86, -1.12, -2.59 respectively, indicating that these crosses were good specific combinations for reduced stalk lodging. On the other hand, crosses LixT1, L2xT1, L7xT1, L8xT2, L9xT1, L10xT1, L12xT2, L13xT2, L14xT1, L15xT1, L16xT2, L17xT2L18xT1, L20xT1, L23xT2, L24xT1 revealed positive and significant SCA effects for stalk lodging which are undesirable as these crosses showed increased stalk lodging. The current results are in accordance with Bhatnagar et al. (2004) who found significant SCA effects in the study of combining ability of QPM inbred lines.

Root lodging percent(RLP): Crosses L1xT2, L2xT1, L3xT2, L4xT2, L5xT2, L7xT2, L8xT2, L13xT1, L16xT1, L17xT1, L21xT1, L22xT1, L25xT1 expressed negative and significant SCA effects for RLP with SCA values of -2.81, -1.07, -1.25, -2.13, -1.85, -1.64, -1.82, -2.29, -6.05, -2.42, -2.28, -7.72, -1.20, -1.80, -1.83, -1.30 respectively, indicating that these crosses were good specific combinations for resistance to root lodging. On the other hand, crosses L1xT1, L2xT2, L3xT1, L4xT1, L7xT1, L8xT1, L13xT2, L16xT2, L17xT2, L21xT2, and L25xT2 revealed positive and significant SCA effects for root lodging percent which are undesirable as these crosses showed higher root lodged percent in their hybrid combinations. Similarly, Bhatnagar et al. (2004) reported SCA significance for the same trait.

Husk cover percent (HCP): Crosses L2xT2, L1xT1, L5xT1, L3xT2, L4xT2, l5xT1, L8xT1, L11xT2, L12xT1, L13xT2, L14xT2, L15xT1, L17xT1, L18xT2, L19xT2, L20xT2, L21xT2, L22xT2, L23xT2, L24xT2, L25xT1 expressed negative and significant SCA effects for HCP indicating that these crosses were good specific combinations for resistance to husk cover. On the other hand, crosses L1xT2, L1xT2, L5xT2, L3xT1, L4xT1, L11xT1, L12xT2, L13xT1, L14xT1, L15xT2, L17xT2, L18xT2, L19xT1, L20xT1, L22xT1, L23xT1, L24xT1, L25xT2 revealed positive and significant SCA effects for husk cover percent which are undesirable as these crosses showed higher opened husk percent in their hybrid combinations.

Ear rot percent (ERP): Crosses L2xT2, L3xT1, L4xT2, L6xT2, L7xT2, L8xT2, L11xT2, L13xT1L15xT1, L17xT1, L19xT2, L21xT2, L22xT1, L23xT1 expressed negative and significant SCA effects for ear rot percent (ERP) with SCA values of 1.49, 0.93, 2.17, 1.23, 1.88, 1.05, 1.06, 1.21, 1.51, 0.96, 1.63, 1.91, 1.95, 1.58 respectively, indicating that these crosses were good specific combinations for resistance to ERP. Hence, such cross combinations could effectively be exploited in hybrid breeding program in maize research for developing ear rot free genotypes. The result of this finding agrees with Worku et al. (2008) who found significant GCA effect for the same trait.

Turcicum leaf blight severity index (TLBSI): Crosses L8xT2, L12xT2, L13xT2, L17xT1, L18xT2, revealed negative and significant SCA effects for TLB with SCA values of 8.69, 8.03, 7.31, 20.64, 6.64 respectively, indicating that these crosses were good specific combinations for resistance to TLB. Hence such cross combinations could effectively be exploited in hybrid breeding program in maize research for developing tolerant maize genotypes to Turcicum leaf blight. On the other hand, crosses L8xT1, L12xT1, L13xT1, L17xT2, and L18xT1, revealed positive and significant SCA effects for Turcicum leaf blight which are undesirable as these crosses showed higher percent incidence in their hybrid combinations. On contrary to this finding, Legesse et al. (2009) reported non-significant SCA effects for the same trait.

In Summary, the preponderance of GCA effects for expression of YLDT and yield related traits considered in this study indicated the possibility for improvement of these traits through simple selection procedures. However, the chance of success could be hampered in the presence of substantial amount of epistatic component. In such cases selection procedure would not be fruitful in immediate progenies and process has to be delayed to later generations when appreciable homozygosity is achieved (Sofi et al. 2006). For complex traits like YLDT and similar traits, recurrent selection procedure that exploits both the additive and non additive component of genetic variation are more appropriate in bringing about a better improvement. Similar suggestion was made by Worku et al. (2008) for secondary traits.

d) Heterotic Grouping of inbred lines

Study on test cross performance and combining ability of maize (Zea mays L.) inbred lines was undertaken and evaluated for performance, general and specific combining ability and heterotic groups using line by tester mating design. Twenty five inbred lines were crossed to two CIMMYT testers: Tester 1 (CML 312/CML442) and Tester 2 (CML395/CML202) which belongs to maize heterotic group A and B, respectively. Heterotic grouping designate broad classes in maize with diverse genetic base that are complimentary and result in expression of heterosis after crossing. On the other hand, synthetic varieties are developed from inbred lines belonging to the same heterotic group.

In heterotic grouping, an inbred line express negative SCA effect when crossed to a certain tester implies that both the line and the tester belong to the same heterotic group, while the reverse is true when the SCA effect is positive (Vasal et al. 1992). Table 6 shows that six inbred lines expressed significant negative SCA effects and three inbred lines expressed positive SCA effects when crossed to CML312/CML442 and when crossed to CML395/CML202, six inbred lines expressed

positive and three expressed negative SCA effects. The study exhibited that the six inbred lines belong to heterotic group A, while the remaining three belong to heterotic group B.

In order to maximize genetic diversity and therefore heterosis during hybrid variety development using these inbred lines, one parent should come from the six inbred lines belonging to heterotic group A while the other parent should be from the three inbred lines belonging to heterotic group B. In the case of the development of synthetic varieties, inbred lines belonging to the same heterotic group should be used. Likewise, Legesse et al. (2009) using population and inbred line testers separated inbred lines into different heterotic groups on the basis of grain yield SCA values.

Table 6 : Grain yield mean, SCA effect and heterotic group of 9 maize inbred lines teste crosses to CML312/CML442 and CML395/CML202 tested for one year at Bako (2012/13)

Line	Tester (CML312/CML442)		Tester 2(CML395/CML202)		Heterotic group
	Grain yield	SCA	Grain yield	SCA	
1	6.80	0.1	6.97	-0.1	---
2	8.57	-0.42**	9.37	0.42**	A
3	8.40	-0.22	7.93	0.22	---
4	7.67	0.02	7.67	-0.02	---
5	7.90	-0.55**	8.97	0.55**	A
6	7.27	0.05	7.33	-0.05	--
7	7.77	0.1	7.53	-0.1	--
8	7.57	-0.03	7.47	0.03	--
9	7.77	0.03	7.67	-0.03	--
10	7.93	0.04	7.97	-0.04	--
11	7.90	-0.47**	6.93	0.47**	A
12	7.57	0.37*	8.27	-0.37*	B
13	8.07	-0.23	8.50	0.23	--
14	7.77	0.35*	8.43	-0.35*	B
15	8.30	0.02	8.30	-0.02	--
16	8.23	-0.02	8.23	0.02	--
17	9.20	-0.43**	8.30	0.43**	A
18	9.47	0.07	9.30	-0.07	--
19	8.47	0.63**	9.70	-0.63**	B
20	9.13	-0.41**	8.27	0.41**	A
21	9.07	0.07	8.90	-0.07	--
22	9.93	-0.43**	9.03	0.43**	A
23	8.97	0.03	8.87	-0.03	--
24	9.97	0.25	9.43	-0.25	--
25	7.63	-0.21	7.17	0.21	--

**=significant at 0.05 probability level, **=significant at 0.01 probability level*

IV. Conclusion and Recommendation

The analysis of variance showed the genotypes were significantly different at (P<0.01 or P<0.05) for all traits tested except for number of ear per plant. Moreover, Mean squares due to crosses were significant for all traits studied. In addition, significant differences were not found among the checks and checks vs crosses for most traits.

Out of the 50 crosses, 30 crosses recorded more than 10 percent higher grain yield advantage as compared to the best check BH543.The mean performance for crosses revealed L24xT1, L22xT2, L19xT2, L18xT1, L24xT2, L2xT2, L18xT2, L17xT1, L20xT1, L21xT1 and L22xT2 with mean grain yield of 9.97, 9.93, 9.70, 9.47, 9.43, 9.37, 9.30, 9.20, 9.13, 9.07, 9.03 t ha-1. These hybrids could be included in further investigation for grain yield and related traits and could be possible candidates of future release after verifying their yield stability across more environments.

Mean squares due to GCA of lines and SCA of line by tester interactions were also significant (P<0.01) or (P<0.05) for most studied traits. This indicated that both additive and non-additive genetic variances were important in the control of traits revealed in the crosses. Mean squares due to GCA of testers were significant for EH, GLSSI, ED and NKRE. It showed non-significant differences for the rest of the traits. The additive gene effects were responsible for variability observed in grain yield and most agronomic traits.

Based on combining ability analysis L2, L17, L18, L19, L20, L21, L22, L23 and L24 were found the best general combiners for grain yield. Inbred lines with a high GCA effect for grain yield are desirable for

hybrids and open pollinated varieties development as well as for inclusion in breeding program.

Inbred lines with significant positive GCA effects were found for NKRE, NKR, EL and ED, suggesting presence of divergence to improve these traits. Thus, the inbred lines L17, L19, L20, L21 L22 and L24 showed significant positive GCA effects for increase NKR. For NKRE significant positive GCA effects were shown by inbred lines L3, L5, L10 and L23. L12, L17, L19, L20, L22, L23 and L24 showed significant positive GCA effects for EL. For ED L3, L17, L23 and L25 recorded significant positive GCA effects.

For days to anthesis/Tasseling, L3, L6, L7, L8, L18, L19 and L25 and for silking L7, L8 and L13 were the best combiners, indicating that these lines had favorable allele frequency for early maturity. Inbred lines L5, L6, L3, L11 and L7 were good general combiners for shorter plant height, which are desirable for lodging resistance.

For grain yield crosses L2xT2, L5xT2, L11xT2, L12xT1, L14xT1, L19xT1, L20xT2 and L22xT2 had good specific combining ability. These hybrids could be included for further studies for the improvement of grain yield and related traits.

Crosses L8xT2, L12xT2, L13xT2, L17xT1 and L18xT2 displayed negative and significant SCA effects for TLB, indicating that these crosses were good specific combinations for resistance to Turcicum leaf blight (TLB). Hence, such cross combinations could effectively be exploited in hybrid breeding program in maize research for developing tolerant maize genotypes to Turcicum leaf blight.

Based on the SCA and GCA effects for grain yield, only nine maize inbred lines were established into A and B heterotic groups. These heterotic groups could serve as sources for developing inbred line and hybrids. However, the testers used in the current study could not clearly discriminate most of the inbred lines into distinct heterotic groups. Therefore, further studies should explore the possibility of separating these and other inbred lines into distinct heterotic groups using the currently used and other more divergent testers.

From this study, it can be concluded that better performing testcrosses, inbred lines with desirable GCA and cross combinations with desirable SCA effects for grain yield and other grain yield related traits were successfully identified. These germplasm constitute a source of valuable genetic material that could be used for future breeding work. In general, the results of this study could be useful for researchers who need to develop high yielding varieties of maize particularly adapted to the mid altitude areas of Ethiopia.

References Références Referencias

1. Abakemal, D., H. Zelleke, K. R. Kanuajia and D. Wegari (2011). "Combining ability in maize lines for agronomic traits and resistance to weevil." Ethiopian J. Agri.Sci.
2. Abdel-Moneam, M., A. Attia, M. El-Emery and E. A. Fayed (2009). "Combining ability and heterosis for some agronomic traits in crosses of maize." Pakistan journal of biological sciences: PJBS 12(5): 433-438.
3. Abebe, S. (1983). Heterosis and combining ability in 7x7 diallel crosses of selected inbred lines of maize (Zea mays). Natural Scieces. Addis Ababa, Addis Ababa University. MSc.
4. Allard, R. W. (1999). Principles of plant breeding, John Wiley & Sons.
5. Amiruzzaman, M., M. Islam, L. Hassan and M. Rohman (2010). "Combining ability and heterosis for yield and component characters in maize." Academic Journal of Plant Sciences 3(2): 79-84.
6. Asefa, B., H. Mohammed and H. Zelleke (2008). "Combining Ability of Transitional Highland Maize Inbred Lines." East African Journal of Sciences 2(1): 19-24.
7. Bayisa, A., M. Hussein and Z. Habtamu (2005). "Combining ability of highland maize inbred lines Ethiopia." J. Agric. Sci. 18(2): 181-189
8. Benti, T., G. Tasew, W. Mosisa, D. Yigzaw, M. Kebede and B. Gezahgne (1993). Genetic improvement of maize in Ethiopia: a review. In: Benti T. and J.K. Ransom. Proceedings of the first national maize workshop of Ethiopia., Addis Abeba, Ethiopia, IAR/CIMMYT.
9. Beyene, Y. (1998). Heterosis and combining ability and correlation in a 6x6 diallel crosses of selected inbred lines and populations of maize (Zea mays L.). . Plant Sciences. Haramaya Haramaya University. MSc.
10. Bhatnagar, S., F. Betran and L. Rooney (2004). "Combining abilities of quality protein maize inbreds." Crop Science 44(6): 1997-2005.
11. CIMMYT-Zimbabwe, P. (2008). "Relative importance of general combining ability and specific combining ability among tropical maize (Zea mays L.) inbreds under contrasting nitrogen environments."
12. CSA, C. S. A. (2012). "Agricultural Sample Survey 2011/2012 " Addis Ababa, Ethiopia.
13. Dabholkar, A. (1999). Elements Of Bio Metrical Genetics (revised And Enlarged Edition), Concept Publishing Company.
14. Dagne, W., Z. Habtamu, A. Demissew, H. Temam and S. Harjit (2008). "Combining ability of maize inbred lines for grain yield and reacti on to leaf spot disease." East African Journal of Science 2: 135–145.
15. Dagne, W., Z.Habtamu, M. T. Labuschagne, H. Temam and H. Singh (2007). "Heterosis and combining ability for grain yield and its components in selected maize inbred lines." S. Afr. J. Plant Soil.(3): 133-137.

16. Dowsell, C. R., R. L. Paliwal and R. P. Cantrell (1996). Maize in the third world, Westview Press.
17. DZARC, D. A. R. C. (2004). Annual report on highland food and forage legumes research program. DebreZiete.
18. FAOSTAT (2008). Statistical Database of the Food and Agriculture of the United Nations. 9/2013.
19. Fehr, W. R. (1987). Principles of cultivar development. Volume 2. Crop species, Macmillan publishing company.
20. Gebre, T., M. Nigussie, D. Tanner and S. Twumasi-Afriyie (2002). Maize technology adoption in Ethiopia: Experiences from the Sasakawa-Global 2000 agriculture program. Enhancing the contribution of maize to food security in Ethiopia. Proceedings of the Second National Maize Workshop of Ethiopia, Addis Ababa, Ethiopia, 12-16 November 2001., Ethiopian Agricultural Research Organization.
21. Genter, C. and M. Alexander (1965). "Testcross Variability of Samples Froma Broad Base Population of Maize (Zea mays Lt.)." Crop science 5(4): 355-358.
22. Jumbo, M. and M. Carena (2008). "Combining ability, maternal, and reciprocal effects of elite early-maturing maize population hybrids." Euphytica 162(3): 325-333.
23. Kebede, M., B. Gezahgne, T. Benti, W. Mosisa, D. Yigizaw and A. Asefa (1993). Proceedings of Maize production trends and research in Ethiopia.
24. Kempthorne, O. (1957). "An introduction to genetic statistics."
25. Legesse, B., K. Pixley and A.-M. Botha (2009). "Combining ability and heterotic grouping of highland transition maize inbred lines."
26. Melchinger, A. (1999). Genetic diversity and heterosis, chapter. 10.
27. Menkir, A. (2005). "Genetic Analysis of Resistance to grey Leaf Spot of Mid-altitude Maize Inbred Lines." Crop Science 45: 163-170.
28. Mihaljevic, R., C. C. Schön, H. F. Utz and A. E. Melchinger (2005). "Correlations and QTL correspondence between line per se and testcross performance for agronomic traits in four populations of European maize." Crop science 45(1): 114-122.
29. Mosisa, W., W. Legesse, T. Berhanu, D. Girma, A. Girum, A. Wende, K. Tolera, B. Gezahegn, W. Dagne, A. Solomon, Z. Habtamu, Y. Kasa, C. Temesgen, J. Habte, N. Demoz and B. Getachew (2011). Genetic Improvement of Maize for Mid-Altitude and Lowland Sub-Humid Agro-Ecologies of Ethiopia. Proceedings of the 3rd National Maize Workshop of Ethiopia. Addis Ababa, Ethiopia: 24-34
30. Mulatu, K., G. Bogale, B. Tolesa, M. Worku, Y. Desalegne and A. Afeta (1993). "Maize production trends and research in Ethiopia."
31. Nepir, G. (2007). Heterosis and combining ability in QPM versions of early generation highland maize (Zea mays L.) inbred lines. Plant Sciences. Haramaya, Haaramaya University. MSc.
32. Nigusie, M. (1999). Heterosis, combining ability and correlation in 8x8 diallel crosses of drought tolerant maize (Zea mays L.) population. Plant Sciences. haramaya Haramaya University. MSc.
33. Nigussie, M. and H. Zelleke (2001). "Heterosis and combining ability in a diallel among eight elite maize populations."
34. Ojo, G., D. Adedzwa and L. Bello (2007). "Combining ability estimates and heterosis for grain yield and yield components in maize (Zea mays L.)." Sustainable Development in Agric. Environment 3: 49-57.
35. Patterson, H. and E. Williams (1976). "A new class of resolvable incomplete block designs." Biometrika 63(1): 83-92.
36. Pixley, K. V., T. Dhliwayo and P.Tongoona. (2006). "Improvement of maize populations by full-sib selection alone versus full-sib selection with selection during inbreeding." Crop science 46: 1130-1136.
37. Pswarayi, A. and B. S. Vivek (2008). "Combining ability amongst CIMMYT's early maturing maize (Zea mays L.) germplasm under stress and non-stress conditions and identification of testers." Euphytica 162(3): 353-362.
38. SAS (2008). SAS, SAS Institute Inc.
39. Singh, R. K. and B. D. Chaudhary (1979). "Biometrical methods in quantitative genetic analysis." Biometrical methods in quantitative genetic analysis.
40. Sofi, P., A. G. Rather and S. Venkatesh (2006). "Triple test cross analysis in maize." Indian J. crop science 1(1-2): 191-193.
41. Sprague, G. F. and L. A. Tatum (1942). "General vs. specific combining ability in single crosses of corn." Journal of the American Society of Agronomy.
42. Sughroue, J. R. and A. R. Hallauer (1997). "Analysis of the diallel mating design for maize inbred lines." Crop science 37(2): 400-405.
43. Tamirat T, Alamerew S, Wegary D, Menamo T (2014) Test Cross Mean Performance and Combining Ability Study of Elite Lowland Maize (Zea mays L.) Inbred Lines at Melkassa, Ethiopia. Adv Crop Sci Tech 2: 140.
44. Troyer, A. F. (2004). "Background of US Hybrid Corn II." Crop science 44(2): 370-380.
45. Tuna, H. (2004). Combining ability analysis for yield and yield related traits in quality protein maize (QPM) inbred lines. Plant Sciences. Haramaya, Haramaya University. MSc.
46. Vasal, S. K., G. Srinivasan, J. Crossa and D. L. Beck (1992). "Heterosis and combining ability of

CIMMYT's subtropical and temperate early-maturity maize germplasm." Crop science 32(4): 884-890.
47. Wagary, D. (2002). Combining ability analysis for traits of agronomic importance in maize inbred lines with different levels of resistance to grey leaf spot (Cercospora Zea maydis). Plant Sciences. Haramaya, Haramaya University. MSc.
48. Wegary, D., B.S.Vivek, B. Tadesse, K. Abdissa, M. Worku and L. Wolde (2010) Combining ability and heterotic relationship between CIMMYT and Ethiopian inbred lines.Ethiop 20, 82-93
49. White, J., A. Rodríguez, M. Banziger, G. Srinivasan, G. Granados and J. Crossa (2001). Maize production environments revisited: a GIS-based approach, CIMMYT.
50. Worku, M., M. Bänziger, D. Friesen, G. S. a. m. Erley, W. J. Horst and B. S. Vivek (2008). "Relative importance of general combining ability and specific combining ability among tropical maize (Zea mays L.) inbreds under contrasting nitrogen environments."

Appendix 1: Mean value of 25x2 line by tester crosses of maize evaluated for grain yield and other related traits at Bako (2012/13)

ENTRY	Crosses	TD	SD	MD	PH	EH	SLP	SLP+	RLP	RLT+	EA	ERP	ERP+
1	L1xT2	81.33	83.00	149.67	263.00	139.00	9.27	0.31	7.96	0.28	2.33	3.95	0.19
2	L1xT1	82.00	83.33	149.67	272.00	142.00	6.10	0.24	6.07	0.24	2.50	3.10	0.18
3	L2xT1	81.33	83.67	150.00	285.00	147.00	7.01	0.26	1.04	0.10	2.33	6.09	0.24
4	L2xT2	81.67	82.67	151.33	263.00	145.00	4.01	0.20	3.00	0.17	2.17	2.94	0.17
5	L3xT2	81.00	83.33	150.67	261.33	139.00	1.08	0.10	6.26	0.25	2.33	3.13	0.18
6	L3xT1	79.00	81.00	149.67	265.00	134.33	1.04	0.10	4.11	0.20	2.50	5.15	0.22
7	L4xT2	81.00	83.00	150.00	273.00	132.33	0.00	0.00	3.13	0.18	2.33	6.23	0.25
8	L4xT1	81.33	82.33	149.00	265.67	136.33	0.00	0.00	1.04	0.10	2.00	2.06	0.14
9	L5xT1	81.33	83.33	149.33	252.67	131.33	1.08	0.10	6.22	0.25	2.17	2.08	0.14
10	L5xT2	80.67	82.33	151.33	263.67	141.00	2.02	0.14	1.01	0.10	2.00	1.01	0.10
11	L6xT2	79.67	82.00	147.67	262.00	131.33	1.96	0.14	2.94	0.17	2.17	2.29	0.15
12	L6xT1	81.33	82.67	148.00	260.67	129.00	2.02	0.14	3.01	0.17	2.50	0.00	0.00
13	L7xT1	80.00	81.00	149.67	259.67	130.67	7.35	0.27	6.86	0.26	1.83	3.92	0.20
14	L7xT2	80.67	82.00	149.33	260.67	135.00	0.00	0.00	3.16	0.18	1.83	0.00	0.00
15	L8xT2	79.67	81.00	149.33	274.67	138.67	1.96	0.13	6.90	0.26	2.50	5.97	0.24
16	L8xT1	79.67	81.33	148.67	268.67	128.00	5.08	0.23	2.08	0.14	2.50	4.04	0.20
17	L9xT1	80.67	82.33	149.67	272.67	137.00	6.00	0.24	2.02	0.14	2.50	4.01	0.20
18	L9xT2	81.00	82.00	148.67	258.00	129.00	3.06	0.18	3.00	0.17	2.17	4.04	0.20
19	L10xT2	82.00	83.67	151.67	275.67	145.00	9.13	0.30	2.08	0.14	2.33	1.01	0.10
20	L10xT1	80.67	82.33	148.67	279.00	147.67	5.24	0.23	3.06	0.18	2.33	1.04	0.10

21	L11xT2	81.33	82.33	148.67	264.67	134.67	3.95	0.19	4.96	0.22	2.33	3.95	0.19
22	L11xT1	81.33	82.33	149.00	262.67	126.33	2.97	0.17	6.03	0.24	2.50	2.00	0.14
23	L12xT2	81.67	83.00	150.00	277.33	138.33	3.00	0.17	3.98	0.20	2.33	1.01	0.10
24	L12xT1	81.33	82.67	148.67	282.67	146.33	5.91	0.24	6.00	0.25	2.33	0.98	0.10
25	L13xT1	80.67	82.00	148.67	274.33	147.00	7.10	0.27	2.00	0.14	2.50	2.05	0.14
26	L13xT2	80.67	81.33	150.67	263.33	147.00	16.10	0.41	8,63	0.30	1.83	4.31	0.21
27	L14xT2	81.00	82.33	149.00	269.33	140.00	7.96	0.28	5.02	0.22	2.50	3.00	0.17
28	L14xT1	81.00	82.67	149.00	264.00	139.33	3.23	0.18	3.19	0.18	2.33	3.19	0.18
29	L15xT2	81.67	82.67	147.67	290.67	159.33	26.28	0.54	3.95	0.20	2.33	2.02	0.14
30	L15xT1	81.33	82.33	150.00	284.67	151.00	14.43	0.39	4.11	0.20	2.00	5.21	0.23

ENTRY	Crosses	TD	SD	MD	PH	EH	SLP	SLP^+	RLP	RLT^+	EA	ERP	ERP^+
31	L16xT1	81.67	83.33	151.67	280.33	142.67	3.06	0.18	3.06	0.18	2.33	0.00	0.00
32	L16xT2	82.33	83.33	150.33	274.67	141.67	7.01	0.27	5.97	0.24	2.17	1.01	0.10
33	L17xT2	80.67	84.67	150.67	292.67	153.67	1.04	0.10	4.10	0.20	2.00	0.00	0.00
34	L17xT1	82.33	84.33	152.33	299.33	165.33	6.00	0.24	7.12	0.27	1.83	2.08	0.14
35	L18xT1	81.33	82.67	151.67	288.33	163.67	3.92	0.20	1.96	0.14	2.00	0.98	0.10
36	L18xT2	80.33	81.33	152.33	296.00	171.00	1.11	0.11	3.14	0.18	1.33	0.00	0.00
37	L19xT2	80.00	82.00	150.67	270.67	156.00	1.04	0.10	6.16	0.25	1.33	3.09	0.17
38	L19xT1	80.33	82.00	151.67	280.00	146.00	0.00	0.00	5.05	0.22	1.50	0.00	0.00
39	L20xT2	81.33	82.67	150.33	298.67	174.33	3.16	0.18	2.08	0.14	2.00	1.01	0.10
40	L20xT1	82.33	83.67	151.67	275.00	157.67	0.00	0.00	2.97	0.17	2.00	0.00	0.00
41	L21xT1	81.00	82.67	152.67	261.33	133.00	3.95	0.19	0.00	0.00	1.67	3.98	0.20
42	L21xT2	81.67	83.00	151.67	268.33	149.33	3.03	0.17	6.12	0.24	1.50	0.00	0.00
43	L22xT2	82.33	83.67	152.67	285.33	157.00	3.92	0.20	3.13	0.18	1.50	0.00	0.00
44	L22xT1	81.00	83.67	153.33	294.00	156.00	2.02	0.14	8.15	0.29	1.33	4.07	0.20
45	L23xT1	81.00	82.67	151.33	280.33	159.67	0.00	0.00	4.01	0.20	2.00	0.00	0.00
46	L23xT2	81.33	82.67	151.33	292.67	172.33	6.09	0.24	2.08	0.14	1.50	3.00	0.17
47	L24xT1	82.67	84.67	151.33	291.00	161.33	3.09	0.17	1.01	0.10	1.50	2.02	0.14
48	L24xT2	82.33	84.33	152.33	286.33	165.00	1.96	0.13	2.02	0.14	1.50	0.98	0.10

49	L25xT2	80.00	82.00	149.67	268.67	143.00	3.06	0.17	5.03	0.22	2.33	1.04	0.10
50	L25xT1	80.00	81.67	150.00	283.00	138.00	1.67	0.13	19.79	0.46	2.00	1.01	0.10
51	BH-540	78.67	79.67	148.00	267.33	142.67	4.20	0.21	11.69	0.35	2.50	1.08	0.10
52	BH-543	81.67	82.33	150.33	257.67	139.67	4.17	0.21	9.38	0.31	2.17	3.13	0.17
MEAN		81.04	82.6	150.22	274.26	145.33	4.38	0.18	4.56	0.2	2.08	2.27	0.13
MINIMUM		78.67	79.67	147.67	252.67	126.33	0.00	0	0.00	0.00	1.33	0.00	0.00
MAXIMUM		82.67	84.67	153.33	299.33	174.33	26.28	0.53	19.79	0.46	2.5	6.23	0.25
CV(%)		1.08	0.99	0.76	3.84	5.5	33.77	17.81	37.25	18.05	12.77	47.32	19.97
LSD (5%)		1.43	1.34	1.86	17.15	13.02	2.41	0.05	2.77	0.06	0.43	1.75	0.04

+ *Traits with transformed data*

**=significant at 0.05 probability level, **=significant at 0.01 probability level*

TD=50% days to tasseling ,SD=50% days to silking, MD =Maturity date, PH=Plant height, EH=Ear height, SLP=stalk lodging percent, RLP= root lodging percent, EA=Ear aspect, , ERP= ear rot percent

Continue appendix 1

ENTRY	Crosses	HCP	HCT	YLDT	TLBSI	TLBSI+	GLSSI	GLSSI+	EL	ED	NKRE	NKR
1	L1xT2	0.00	0.00	6.97	42.67	0.71	21.33	0.48	16.60	4.80	13.73	39.00
2	L1xT1	1.08	0.10	6.80	41.33	0.70	34.67	0.62	17.03	4.70	13.33	40.13
3	L2xT1	4.99	0.22	8.57	42.67	0.71	46.67	0.75	17.10	4.80	13.60	41.40
4	L2xT2	0.00	0.00	9.37	30.67	0.58	37.33	0.65	17.40	4.93	13.73	40.90
5	L3xT2	24.16	0.51	7.93	29.33	0.57	21.33	0.48	18.13	5.13	16.00	40.60
6	L3xT1	21.39	0.48	8.40	28.00	0.55	28.00	0.55	18.33	5.00	15.47	42.40
7	L4xT2	9.23	0.31	7.67	26.67	0.54	20.00	0.46	19.20	4.80	14.40	43.33
8	L4xT1	6.10	0.24	7.67	22.67	0.49	29.33	0.56	18.00	4.87	15.07	41.20
9	L5xT1	3.19	0.18	7.90	56.00	0.86	34.67	0.62	17.50	4.87	15.07	39.13
10	L5xT2	8.08	0.29	8.97	44.00	0.72	20.00	0.46	17.63	4.70	15.20	42.40
11	L6xT2	4.90	0.21	7.33	28.00	0.55	30.67	0.58	17.13	4.80	13.73	38.43
12	L6xT1	5.05	0.22	7.27	24.00	0.51	25.33	0.52	17.37	4.80	15.33	38.27
13	L7xT1	5.88	0.24	7.77	32.00	0.60	65.33	0.95	18.70	4.93	14.93	40.27
14	L7xT2	6.07	0.24	7.53	30.67	0.59	20.00	0.46	18.77	4.70	14.40	38.33
15	L8xT2	6.95	0.26	7.47	36.00	0.64	22.67	0.49	19.47	4.67	14.40	38.40
16	L8xT1	10.02	0.32	7.57	22.67	0.49	34.67	0.63	18.23	4.67	14.80	37.33
17	L9xT1	7.99	0.29	7.77	25.33	0.53	61.33	0.91	18.33	4.80	15.07	39.53
18	L9xT2	9.06	0.30	7.67	28.00	0.55	40.00	0.68	18.60	4.70	14.27	40.27
19	L10xT2	0.00	0.00	7.97	26.67	0.54	28.00	0.55	17.30	4.63	14.93	36.93
20	L10xT1	0.00	0.00	7.93	21.33	0.48	48.00	0.77	18.13	4.63	14.93	39.20
21	L11xT2	3.92	0.20	6.93	26.67	0.54	20.00	0.46	18.27	4.73	14.80	39.87
22	L11xT1	0.00	0.00	7.90	37.33	0.66	44.00	0.73	18.80	4.80	14.80	41.07
23	L12xT2	1.99	0.14	8.27	41.33	0.70	42.67	0.71	19.83	4.70	14.27	42.87
24	L12xT1	4.99	0.22	7.57	29.33	0.57	56.00	0.86	19.17	4.73	14.40	41.67
25	L13xT1	6.09	0.25	8.07	38.67	0.67	41.33	0.70	18.53	4.77	14.00	41.33
26	L13xT2	2.15	0.15	8.50	20.00	0.46	34.67	0.62	18.83	4.73	14.00	42.33
27	L14xT2	17.03	0.43	8.43	37.33	0.65	34.67	0.62	18.63	4.47	13.07	41.27
28	L14xT1	4.30	0.21	7.77	45.33	0.74	52.00	0.83	18.00	4.77	14.13	40.13
29	L15xT2	0.98	0.10	8.30	32.00	0.60	44.00	0.72	17.80	4.60	13.93	42.13
30	L15xT1	5.18	0.23	8.30	34.67	0.62	62.67	0.95	19.27	4.77	14.13	42.73
ENTRY	Crosses	HCP	HCP+	YLDT	TLBSI	TLBSI+	GLSSI	GLSSI+	EL	ED	NKRE	NKR
31	L16xT1	1.01	0.10	8.23	34.67	0.62	78.67	1.09	17.00	4.93	13.60	38.27
32	L16xT2	1.01	0.10	8.23	25.33	0.52	50.67	0.79	17.17	4.73	13.33	40.67
33	L17xT2	0.98	0.10	8.30	26.67	0.53	45.33	0.73	20.00	5.00	14.27	45.07
34	L17xT1	1.96	0.14	9.20	72.00	1.02	41.33	0.69	20.13	4.97	14.93	41.53
35	L18xT1	3.92	0.20	9.47	49.33	0.78	22.67	0.49	18.60	4.77	15.07	40.93
36	L18xT2	0.00	0.00	9.30	32.00	0.60	20.00	0.46	18.97	4.97	14.13	41.87
37	L19xT2	9.31	0.31	9.70	25.33	0.53	25.33	0.52	20.90	4.57	13.73	44.47
38	L19xT1	7.11	0.27	8.47	30.67	0.59	29.33	0.56	21.30	4.67	14.60	44.67

39	L20xT2	18.04	0.44	8.27	41.33	0.69	22.67	0.49	19.30	4.67	13.87	47.60
40	L20xT1	1.96	0.14	9.13	46.67	0.75	52.00	0.82	21.23	4.83	14.27	46.47
41	L21xT1	4.99	0.22	9.07	50.67	0.79	20.00	0.46	18.77	4.73	14.67	41.67
42	L21xT2	4.07	0.20	8.90	53.33	0.82	26.67	0.53	19.17	4.60	15.07	43.93
43	L22xT2	4.02	0.20	9.03	44.00	0.72	20.00	0.46	20.33	4.77	14.13	44.87
44	L22xT1	0.98	0.10	9.93	40.00	0.68	22.67	0.49	20.33	4.97	15.47	44.47
45	L23xT1	5.97	0.25	8.97	45.33	0.74	60.00	0.90	20.20	4.93	16.67	42.47
46	L23xT2	3.00	0.17	8.87	40.00	0.69	26.67	0.53	18.93	4.83	15.33	42.13
47	L24xT1	3.03	0.17	9.97	38.67	0.67	25.33	0.52	18.57	4.83	14.67	41.33
48	24xT2	0.00	0.00	9.43	42.67	0.71	28.00	0.55	21.23	4.70	14.53	45.53
49	L25xT2	0.00	0.00	7.17	28.00	0.55	22.67	0.49	16.60	5.17	14.27	36.60
50	L25xT1	1.96	0.14	7.63	30.67	0.58	20.00	0.46	17.60	5.03	14.00	39.13
51	BH-540	13.81	0.38	6.80	22.67	0.49	26.00	0.52	17.03	4.77	13.07	38.07
52	BH-543	2.09	++	7.20	61.33	0.92	45.33	0.75	18.77	4.60	14.40	39.73
MEAN		5.19	0.19	8.23	35.82	0.64	35.24	0.63	18.62	4.79	14.46	41.24
MINIMUM		0	0	6.8	20	0.46	20	0.46	16.6	4.47	13.07	36.6
MAXIMUM		24.16	0.51	9.97	72	1.02	78.67	1.09	21.3	5.17	16.67	47.6
CV(%)		26.67	14.99	7.5	30.69	18.79	37.63	23.1	6.51	3.4	4.95	5.12
F-TEST		**	**	**	**	**	**	**	**	**	**	**
LSD (5%)		2.26	0.05	1.01	17.92	0.2	21.62	0.24	1.98	0.27	1.17	3.44

+Traits with transformed data

=significant at 0.05 probability level,=significant at 0.01 probability level*

HCP=husk cover percent, YLDT=Grain yield tones per hectare, TLBSID=Turcicum leaf blight severity index, GLSSID=Gray leaf spot severity index, EL=Ear length, ED=Ear diameter, NKRE=Number of kernel rows per ear, NKR=Number of kernels per row

This page is intentionally left blank

Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 15 Issue 4 Version 1.0 Year 2015
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Contract Farming in Sugarcane and Reactions of the Farmers- A Study in Odisha

By Dr. Sangram Paramaguru, Dr. (Mrs.) Anindita Saha,
Mrs. Sanghamitra Mohapatra & Miss Plabita Ray
Orissa University of Agriculture and Technology, India

Abstract- Contract farming requires a long term commitment from both the contracted growers and sponsoring firms. Exploitative arrangements can jeopardize agribusiness investments. The study revealed that the contracted sugarcane growers reacted significantly towards immediate payment, arranging credit for infrastructure, implements and machineries on custom hiring, increasing risk bearing abilities, conflict resolution, quality production, transparency in measurement, contingent measures in catastrophes, exposure visit etc. The sponsoring firms have to analyze all these reactions of the respondents and extend all possible supports for sustainability of the contract farming in sugarcane cultivation.

Keywords: *contract farming, sugarcane cultivation, respondents, support.*

GJSFR-D Classification : *FOR Code: 040699*

Strictly as per the compliance and regulations of :

Contract Farming in Sugarcane and Reactions of the Farmers – A Study in Odisha

Dr. Sangram Paramaguru [α], Dr. (Mrs) Anindita Saha [σ], Mrs.Sanghamitra Mohapatra [ρ] & Miss Plabita Ray [ω]

Abstract- Contract farming requires a long term commitment from both the contracted growers and sponsoring firms. Exploitative arrangements can jeopardize agribusiness investments. The study revealed that the contracted sugarcane growers reacted significantly towards immediate payment, arranging credit for infrastructure, implements and machineries on custom hiring, increasing risk bearing abilities, conflict resolution, quality production, transparency in measurement, contingent measures in catastrophes, exposure visit etc. The sponsoring firms have to analyze all these reactions of the respondents and extend all possible supports for sustainability of the contract farming in sugarcane cultivation.

Keywords: contract farming, sugarcane cultivation, respondents, support.

I. Introduction

Contract farming would appear to have considerable potential where small scale Agriculture continues to be wide spread. It is a win-win situation for both the contracted growers and sponsoring firms in improvement of farm income, development of Agro-processing and expansion of rural economy. The contracted growers get the benefits of input and production services, exposure to appropriate technology, develop knowledge and skill competency in successful crop management, guaranteed and fixed sale price as well as access to reliable markets. However; increased risk, unsuitable technology, crop incompatibility, monopoly and manipulation of quality specifications by the contracting firms are some of the potential problems faced by the farmers. These potential problems however can be minimized by efficient management, regular guidance and close monitoring of fields operations. A study was therefore designed to assess the reactions of the sugarcane growers towards successful contract farming.

II. Methodology

The study was undertaken in Dhenkanal and Khurdha districts of Odisha during 2012. Dhenkanal sadar and Kamakshyanagar blocks in Dhenkanal as well as Bolagarh and Begunia blocks in Khurdha districts were selected considering the potentialities of sugarcane cultivation and involvement of farmers under contract farming. Twenty sugarcane growers each under contract farming from three panchayats of each blocks were selected randomly as the respondents for the study covering total sample size of 240.

Reactions of the respondents towards planning, organizing, input supply, credit and finance, technological backstopping, infrastructure support, harvesting and marketing were selected as the variables. Information was collected personally from the respondents with a semi-structured schedule pre-tested earlier. The data collected on scale point of regularly, occasionally and never over the framed statements were analyzed with score value of 3, 2 and 1 respectively. Mean score, gap percentage and multiple regression tests were employed to reveal the results.

III. Results and Discussion

Planning is the most fundamental function of management. Effective planning provides for co-operative and coordinated efforts, facilitates timely execution of tasks, reduce uncertainties and makes implementation easier. Analysis of data (Table – 1) revealed that considerable percentages of gaps

Author α: SMS, Agril. Extension, Krishi Vigyan Kendra, Puri, O.U.A.T, Odisha. e-mail: sangram_takan@yahoo.co.in
Author σ: Asso. Professor, Agril. Extension, Palli Siksha Bhavana,Visva-Bharati, Santiniketan, West Bengal.
Author ρ: Asst. Prof. Dept. of Home Science, Extension and Communication Management, SHIATS, Allahabad, Uttar Pradesh.
Author ω: Ph. D. Schola, Agronomy, O.U.A.T, Bhubaneswar, Odisha.

Table1: Reactions towards planning by contracting firms

Sl. No.	Reaction	Dhenkanal district (n=120)		Khurdha district (n=120)		Total (n=240)	
		Mean score	Gap (%)	Mean score	Gap (%)	Mean score	Gap (%)
1.	Participatory decision making	1.82	39.33	1.78	40.67	1.80	40.00
2.	Cluster approach	1.82	39.33	1.98	34.00	1.90	36.67
3.	Optimum utilization of available resources	1.98	34.00	1.87	37.67	1.93	35.67
4.	Participatory selection of land	2.12	29.33	2.07	31.00	2.10	30.00
5.	Beneficiary selection with common agreement	1.84	38.67	1.78	40.67	1.81	39.67
6.	Due attention for environment protection	1.93	35.67	1.98	34.00	1.96	34.67
7.	Detail understanding of the objectives	1.86	38.00	1.95	35.00	1.91	36.33

(Maximum obtainable score – 3)

were observed on various aspects of planning as mentioned in the table. Participatory decision making facilitates team spirit, coordination and cooperation among the growers. Cluster approach makes effective monitoring and supervision as well as optimum utilization of resources. Moreover, the growers should have detail understanding about contract farming. The officials of the contracting firms have to analyze these deficiencies and take steps accordingly while planning for sugarcane cultivation.

Community organization and group formation are essential for developing team spirit and interest among the farmers to involve under contract farming. As revealed from the study (Table – 2), the respondents of both the

Table 2 : Reactions towards organizational support

Sl. No.	Reaction	Dhenkanal district (n=120)		Khurdha district (n=120)		Total (n=240)	
		Mean score	Gap (%)	Mean score	Gap (%)	Mean score	Gap (%)
1.	Community organization	1.75	41.67	1.85	38.33	1.80	40.00
2.	Group formation	1.83	39.00	1.68	44.00	1.76	41.33
3.	Leadership development	2.11	29.66	2.03	32.33	2.07	31.00
4.	Motivating for risk bearing ability	2.21	26.33	2.38	20.67	2.30	23.33
5.	Climate of team work	1.98	34.00	2.05	31.67	2.02	32.67
6.	Conflict resolution	1.67	44.33	1.53	49.00	1.60	46.67
7.	Assigning responsibility individually	1.95	35.00	1.93	35.67	1.94	35.33

(Maximum obtainable score – 3)

districts had favorably opined for leadership development, motivating for the risk bearing abilities and climate of team work. Further emphasis may be given for community organization, group formation, conflict resolution and assigning responsibility to individual growers for the sustainable continuance of sugarcane cultivation under contract farming.

Many contractual agreements involve considerable production supports in addition to the supply of basic inputs like seeds, fertilizers, plant protection chemicals etc. for desired production with quality parameters. The data inTable-3 revealed for the contradictory opinions among the respondents of both the

Table 3 : Reactions towards input support

Sl. No.	Reaction	Dhenkanal district (n=120)		Khurdha district (n=120)		Total (n=240)	
		Mean score	Gap (%)	Mean score	Gap (%)	Mean score	Gap (%)
1.	Pre-arrangement of inputs	2.07	31.00	1.68	44.00	1.88	37.33
2.	Timely supply and use	2.08	30.67	1.88	37.33	1.98	34.00
3.	Supply of quality inputs	1.98	34.00	2.06	31.33	2.02	32.67
4.	Developing competency in use of inputs	2.17	27.67	2.25	25.00	2.21	26.33
5.	Arranging additional inputs	1.92	36.00	1.93	35.67	1.93	35.67
6.	Transparency in supply of inputs	1.67	44.33	1.82	39.33	1.75	41.67

(Maximum obtainable score – 3)

have to analyze all these reactions of the growers and ensure availability of quality inputs in time for optimum quality production.

Contract farming facilitates the access of the growers to the credit institutions for credit support since sugarcane crop required more production inputs. Reactions of the respondents revealed (Table–4) that very poor

Table 4 : Reaction towards credit and finance support

Sl. No.	Reaction	Dhenkanal district (n=120)		Khurdha district (n=120)		Total (n=240)	
		Mean score	Gap (%)	Mean score	Gap (%)	Mean score	Gap (%)
1.	Providing credit for crop management	1.67	44.33	1.70	43.33	1.69	43.67
2.	Arranging credit for crop inputs	1.58	47.33	1.80	40.00	1.69	43.67
3.	Liasoning for subsidy facilities	1.46	68.49	1.62	46.00	1.54	48.67
4.	Arranging credit for infrastructure	1.33	55.67	1.48	50.67	1.41	53.00
5.	Crop insurance	1.48	50.67	1.53	49.00	1.51	49.67

(Maximum obtainable score – 3)

attempts were taken for providing necessary credit support. The contracting firms have either to provide credit for production management or make arrangement of credit from the credit institutions enabling the respondents to use recommended inputs for desired quality production as well as developing infrastructure. Liasoning have also to be made for crop insurance and subsidy facilities to develop interest among the growers for continuance of the contract farming.

Farm mechanization is of paramount importance due to labour scarcity and wage hike. Moreover; irrigation facilities are required for successful crop rising. As observed from Table – 5, the respondents had favourably opined for

Table 5 : Reactions towards infrastructure support

Sl. No.	Reaction	Dhenkanal district (n=120)		Khurdha district (n=120)		Total (n=240)	
		Mean score	Gap (%)	Mean score	Gap (%)	Mean score	Gap (%)
1.	Motivating for farm mechanization	2.05	31.67	2.17	27.67	2.11	29.67
2.	Arranging implements/ machineries on custom hiring	1.54	48.67	1.40	53.33	1.47	51.00
3.	Developing irrigation facilities	1.77	41.00	1.62	46.00	1.70	43.33
4.	Skill competency in use of implements	2.42	19.33	2.12	29.33	2.27	24.33
5.	Arranging credit for infrastructure	1.58	47.33	1.73	42.33	1.66	44.67

6.	Increasing risk management abilities for infrastructure	1.51	49.67	1.68	44.00	1.60	46.67

(Maximum obtainable score – 3)

farm mechanization and skill competency in use of implements. But the reactions of the respondents towards arranging implements and machineries on custom hiring, developing irrigation facilities, credit for developing own infrastructure along with increasing their risk bearing abilities are genuine and suggested for favorable action by the contracting firms towards these infrastructure support.

Technologies are changing very fast. Small scale farmers are reluctant frequently to adopt these new technologies because of possible risk and cost involved. These new technologies should therefore be initiated in a well managed and structured farming operation. Reactions of the respondents towards technological support indicated (Table – 6) that the respondents of

Table 6 : Reactions towards technological support

Sl. No.	Reaction	Dhenkanal district (n=120)		Khurdha district (n=120)		Total (n=240)	
		Mean score	Gap (%)	Mean score	Gap (%)	Mean score	Gap (%)
1.	Developing knowledge competency	2.31	23.00	2.32	22.67	2.32	22.67
2.	Skill competency in use of technology	2.25	25.00	2.30	23.33	2.28	24.00
3.	Patience in educating farmers	1.96	34.67	1.97	34.33	1.97	34.33
4.	Exposure visit for gaining experience	1.77	41.00	1.75	41.67	1.76	41.33
5.	Continuous flow of information	1.98	34.00	2.03	32.33	2.01	33.00
6.	Proper guidance	2.08	30.67	2.13	29.00	2.11	29.67
7.	Sharing information with farmers	1.70	43.33	1.73	42.33	1.72	42.67
8.	Timely feed back	1.73	42.33	1.70	43.33	1.72	42.67
9.	Encouraging farmers for discussion	1.75	41.67	1.82	39.33	1.79	40.33
10.	Believe farmers ability in success	2.25	25.00	2.46	18.00	2.36	21.33

(Maximum obtainable score – 3)

both Dhenkanal and Khurdha district were almost of similar opinions. The respondents had favourably opined for developing knowledge and skill competency as well as believe farmers ability in success. But, further strengthening are suggested towards sharing of information with farmers for detail understanding, timely guidance, encouraging for discussions to clarify doubts, exposure visit for experience.

Contact farming provides market guarantee to the growers along with procurement of produce with remunerative price. The alayzed data reflected in Table-7 revealed that the respondents both Dhenkanal and Khurdha district had

Table 7 : Reactions towards harvesting and marketing support

Sl. No.	Reaction	Dhenkanal district (n=120)		Khurdha district (n=120)		Total (n=240)	
		Mean score	Gap (%)	Mean score	Gap (%)	Mean score	Gap (%)
1.	Educating for timely harvest	2.38	20.67	2.33	22.33	2.36	21.33
2.	Participatory decision on harvesting	2.33	22.33	2.25	25.00	2.29	23.67
3.	Fixing remunerative sale price	1.68	44.00	1.88	37.33	1.78	40.67
4.	Immediate lifting of the produce	1.78	40.67	1.68	44.00	1.73	42.33
5.	Due attention for quality maintenance	1.77	41.00	1.53	49.00	1.65	45.00
6.	Immediate measurement at factory side	1.96	34.67	1.68	44.00	1.82	39.33

7.	Transparency in measurement	1.71	43.00	1.60	46.67	1.66	44.67
8.	Immediate payment	1.40	53.33	1.15	61.67	1.28	57.33

(Maximum obtainable score – 3)

reacted for not fixing remunerative sale price, insufficient attempt for quality maintenance, no transparency in measurement, not lifting the produce in time and no immediate payment. All these indicated for the deviation of contracting norms and monopolies of the sponsoring firms. Hence, the sponsoring firms have to analyze these reactions and take appropriate steps for the sustainability of the contract farming in sugarcane cultivation.

Multiple regressions revealed (Table-8) that the best fitted regression equation could explain only 17.90% of the total variance in influencing the attitudes of the respondents towards sugarcane cultivation under contract farming. It the therefore inferred that socio-economic variables of the respondents had not much influence in developing interest among the growers towards sugarcane cultivation under contract farming.

Table 8 : Regression analysis of the socio-economic variables influencing sugarcane cultivation (N=240)

Sl. No.	Variable	Un standardized Co-efficient		Standardized Co-efficient		T value	Significance
		Beta	Std. Error	Beta	Std. Error		
1	Age	-0.637	3.042	-0.016	0.077	-0.210	0.834
2	Caste	0.302	1.321	0.015	0.065	0.228	0.819
3	Education	-2.456	2.027	-0.099	0.081	-1.212	0.227
4	Family type	3.063	3.677	0.065	0.078	0.833	0.406
5	Family size	2.679	2.485	0.083	0.077	1.078	0.282
6	Social participation	-0.195	1.279	-0.011	0.071	-0.152	0.879
7	Extension contact	-0.061	0.597	-0.007	0.070	-0.102	0.919
8	Cosmopoliteness	0.086	0.666	0.009	0.074	0.129	0.897
9	Housing pattern	1.015	1.483	0.046	0.067	0.685	0.494
10	Holding size	3.523	1.981	0.166	0.093	1.778	0.077
11	Occupation	2.739	2.071	0.095	0.072	1.323	0.187
12	Possession of farm implements	0.431	0.302	0.157	0.111	1.424	0.156
13	Sources of information	0.716	0.829	0.057	0.066	0.863	0.389
14	Annual income	-1.113	1.474	-0.049	0.065	-0.755	0.451
15	Social character	-0.188	0.513	-0.052	0.143	-0.367	0.714
16	Economic character	0.179	0.637	0.040	0.142	0.281	0.779

$R^2=0.179$, $Adj.R^2=0.113$, $S.E = 15.187$

IV. Conclusion

Sugarcane growers are usually opting for contract farming due to assured marketing with remunerative price, technological expertise and supply of quality inputs. But the findings revealed that the respondents had reacted much towards weak supports on immediate payment, arranging credit for farm mechanization and irrigation, implements and machineries on custom hiring, increasing risk bearing abilities, conflict resolution, quality production, transparency in measurement, contingent measures in catastrophes, exposure visit etc. Socio-economic variables of the respondents had not much influence in accelerating the proficiency of the respondents.

It is therefore suggested that the sponsoring firms have to analyze these reactions and extend all possible support for sustainability of the contract farming in sugarcane cultivation.

References Références Referencias

1. *Adewumi, M.O., Afolayan, A.J. and Masika, P.J., (2010):* Contract farming approach to essential oil production in the Eastern Cape province of South Africa, *Journal of Agriculture and Social Research*, *10 (1) : 73-79.*
2. *Gupta, S., 2002 :* Contract farming, *National Bank News Reviews, 18 (1) : 64-67.*
3. *Kumar, H and Singh, R., (2005):* Success and failure of contract farming in Himachal Pradesh; A case study of cauliflower seed production, *Indian Journal of Agricultural Marketing, 19 (2):170-174.*
4. *Masakune and Henson, S. 2005 :* why do small scale producers choose to produce under contract, *World Development 33 (10) : 1721-1733.*
5. *Pandit, A, Pandey, N.K., Rana, R.K. and Lal, B. 2009* : An impirical study of grains from potato contract farming, *Indian Journal of Agriculture Economics, 64 (3) : 200-204.*

This page is intentionally left blank

Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 15 Issue 4 Version 1.0 Year 2015
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Coastal Farmers' Perception of Climate Change Effects on Agriculture at Galachipa Upazila under Patuakhali District of Bangladesh

By M. G. R. Akanda & M. S. Howlader
Patuakhali Science and Technology University, Bangladesh

Abstract- Bangladesh is one of the most vulnerable countries to climate change with a very high population density. The increasing risks from climate change, sea level rise, and natural and man-made hazards—such as cyclones, storm surge, flooding, land erosion, water logging, and salinity intrusion in soil and water have already adversely affected livelihoods of people living in environmentally fragile coastal areas of Bangladesh. This study identifies the relationship between the characteristics of the farmers and their perception of climate change effects on coastal agriculture at Patuakhali district of Bangladesh. To make the outcomes useful, both qualitative and quantitative approaches of field investigations were done.

Keywords: *agriculture, coastal, climate change, farmer, perception, adaptation.*

GJSFR-D Classification : *FOR Code: 960399, 079999*

Strictly as per the compliance and regulations of :

Coastal Farmers' Perception of Climate Change Effects on Agriculture at Galachipa Upazila under Patuakhali District of Bangladesh

M. G. R. Akanda [α] & M. S. Howlader [σ]

Abstract- Bangladesh is one of the most vulnerable countries to climate change with a very high population density. The increasing risks from climate change, sea level rise, and natural and man-made hazards—such as cyclones, storm surge, flooding, land erosion, water logging, and salinity intrusion in soil and water have already adversely affected livelihoods of people living in environmentally fragile coastal areas of Bangladesh. This study identifies the relationship between the characteristics of the farmers and their perception of climate change effects on coastal agriculture at Patuakhali district of Bangladesh. To make the outcomes useful, both qualitative and quantitative approaches of field investigations were done. The perception scores of the farmers ranged from 50 to 88 with a mean and standard deviation 78.03 and 5.72 respectively. Majority (80.20 percent) of the farmers has low to medium perception and 19.80 percent high perceptions were found in this area. The research showed that some respondents had a clear understanding of climate change which directly affecting their lives and livelihoods. Most respondents were also aware of to adapt to the climate change effects on coastal agriculture. However, the most respondents were less able to understand about climate change impacts on agriculture due to several factors which also characterize in this study. Among the selected personal characteristics some were positively related and some were negatively related with their perception on climate change effects on coastal agriculture. The perceived aspects according to the perceived frequency/index were increased temperature, increased disease of crop, longer summer, increased insect infestation, unexpected rainfall, during winter water shortage hinder fish production, increase in poultry disease, unavailability of fish, reduced soil fertility, Saline water intrusion due to increased tidal flow, climate change occur due to deforestation, emission of industrial CO2 cause global warming, etc.

Keywords: agriculture, coastal, climate change, farmer, perception, adaptation.

I. Introduction

Agriculture is the backbone of economy of Bangladesh. About 80% of the population lives in rural areas and directly or indirectly depends on agriculture. There are concerns regarding agricultural sector as Climate change effects on the same sector as Climate change effects on the same becoming prominent. Climate change is a major challenge to agricultural development in the country like Bangladesh and the world at large. It is not only challenge to agricultural development but to food security and the general livelihood conditions of any population. Agriculture, being one of the most weather-dependent of activities is highly vulnerable to climate change because of its dependence on rain fed agriculture, high levels of poverty, and low levels of human and physical capital, inequitable land distribution and poor infrastructure.

Bangladesh is located between 20̊34' to 26˚38' North latitude and 88˚01' to 92˚42' East longitude. The country occupies an area of 147,570 sq. km (BBS, 2012). Bangladesh is one of the most populated countries in the world having a coastal area of 47,211 sq. km. which is 32% of its entire land. The coast of Bangladesh is approximately 711 km. long which has a very low-laying flat land. Sixty two (62%) percent of the land has an elevation less than 3 meters and 86% have less than five meters (Mobassarul et al., 2009) [20]. The population of the coastal zone of Bangladesh was 36.8 million in 2001. Agricultural labourers, small farmers, fisherfolk and the urban poor make up 71 percent of the 6.85 million households (Ahmad, 2004) [1]. Severe floods, cyclones, tornados are hitting every year; salinity and cold spell claims human lives as well as damage crops. According to experts these are early sign of global warming effects. Sea level rise in the coming decades will create over 25 million climate refugees (Climate Change Cell, 2007) [8]. According to UNFCCC (2005) [29] Bangladesh is one of the top risked countries in terms of natural disaster in the world.

The effects of climate change in Bangladesh are still being understood, but it is likely that changes include higher temperatures throughout the year and problems with rainfall predictability leading to greater shortages in some seasons and flooding in others (Khan 2011; Rana, Rajib, and Rahman 2011; Shahid 2010a; Thurlow et al. 2012) [17][22][25][27]. Some studies predict that rainfall will increase in the wet monsoon season and decrease in the dry winter and spring months (Shahid 2010a; Thurlow et al 2012) [25][27], while other studies vary in predicting which

Author α: Professor, Department of Agricultural Extension and Rural Development, Patuakhali Science and Technology University, Bangladesh. e-mail: rabbanipstu@yahoo.com
Author σ: MS student, Department of Agricultural Extension and Rural Development, Patuakhali Science and Technology University, Bangladesh. e-mail: hsumonpstu10@gmail.com

months will be most affected by erratic rainfall (Thomas et al. 2013) [26]. In coastal areas, it is likely that sea level rises will lead to increased salinity of groundwater. Moreover, greater frequency of cyclones and storm surges is likely (Karim and Mimura 2008) [15]. These complex changes interact with other trends not directly caused by climate change—particularly the impact of increased agricultural water extraction and potential adverse water availability impacts from diversion of rivers upstream in India—in depleting river flow and replenishment of ground water aquifers in Bangladesh.

Thurlow et al. (2012) [27] predict that climate change may reduce dry (winter) season (irrigated) boro production more than wet season aus and aman, and increase food insecurity in Bangladesh. Karim et al. (1996) [16] reported that the 1988 flood caused reduction of agricultural production by some 45 percent. Prolonged flood can cause death of livestock through a number of direct and indirect mechanisms (Ahmad and Mirza, 2000; Choudhury et al., 2003) [2][7]. Climate change has increased the extent of monsoon flooding and threat to culture fishes has also increased under climate change (GOB, 2005) [10]. Cyclone and storm surge have both immediate and long term consequences on coastal agriculture (Uddin, 2012) [28]. The saline water hampers the productivity of the soil for several years. In recent cyclone SIDR, among the productive sectors, damage was highest (USD 0.43 Million) in agriculture. According to the latest estimates, about 800,000 to 1300,000 MTs of paddy have been destroyed in SIDR which created severe food insecurity among the affected people (GoB, 2008) [11]. Shrimp culture in ghers both inside and outside embankments are threatened by high tides and flood (Howlader et. al., 2015) [12]. Livestock also suffer large-scale death in cyclonic storm surge (Haider et al., 1991)[13].

Droughts disturb land preparation and ploughing activities, delaying the broadcasting, sowing and the planting of crops. Boro, wheat and other crops grown in the dry season are also affected by drought. After independence major droughts occurred in Bangladesh causing substantial reduction in food production. FAO (2008)[9] forecast that, dry season rainfall may decrease by 37 percent, which will increase the risk of droughts significantly. The local elder persons said that, gradual increase in salinity also increased competition for freshwater resources; the livestock suffered the brunt of such a calamity (RVCC, 2003) [23].

Bangladesh has been ranked as the 3rd most vulnerable in the world to sea level rise in terms of the number of people and in the top ten in terms of percentage of population living in the low elevation coastal zone. World Bank (2000) [30] estimated that by the year 2020, 2050 and 2100 the sea level of Bangladesh would increase 10 cm, 25 cm and 1 m. Sea level rise could potentially force around 33 million people to lose their home by 2050 and up to 43 million by 2080 (Mohal & Hossain, 2007) [21]. CEGIS (2006)[6] has shown that rice suitable areas would decrease significantly due to sea level rise along the coastal region of Bangladesh. Sea level rise has increased coastal flood frequency which caused salinity intrusion and the secondary impact is a significant reduction of rice yield in coastal area (Ali, 2005) [3]. A World Bank (2000) [30] study suggest that increased salinity alone from a 0.3 meter level sea rise will cause a net reduction of 0.5 million metric tons of rice. Global Circulation Model (GCM) results predict an average temperature increase in Bangladesh due to climate change of 1.0^{o}C by 2030 and 1.4^{o}C by 2050 (IPCC,2007)[14].

Perception refers to the process concerned with the acquisition and interpretation of information from one's environment (Maddox, 1995) [19]. Maddison (2006)[18] described that adaptation to climate change requires that farmers first notice that the climate has changed, and then identify useful adaptations and implement them. Another important issue related to adaptation in agriculture pointed out by Bryant et al. (2000) [5] is how perceptions of climate change are translated into agricultural decisions. Howlader et al., (2015) [12] described that adaptation towards climate change is affected by mostly the same factors affect farmers perception in this study, thus perception is the preliminary stage to adaptation towards climate change. Maddison (2006) [18] argues that if farmers learn gradually about the change in climate, they will also learn gradually about the best adaptation options towards it. According to him, farmers learn about the best adaptation options through three ways: (1) learning by doing, (2) learning by copying, and (3) learning from instruction. So, Farmers' perception of climate change need to be documented for these are thought to influence the success of agricultural production compared to other factors. Therefore, study of farmers' perception of climate change effects on coastal agriculture should be appraised as well as identify gaps where scientists and other stakeholders including extension agents could provide vital inputs to assists farmers. Thus the need for this research to assess the farmers' perceptions of climate change effects on costal agriculture to meet the need of this important group of stakeholders in the agricultural development system.

a) Purpose and Objectives

The overall purpose of the study was to identify the perception of climate change effects on coastal agriculture among farming households of Coastal Bangladesh. Specifically, the paper sought to:

1. To determine and describe the extent of farmer's perceptions of climate change effects on coastal agriculture.
2. To explore the relationship between the dependent variables (farmers' perception) and the independent variables (farmers selected characteristics)

II. Materials and Method of the Study

a) Study location and Sampling

The study area was coastal area namely Galachipa upazila at Patuakhali district of Bangladesh. The geographic location of the study area is 22.1639°N 90.4306°E. Galachipa upazila has 13 unions from which Galachipa union was selected randomly. From 12 villages 5 villages viz. Boalia, East Ratandi, Gorabala, Kalikapur and Pokkhia were selected randomly. Landless and absentee farmers were discarded from the farmers list with the help of SAAOs. Thus the Sample population was 1012. Then 10 percent of the sample population from each village was selected separately as the sample of the study by simple random sampling procedure. Thus the sample size was 101. A reserve list of 10 percent of the sample size was also prepared in case of absence of the selected sample during data collection despite all attempts.

b) Data collection and processing

Data were collected personally by the researcher himself through face to face visit to all the selected farmers during 1st August, 2014 to 10th September, 2014. The collected data were systematically recorded, edited, arranged, compiled, tabulated, computerized and analyzed in accordance with the objectives of the study. Different statistical treatments like frequency, range, mean, percentage, distribution, standard deviation, categories and indices etc. were used to describe, represent and explaining the relationship among variables in this study.

c) Variables of the study

In the present study, ten selected characteristics namely age, education, farm size, farming experience, annual income, training experience, communication exposure, organizational participation, agricultural knowledge and fatalism were selected as the independent variable, which measured using the prevailing standard methods.

Farmers' perception of climate change effects on coastal agriculture was the dependent variable. The procedure followed in measuring the dependent variable is presented below.

d) Measurement of Farmers' perceptions on effects of climate change on coastal agriculture

A-five point rating scale ranging from ''strongly agree'' to ''strongly disagree'' was developed to measure the extent of perception of climate change effect in affected areas. Strongly agree, agree, undecided, disagree and strongly disagree was assigned as 4,3,2,1 and 0. The extent of perception of climate change found by the farmers was computed by adding all scores obtained from 25 aspects of perception on climate change observed by respondents. The perception of climate change score of the respondents ranged from 0 to 100 where 0 indicating no perception of climate change and 100 indicating extreme perception.

To find out the relationship between the farmers' perception of climate change effects on coastal agriculture and the selected characteristics of the farmers, the Pearson's Product Correlation was computed. To determine the interrelationships among the variables Correlation matrix was also computed. Five percent (0.5) levels of significance were used as the basis of statistical significance.

III. Result and Discussion

The perception scores of the farmers ranged from 50 to 88. The mean and standard deviation were 78.03 and 5.72 respectively. On the basis of perception scores of the farmers were classified into three groups viz. "low perception ", "medium perception", ''high perception" The distribution of the farmers based on their perception score shown in Figure 1.

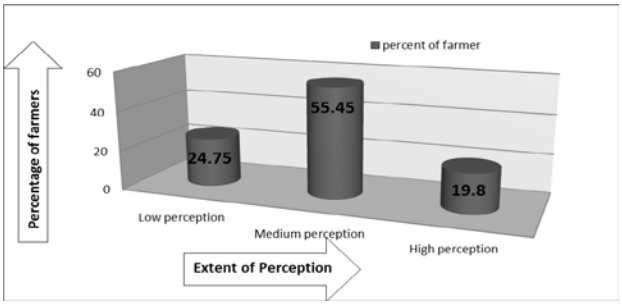

Figure 1 : Distribution of farmers according to their perception

Slightly less than three-fifth (55.45 percent) of the farmers had medium perception compared to 24.75 percent of them having low and 19.80 percent high perception were found in this area. Thus majority (80.20 percent) of the farmers has low to medium perception.

a) Rank order of Farmers perceived aspects of climate change effects on coastal agriculture

It was necessary to have an understanding about the comparative perception of the farmers on the 25 selected aspects. A perception Index (PI) for selected 25 aspects was computed to serve the purpose by using the formula.

Perception Index (PI)= PI×1+Pm×2+ Ph×3

Where,

PI = Percentage of farmers having low perception.

Pm = Percentage of farmers having medium perception.

Ph= Percentage of farmers having high perception.

Perception Index (PI) for any of the selected aspects could range from 0 to 404, where 0 indicating minimum perception and 404 indicating maximum

perception. However, computed perception index ranged from 222- 382.

Table 1 : Rank order of farmer's perceived aspect of climate change effects on coastal agriculture

Statements	Perception index	Rank
Increased Temperature	386	1st
Increased disease of crop	384	2nd
Longer Summer	382	3rd
Increased insect infestation	381	4th
Unexpected rainfall	378	5th
During winter water shortage hinder fish production	375	6th
Increased poultry disease	371	7th
Unavailability of fish	370	8th
Reduced Biodiversity	358	9th
Reduced Soil fertility	357	10th
Increased soil salinity	348	11th
Crop failure increased due to seasonal change	339	12th
Decreased yield	326	13th
Scarcity of irrigation water in Drought season	311	14th
River erosion decreases Agricultural land	303	15th
Frequency of flood/cyclone increased	291	16th
Lower production of cattle due to scarcity of grazing land at drought season	283	17th
Increased Food shortage	275	18th
Intensified winter	270	19th
Increased water logging condition	266	20th
Shorter winter	265	21st
Saline water intrusion due to increased tidal flow	260	22nd
Deforestation cause climate change	243	23rd
Emission of industrial CO2 cause Global warming	242	24th
Greenhouse gas cause climate change	222	25th

i. *Measurement of independent variables*

In this study 10 selected characteristics of the farmers were selected for investigation. The characteristics were age, education, farm size, farming experience, annual family income, training experience, communication exposure, organizational participation, agricultural knowledge and fatalism. The salient features of the different characteristics have been presented below-

Table 2 : Distributions of the farmers according to their personal characteristics

Characteristics	Categories	Number	Percentage	Mean	SD
Age	Young (up to 35)	20	19.80	44.50	8.67
	Middle aged (36-50)	54	53.50		
	Old (>50)	27	26.70		
Education	Illiterate (0)	15	14.85	4.56	3.40
	Can sign only(0.5)	22	21.80		
	Primary (1-5)	30	29.75		
	Secondary (6-10)	28	27.70		
	Above secondary(>10)	6	5.90		
Farm size	Marginal (>.02-.20 ha)	8	7.90	2.16	1.67
	Small (.21-1.00 ha)	20	19.80		
	Medium (1.01-3.00 ha)	50	49.50		
	Large (above 3.01 ha)	23	22.80		
Farming experience	Short (8-19 years)	30	29.70	24.40	8.21
	Medium (20-30 years)	47	46.50		
	Long (>30 years)	24	19.80		
Annual family income ('000' tk)	Low (90-200)	73	72.30	185.64	79.58
	Medium (201-300)	20	19.80		
	High (>300)	8	7.90		
Training experience	No (0 days)	28	27.70	14.12	12.86
	Short (1-12 days)	12	11.90		
	Medium (13-20 days)	44	43.56		
	Long (>20 days)	18	17.84		
Communication exposure	Low (22-30)	14	13.87	37.21	4.84
	Medium (31-38)	62	61.38		
	High (>38)	25	24.75		

Organizational participation	No (0)	27	26.73	6.49	4.36
	Low (1-7)	30	29.70		
	Medium (8-14)	34	33.67		
	High (>14)	10	9.90		
Agricultural knowledge	Low (up to 30)	20	19.80	32.68	3.10
	Medium (31-35)	63	62.37		
	High (>36)	18	17.83		
Fatalism	High (>41)	17	16.83	37.60	4.17
	Medium (34-40)	56	55.45		
	Low (27-33)	28	27.72		

Data presented in table 2 indicate that Majority of the respondents were having low level of education (69.30 percent). Majority (72.30 percent) were aged 35 to 65 years, with farming experience ranging from 20 to 45 years (66.3%). Most of the farmers (79.20 percent) have medium to marginal farm size and majority of them belongs to low income (72.30 percent). About 27.70 percent of the respondents have no training experiences. Majority (56.43 % and 73.25%) of respondents had low to medium organizational participation and communication exposure respectively. Majority of the farmers (72.28 percent) are fatalistic in behavior.

b) Relationship between selected characteristics of the farmers and their perception of climate change effects on coastal agriculture

Farmers' perception and adaptation strategies towards climate change effects on coastal agriculture studied in the study. The relationship of 10 selected characteristics of the farmers to their problem confrontation in the selected area was determined. In order to know the relationship of the selected 10 characteristics (independent variables) of the farmers with their perception (dependent variable), correlation analysis was done between the variables. The results of correlation analysis are shown in Table 3.

Table 3 : Relationship between selected characteristics of the farmers and their perception of climate change effects on coastal agriculture

Dependent variable	Independent variable (Farmers characteristics)	Coefficient of correlation (r)
Farmers' Perception of climate change effects on coastal agriculture	1.Age	.040
	2. Education	.305**
	3. Farm size	.239*
	4. Farming experience	.037
	5. Annual family income	.229 *
	6. Training experience	.168
	7. Communication exposure	.496**
	8. Organizational participation	.166
	9. Agricultural knowledge	.663**
	10. Fatalism	-.666 **

** = Significant at .01 level,

*= Significant at .05 level

IV. Conclusion

Bangladesh's coast is the worst victim to natural disasters. Climate change impacts are already adding significant stress to physical and environmental resources of the people, their human ability, and socio-economic activities. In this paper the perception of farmers towards climate change effects on coastal agriculture in the study has been explored. Out of 10 independent variables, the correlation coefficients of 6 variables were significant. These were education, farm size, annual family income, communication exposure, agricultural knowledge, and fatalism. Fatalism was negatively significant and rests of those were positively significant. It is found that majority farmers have unfavorable perception about climate change effects on agriculture as because most of the farmers have lower access to education, low communication exposure and they are highly fatalistic in nature. Most of them are living hand to mouth with small farm size and low income. Due to low income farmers children are drop out from schools at early age and those drop out students one day become farmer by tradition and they also bear the fatalistic behavior and seldom tries to adapt with the changed climatic effects on agriculture. If someone tries to take any adaptation measures due to lack of information they can't because of the lower communication exposure and extension agents are not available to them. Thus the fate of the coastal farmers remains unchanged as they are the victim of vicious cycle of poor. So the study conclude that proper stakeholders like NGOs, Government, donor agencies etc. should take necessary steps to educate the farmers children, prevent drop out of farmers children, subsidies for coastal students education under different projects, should initiate training programme for the coastal farmers about climate change effects on coastal agriculture and adaptation measures, which will increase their perception level towards climate change effects on coastal agriculture.

V. Recommendations

Firstly, the Government and other Organizations may set up further research to detect the perception level and the causes which hinder their perception towards climate change. Secondly, to identify the aftermath of global warming and take possible steps of how to counter it so that the harmful consequences of climate change can be lessened in the coastal areas. Thirdly, the Government may set up a center/cell under the control of its relevant Ministry and take policies to deal with climate change affectations especially in the affected areas. Fourthly, measures should be taken to give protection to the coastal-belt dwellers vulnerable to often occurred natural hazards so that they may be saved from constant loss and poverty. Fifthly, a framework can be developed for constant assessment of climate change scenarios, its impacts for mitigation. Sixthly, relevant sectors (local, Govt. NGOs and other Agencies) can study climate change impacts and take possible adaptation measures for the livelihoods groups in terms of their regional basis acuteness of troubles. Seventhly, various agencies may come forward to train the people who can face challenges of climate change effects on coastal agriculture. Eighthly, it is to be ensured that all productive land in the coastal belt can be properly utilized to improve poverty situation. Ninthly, regular research, projects, field study, and subsequent evaluation are essentially required to address coastal climate change scenario. Tenthly, as the coastal areas are relatively vulnerable to different hazards on account of climate change, the physical infrastructure in such places is to be developed keeping in contemplation the effects caused by the climate change to change livelihood patterns across the coastal Bangladesh.

VI. Acknowledgement

The authors are grateful to the teachers of Department of Agricultural Extension and Rural development for their constructive suggestions and encouragement throughout the whole period of this piece of research. The authors are also thankful to the Ministry of Science and Technology (MOST), Bangladesh, for providing the National Science and Technology (NST) fellowship-2014/15 and Patuakhali Science and Technology University for partial fund to conduct this research.

References Références Referencias

1. Ahmad, M. 2004. Living in the coast: people and livelihoods. Dhaka, Program Development Office for Integrated Coastal Zone Management Plan Project, Water Resources Planning Organization. March 2004.
2. Ahmed, A. U. and Mirza, M. M. Q, 2000, 'Review of Causes and Dimensions of Floods with Particular Reference to Flood '98: National Perspectives'. In Q.K. Ahmad, A. K. A. Chowdhury, S.H. Imam, M. Sarker, (Eds.)
3. Ali, A., 2005. Vulnerability of Bangladesh Coastal Region to Climate Change with Adaptation Option. Bangladesh Space Research and Remote Sensing Organization (SPARRSO), Dhaka.
4. BBS, 2012. Statistical Year Book of Bangladesh. Bureau of Statistics. Planning Division, Ministry of Planning, Government of the Peoples's Republic of Bangladesh.
5. Bryant, R.C., B. Smit, M. Brklacich, R.T. Johnston, J. Smithers, Q. Chiotti, and B. Singh. 2000. Adaptation

in Canadian agriculture to climatic variability and change. Climatic Change 45:181–201.
6. CEGIS, 2006. Impacts of Sea Level Rise on Land use Suitability and Adaptation Options, Draft Final Report. Submitted to the Ministry of Environment and Forest, Government of Bangladesh and United Nations Development Programme (UNDP) by Centre for Environmental Geographic Information Services (CEGIS), Dhaka.
7. Choudhury, A. M., Quadir, D. A., Neelormi, S., and Ahmed, A. U., 2003. Climate Change and Its Impacts on Water Resources of Bangladesh, in A. Muhammed (ed.), Climate Change and water Resources in South Asia, Asianics AgroDev International, Islamabad, pp. 21-60.
8. Climate Change Cell 2007. Climate Change and Bangladesh, published with support from Comprehensive Disaster management programme of the Government of the People's Republic of Bangladesh andits development partners, UNDP and DFID.
9. FAO, 2008. Community Based Adaptation in Action: A case study from Bangladesh. Project Summary Report (Phase I), Improved Adaptive Capacity to Climate Change for Sustainable Livelihoods in the Agriculture Sector, Food and Agriculture Organization of the United Nations, Rome.
10. GOB, 2005. National Adaptation Programme of Action (NAPA), Final report: November 2005, Ministry of Environment and Forest, Government of the People's Republic of Bangladesh (GOB), Dhaka, 48 p.
11. GoB, 2008. Cyclone Sidr in Bangladesh: Damage, Loss, and Needs Assessment for Disaster Recovery and Reconstruction. A Report Prepared by the Government of the People's Republic Bangladesh Assisted by the International Development Community with Financial Support from the European Commission, April 2008, Dhaka, Bangladesh.
12. Howlader, M. S., M.G.R. Akanda and A.K.M. M. Zaman. 2015. Adaptation towards Climate Change Effects on Coastal Agriculture by the Farmers of Patuakhali District of Bangladesh. International Journal of Agricultural Innovations and Research. IJAIR 3.5 (1560-1566).
13. Haider, R., A.A. Rahman and S. Huq (eds.), 1991, "Cyclone '91: An Environmental and Perceptional Study", Bangladesh Centre for Advanced Studies, Dhaka, 91 pp.
14. IPCC (2007) Impacts, Adaptations and Vulnerability. Cambridge: Contribution of Working Group II to the Fourth Assessment Report of IPCC on Climate Change, 2007. Intergovernmental Panel on Climate Change (IPCC).
15. Karim, M., and N. Mimura. 2008. "Impacts of Climate Change and Sea-Level Rise on Cyclonic Storm Surge Floods in Bangladesh." Global Environmental Change 18 (3): 490–500.
16. Karim, Z., Hussain, S. G. and Ahmed, M., 1996, "Assessing Impacts of Climate Variations on Foodgrains Production in Bangladesh", Journal of Water, Air and Soil Pollution, 92, 53-62.
17. Khan, A. E., W. W.Xun, H. Ahsan, and P. Vineis. 2011. Climate Change, Sea-Level Rise, & Health Impacts in Bangladesh. Environment: Science and Policy for Sustainable Development 53 (5): 18–33.
18. Maddison, D. 2006. The perception of and adaptation to climate change in Africa. CEEPA Discussion Paper No. 10. Centre for Environmental Economics and Policy in Africa, University of Pretoria, South Africa.
19. Maddox, G. L. 1995. The Encyclopedia of Aginy. 2nd edn. New York: Springer Publishing Company,Inc.
20. [20] Mobassarul, K., Hoque, Z. and Upal, M. 2009. Impact of Climate Change on Coastal Community of Bangladesh, from Fourth South Asia Water Resource Conference, May 2009, Kathmandu, Nepal.
21. Mohal, N., & Hossain, M. M. A. 2007. Investigating the impact of relative sea level rise on coastal communities and their livelihoods in Bangladesh. Draft Final Report. Dhaka: Institute of Water Modelling (IWM) and Center for Environmental and Geographic Information Services (CEGIS). Submitted to UK Department for Environment Food and Rural Affairs in May 2007.
22. Rana, S. M. M., M. A. Rajib, and M. Rahman. 2011. "Changes in Cyclone Pattern with Climate Change Perspective in the Coastal Regions of Bangladesh." Environmental Research, Engineering and Management 2 (2): 20–27.
23. RVCC, 2003. Report of a Community Level Vulnerability Assessment Conducted in Southwest Bangladesh. A report prepared by the Reducing Vulnerability to Climate Change (RVCC) Project, CARE Bangladesh, Dhaka.
24. Shahid, S. 2010a. "Probable Impacts of Climate Change On Public Health in Bangladesh." Asia-Pacific Journal of Public Health / Asia-Pacific Academic Consortium for Public Health 22 (3): 310–319.
25. Thomas, T. S., K. Mainuddin, C. Chiang, A. Rahman, A. Haque,N. Islam, , S. Quasem, Y. Sun. 2013. Agriculture and Adaptation in Bangladesh: Current and Projected Impacts of Climate Change. IFPRI Discussion Paper 01281. Washington, DC: International Food Policy Research Institute.
26. Thurlow, J., Dorosh, P., and Yu, W. 2012. A Stochastic Simulation Approach to Estimating the Economic Impacts of Climate Change in Bangladesh. Review of Development Economics 16 (3): 412–428.

27. Uddin, M. E. 2012. Household Food Security Status of Marginal Farmers in Selected Storm Surge Prone Coastal Area of Bangladesh. The Agriculturist, 10(1):98-103.
28. UNFCC.2005. United Nation Framework Convention on Climate Change 2005. Retrieved November 13th, 20014, from unfcc.int/adaptation/ items/ 1973.
29. World Bank, 2000, "Bangladesh: Climate Change and Sustainable Development. Report No. 21104-BD", Rural Development Unit, South Asia Region, The World Bank, Dhaka, pp. 95.

List of Abbreviations

Aman= aman is transplanted at the onset of the monsoon in June-July and harvested in October-December;

Aus= Aus rice is direct-seeded or transplanted in the pre-monsoon period (April-

Boro= upland winter irrigated rice

CEGIS= Centre for Environmental Geographic Information Services

FAO= Food and Agriculture Organization

GCM = Global Circulation Model

Gher= Medium to large pond with protected mud embankment which are used to culture

GOB= Government of the People's Republic of Bangladesh

IPCC= Intergovernmental Panel on Climate Change July) and harvested in August

RVCC= Reducing Vulnerability to Climate Change

SAAO= Sub-Assistant Agricultural Officer

Union=Smallest Administrative rural geographic unit which consist of mauza and village, having institution,

Mauza =Smallest revenue geographic unit having jurisdiction list number

USD= United States Dollar

This page is intentionally left blank

Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 15 Issue 4 Version 1.0 Year 2015
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Investigation of Microwave Power Effects on Drying Kinetics and Energy Efficiency of Banana Samples

By Azar Khodabakhshi, Mandana Mahfeli & Mohammad Zarein

Tarbiat Modares University (TMU), Iran

Abstract- The banana samples were dried in a laboratory scale microwave oven at different powers of 200, 300, 400 and 500 W. The results showed that microwave power significantly influenced the total heating time and energy efficiency of drying processing. In this study, the measured moisture ratio (MR) values were fitted and compared with predicted values obtained from Midilli's thin layer drying semi-empirical equation. Highest value of R2 and the lowest values of χ^2 and RMSE for banana samples at different powers are obtained as 0.9999, 1.6618×10-5 and 0.0043 respectively. Also, within the range of microwave power values, 200–500 W, effective moisture diffusivities were found to be 1.4×10^{-5} to 5.52×10^{-5} m^2/min. The microwave power dependence of the effective diffusivity coefficient followed an Arrhenius-type relationship.

Keywords: microwave power, energy efficiency, moisture diffusivity, activation energy, banana samples.

GJSFR-D Classification : FOR Code: 079999

Strictly as per the compliance and regulations of :

Investigation of Microwave Power Effects on Drying Kinetics and Energy Efficiency of Banana Samples

Azar Khodabakhshi [α], Mandana Mahfeli [σ] & Mohammad Zarein [ρ]

Abstract- The banana samples were dried in a laboratory scale microwave oven at different powers of 200, 300, 400 and 500 W. The results showed that microwave power significantly influenced the total heating time and energy efficiency of drying processing. In this study, the measured moisture ratio (MR) values were fitted and compared with predicted values obtained from Midilli's thin layer drying semi-empirical equation. Highest value of R2 and the lowest values of χ^2 and RMSE for banana samples at different powers are obtained as 0.9999, 1.6618×10-5 and 0.0043 respectively. Also, within the range of microwave power values, 200–500 W, effective moisture diffusivities were found to be 1.4×10^{-5} to 5.52×10^{-5} m^2/min. The microwave power dependence of the effective diffusivity coefficient followed an Arrhenius-type relationship. The activation energy for the moisture diffusion was determined to be 11.2 W/g. Increasing the microwave power resulted in a considerable increase in average energy efficiency and it was in the range of 8.8 to 39%.

Keywords: microwave power, energy efficiency, moisture diffusivity, activation energy, banana samples.

I. Introduction

Banana is one of the most prevalently consumed fruits and is amply available in tropical countries. Banana is an excellent source of potassium. it can help cure an upset stomach by stimulating the production of mucus and cells in the stomach, thus creating a barrier between the stomach lining and the acids that cause upset stomachs and heartburn. Banana has antibiotic properties to help fight off infections and viruses [1]. The qualities of fresh banana deteriorate rapidly after harvesting [2-4]. Considerable amounts of this fruit is wasted due to the lack of efficient preservation methods that are unique to banana. One of the oldest methods of food preservation is drying [2]. The basic objective in drying food products is the removal of water from solids to a certain level at which microbial decadence is avoided. The major motives of dried food popularity are Longer shelf life and significant reduction in the volume of the product. Characteristics of conventional drying is: prolonged drying time, hot temperature, rapid drying and low energy efficiency which each one have Some disadvantages. Conventional drying may reduce the capacity of dried product , damage the flavour, colour and nutrients, vapourise volatile compounds, cause case-hardening and have low energy efficiency [5].Therefore, there has been a search for an alternative method of drying for years. MD (Microwave Drying) seems to be a suitable method to reduce the disadvantages. A number of studies have been conducted to improve microwave drying [6-10]. Microwave drying is caused by water vapour pressure differences between interior and surface regions, which provide a driving force for moisture transfer. Microwave drying results in a high thermal efficiency, no case hardening, shorter drying time, reduced costs and improved product quality compared to conventional hot air drying [11]. However, microwave drying will reduce the product's quality if not properly applied [12]. Researchers have shown that applying the energy in decreasing rate or at low moisture content for finish drying results in a higher quality of product [13]. Medeni investigated banana samples drying using convection (60°C at 1.45 m/s), microwave (350, 490 and 700 W power) and convection followed by microwave (at 350 W, 4.3 mm thick sample) finish drying. The drying of banana slices took place in the falling rate drying period with convection drying taking the longest time. Higher drying rates were observed with the higher power level. Microwave finish drying reduced the convection drying time by about 64.3%. A physical model was employed to fit the experimental data and gave good fit for all experimental runs except microwave finish data. Microwave finish dried banana was lighter in colour and had the highest rehydration value [14]. Although the textural property improved at high temperature, the product color was brown as manifested by the low L- and hue values in particular at the drying temperature of 100 °C [12].

The drying time of the convective technique can be shortened by using higher temperatures which increase moisture diffusivity [15] and by cutting the material into small pieces [16]. The drying time can be greatly reduced [17] and the quality of finished product insured [18] by applying the microwave energy to the dried material. Furthermore, commonly used hot air techniques are limited by high energy consumption,

Author α: Azar Khodabakhshi, Biosystems Engineering Department, Sari Agricultural Scince and Natural Resources University, Sari, Iran.
Author σ: Mandana Mahfeli, Biosystems Engineering Department, Shiraz University, Shiraz, Iran
Author ρ: Mohammad Zarein, Biosystems Engineering Department, Tarbiat Modares University (TMU), Tehran, Iran.
e-mail: m.zarein@yahoo.com

long drying times, low energy efficiency and high costs, which is not desirable for the food industry. Due to these difficulties, more rapid, safe and controllable drying methods are required. Also, it is necessary to dry the product with minimum cost, energy and time. In microwave drying, drying time is shortened due to quick absorption of energy by water molecules, causes rapid evaporation of water, resulting in high drying rates of the food. One of the most important aspects of drying technology is the modeling of the drying process. There are various studies at the research level about drying of vegetables. For example; Bakal et al. [19] and Senadeera et al. [20] reported that the Page model best described the drying behaviour of potato. As little research has been performed effect of microwave power on energy consumption and drying efficiency in microwave drying method [21], the present research is focused on this issue. The aim of this study was to (i) describe the influence of microwave output power on drying kinetics and energy efficiency, and (ii) compare the measured findings obtained during the drying of banana samples with the predicted values obtained with Midilli's semi-empirical equation for the purpose of simulation and scaling up of the process.

II. Materials and Methods

Banana samples were purchased from a local market, in Tehran, Iran, and were stored in the refrigerator at temperature of 4±1°C until the experiments were carried out. Samples were prepared as cubic shape with dimension of 30×30×30 mm. The initial moisture content of the samples found about 77.9±1% (w.b.) and was determined by drying in an air convection oven at 103±1 °C till the weight did not change any more [22]. A domestic microwave oven (M 945, Samsung Electronics Ins) with maximum output of 1000 W at 2450 MHz was used for the drying experiments. The oven has a fan for air flow in drying chamber and cooling of magnetron. The moisture from drying chamber was removed with this fan by passing it through the openings on the right side of the oven wall to the outer atmosphere. The microwave dryer was operated by a control terminal which could control both microwave power level and emission time. Experiments were performed at four microwave powers of 200, 300, 400 and 500 W. The moisture losses of samples were recorded at 30s intervals during the drying process by a digital balance (GF-600, A & D, Japan) and an accuracy of ±0.01 g. For measuring the weight of the samples during experimentation without taking them out of the oven, the tray with sample was suspended on the balance with a nylon wire through a ventilation hole in the center of chamber ceiling. Drying was carried out until the final moisture content reaches to a level less than 1% (w.b.) [23]. All measurements were carried out in triplicate. The moisture ratio (MR) was calculated using the following equation:

$$MR = \frac{M_t - M_e}{M_0 - M_e} \quad (1)$$

where, MR is the moisture ratio (dimensionless); M_t, Me and M_0 are the moisture content at any time, the equilibrium moisture content, the initial moisture content (kg [H_2O]/kg dry mater), respectively. The values of M_e are relatively small compared to M_t and M_0, hence the error involved in the simplification by assuming that Me is equal to zero is negligible.

The Midilli's model is an empirical modification of the simple exponential model to overcome its shortcomings. It was successfully used to describe the drying characteristics of a variety of biological materials. Therefore, the semi-empirical Midilli's equation (Eq. (2)) was used to describe the thin layer drying kinetics of samples [24]:

$$MR = \frac{M_t}{M_0} = a\exp(-kt^n) + bt \quad (2)$$

where k is the drying constant (1/min); a and b are constant coefficients and n is the dimensionless exponent. Statistical test using the coefficient of determination (R^2), reduced chi-square (χ^2) and root mean square error (RMSE) were calculated to evaluate the goodness of fit of each model. The statistical parameters were calculated using equations [25]:

$$R^2 = 1 - \frac{\sum_{i=1}^{N}\left(MR_{pre,i} - MR_{exp,i}\right)^2}{\sum_{i=1}^{N}\left(MR_{pre,i} - \overline{MR_{exp,i}}\right)^2} \quad (3)$$

$$\chi^2 = \frac{\sum_{i=1}^{N}\left(MR_{pre,i} - MR_{exp,i}\right)^2}{N - z} \quad (4)$$

$$RMSE = \left(\frac{\sum_{i=1}^{N}\left(MR_{pre,i} - MR_{exp,i}\right)^2}{N}\right)^{\frac{1}{2}} \quad (5)$$

where MR_{exp} is the experimental dimensionless moisture ratio, MR_{pre} is the predicted dimensionless moisture ratio by Page model, N is the number of experimental data points, and z is the number of parameters in model. The model is said to be good if R^2 value is high and, χ^2 and RMSE values are low [26].
Drying rate was defined as:

$$DR = \frac{M_{t+\Delta t} - M_t}{\Delta t} \quad (6)$$

where $M_{t+\Delta t}$ is moisture content at time $t+\Delta t$ (kg [H_2O]/kg dry mater), t is the time (min) and DR is the drying rate (kg [H_2O]/kg dry mater.min).

Fick's second law of diffusion equation, symbolized as a mass-diffusion equation for drying agricultural products in a falling rate period, is shown in the following equation:

$$\frac{\partial M}{\partial t} = D_{eff}\frac{\partial^2 M}{\partial x^2} \quad (7)$$

By using appropriate initial and boundary conditions, Crank [27] gave the analytical solutions for various geometries and the solution for slab object with constant diffusivity is given as:

$$MR = \frac{8}{\pi^2}\sum_{n=0}^{\infty}\frac{1}{(2n+1)^2}\exp\left(-(2n+1)\pi^2\frac{D_{eff}t}{4L^2}\right) \quad (8)$$

where D_{eff} is the effective diffusivity (m^2/s), and L is the half-thickness of samples (m), n is a positive integer.

For long drying times, only the first term (n=0) in the series expansion of the above equation can give good estimate of the solution, which is expressed in logarithmic forms as follows:

$$\ln(MR) = \ln\left(\frac{8}{\pi^2}\right) - \left(\frac{\pi^2}{4L^2}D_{eff}t\right) \quad (9)$$

The diffusion coefficients are typically determined by plotting experimental drying data in terms of ln(MR) versus drying time (t), because the plot gives a straight line with a slope as $\pi^2 D_{eff}/4L^2$ [28].

Inasmuch as temperature is not precisely measurable inside the microwave drier, the activation energy is found as modified from the revised Arehnious equation. In this method it is assumed as related to effective moisture diffusion and the ratio of microwave output power to sample weight (m/p) instead of to air temperature. Then Equation (10) can be effectively used as follows [29]:

$$D_{eff} = D_0\exp\left(-\frac{E_a m}{P}\right) \quad (10)$$

where E_a is the activation energy (W/g), m is the mass of raw sample (g), D_0 is the pre-exponential factor (m^2/s) and P is the microwave power (W).

The microwave drying efficiency was calculated as the ratio of heat energy utilised for evaporating water from the sample to the heat supplied by the dryer [30].

$$\eta = \frac{m_w \times \lambda_w}{P \times t} \quad (11)$$

where η is the microwave-convective drying efficiency (%);P is the microwave power (W); m_w is the mass of evaporated water (kg), and λ_w is the latent heat of vaporisation of water (2257 kJ/kg).

III. Results and Discussion

The moisture content versus drying time curves for microwave drying of banana samples as affected by various microwave powers are shown in Fig. 1. The time required to dry banana samples from initial moisture content of 77.9±1% (w.b.) to the final moisture content of 4±1% (w.b.) was 29.5, 13, 8.5 and 6 min at 200, 300, 400 and 500 W, respectively. Drying microwave power had an important effect on drying time. The results indicated that mass transfer within the sample was more rapidly during higher microwave power heating because more heat was generated within the sample creating a large vapor pressure difference between the center and the surface of the product due to characteristic microwave volumetric heating.

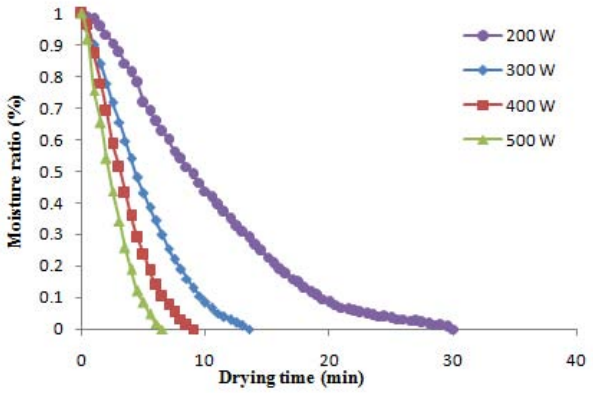

Figure 1 : The variation of the moisture content with drying time at various microwave powers

Fig. 2 shows how the drying rate of banana samples was changed with increased drying time under various drying conditions. The drying rates increased with the increasing microwave power levels. The maximum drying rates were approximately 0.243, 0.441, 0.739 and 1.134 kg [H2O]/kg dry mater .min, when the microwave powers of 200, 300, 400 and 500W were applied, respectively. The moisture content of the material was very high during the initial phase of the drying which resulted in a higher absorption of microwave power and higher drying rates due to the higher moisture diffusion. As the drying progressed, the loss of moisture in the product caused a decrease in the absorption of microwave power and resulted in a fall in the drying rate.

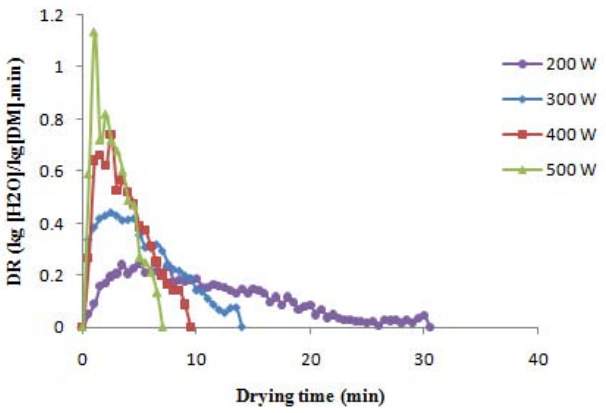

Figure 2 : Variation of drying rate with drying time for banana samples

The moisture content data obtained from the drying experiments was fitted to the Midilli model. The statistical results from the models such as R^2, χ^2 and RMSE values are shown in Table 1. As it is seen, the R^2, χ^2 and RMSE values range from 0.9991 to 0.9999, 1.6618×10^{-5} to 9.9983×10^{-5} and 0.0043 to 0.0102, respectively. The highest values of R^2 and the lowest values of χ^2 and RMSE indicate in the Midilli model a good fit. Based on the multiple regression analysis, the Midilli model, the constants and coefficients were as follows:

$$k = 0.032\exp(0.003P) \qquad R^2 = 0.944$$

$$n = 0.992 + 0.001P - 2\times10^{-6}P^2 \qquad R^2 = 0.988$$

$$a = 0.973 + 7\times10^{-5}P - 1\times10^{-8}P^2 \qquad R^2 = 0.862$$

$$b = -0.011 + 6\times10^{-5}P - 1\times10^{-7}P^2 \qquad R^2 = 0.972$$

Table 1 : Results of statistical analysis on the modeling (Midilli's model) of moisture content and drying time for banana samples

Table 1- Results of statistical analysis on the modeling (Midilli's model) of moisture content and drying time for banana samples

P (W)	Model Constants		R^2	$\chi^2\times10^{-5}$	RMSE
200	a= 0.9893	b= -0.00294	0.9991	9.9983	0.0101
	k= 0.0764	n= 1.282			
300	a= 0.9909	b= -0.00377	0.9998	2.0442	0.0047
	k= 0.0890	n= 1.36			
400	a= 1.005	b= -0.00488	0.9999	1.6618	0.0043
	k= 0.1349	n= 1.435			
500	a= 1.006	b= -0.01082	0.9993	8.5333	0.0102
	k= 0.2361	n= 1.443			

Plots of calculated versus experimental dimensionless moisture content are shown in Fig. 3. As can be observed in this figure, good agreement between the former variables is observed.

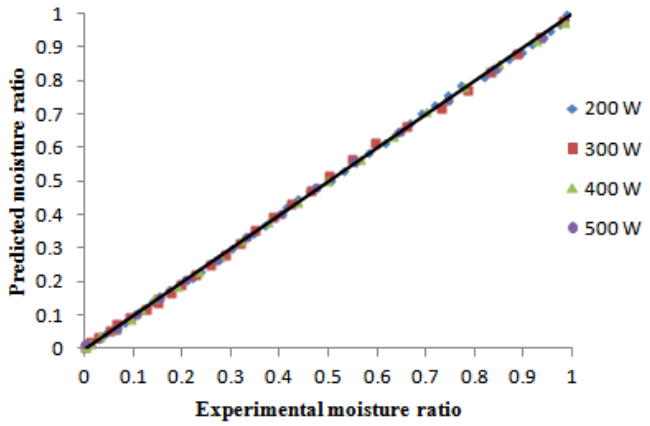

Figure 3: Comparison of experimental and calculated dimensionless moisture content values by the Midilli's model

The determined values of Deff for different microwave powers are given in Table. 2. The values lie within the general range of 10^{-6}–10^{-11} m^2/s for food materials. It can be seen that the values of Deff increased with increasing microwave power. This might be explained by the increased heating energy, which would increase the activity of the water molecules leading to higher moisture diffusivity when samples were dried at higher microwave power.

Table 2 : Effective diffusivity values for microwave drying of potato

P(W)	Effective diffusivity (m^2/min)
200	1.4×10^{-5}
300	2.86×10^{-5}
400	4.18×10^{-5}
500	5.52×10^{-5}

The activation energy was calculated by plotting the natural logarithm of Deff versus sample amount/power (m/P) as presented in Fig. 4. The plot was found to be a straight line in the range of microwave power studied, indicating Arrhenius dependence as Fig. 5. Then, the dependence of the effective diffusivity of banana samples on the microwave power can be represented by the following equation:

$$D_{eff} = 13.2\times10^{-5}\exp\left(-11.2\frac{m}{P}\right) \qquad (12)$$

The activation energy for banana samples was found to be 11.2 W/g.

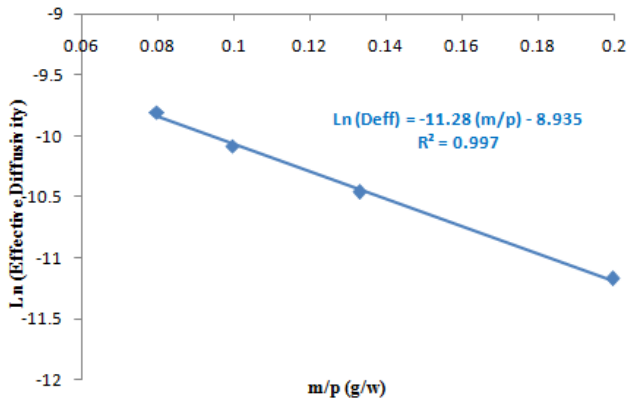

Figure 4 : Arrhenius-type relationship the values of Ln(D_{eff}) versus sample amount/power

Fig. 6 shows the variation of energy efficiency whit drying time for microwave drying of banana samples. The energy efficiency was very high during the initial phase of the drying which resulted in a higher absorption of microwave power. Following moisture reduction, the energy absorbed by the product decreased and reflected power increased. The best result with regard to energy efficiency was obtained from 500W microwave power levels among all microwave power. Average energy efficiency of banana samples ranged from 8.8 to 39% for the output microwave power.

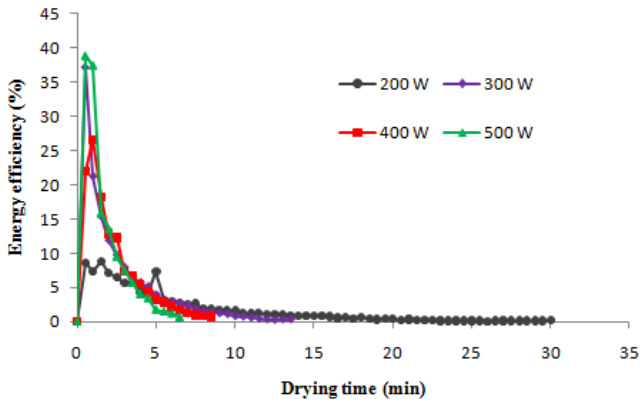

Figure 5 : Energy efficiency versus drying time for microwave drying of potato samples

IV. Conclusion

Characteristics of the microwave drying of banana samples (with dimension of 30×30×30 mm) were determined. Microwave drying period of samples lasted between 29.5 and 6 min at the microwave powers at 200 and 500 W, respectively. The changes of moisture content have been described by using Midilli's model. We concluded that 500 W is the optimum microwave power level in the microwave drying of banana samples with respect to drying time and energy efficiency. The values of effective diffusivity for microwave drying of banana samples ranged from 1.4×10^{-5} to 5.52×10^{-5} m^2/min and activation energy was found 11.2 W/g. Energy efficiency increases with the increase of microwave drying power and moisture content.

References Références Referencias

1. Marisa M.W; Ascorbic acid, vitamin A, and mineral composition of banana (Musasp.) and papaya (Carica papaya) cultivars grown in Hawaii. Food Comp and Anal, 19(2006), 434-445
2. Krokida M.K., Karathanos V.T. and Maroulis Z.B; Effect of osmotic dehydration on color and sorption characteristics of apple and banana. Dry Tech, 18(2001), 937–950
3. Khraisheh M.A.M., McMinn W.A.M. and Magee T.R.A; Quality and structural changes in starchy foods during microwave and convective drying. Food Res Int, 37(2007), 497–503
4. Eshaghbeygi A., Pirnazari K. and Sadeghi M; Quality assessment of electrohydrodynamic and microwave dehydrated banana slices. Food Sci and Tech, 55(2013), 565-571
5. 5. Maskan M. and Gogus F; Sorption isotherms and drying characteristics of mulberry (Morus alba). J of Food Eng, 37(2000), 437–449
6. Andres A., Bilbao C. and Fito P; Drying kinetics of apple cylinders under combined hot air-microwave dehydration. J of Food Eng, 63(2004), 71–78
7. Cui Z.W., Xu S.Y., Sun D.W. and Chen W; Temperature changes during microwave-vacuum drying of sliced carrots. Dry Tech, 23(2005), 1057–1074
8. Clary C.D., Wang S. and Petrucci V.E; Fixed and incremental levels of microwave power application on drying grapes under vacuum. J of Food Sci, 70(2005), 344–349
9. Lu L., Tang J. and Ran X; Temperature and moisture changes during microwave drying of sliced food. Dry Tech, 17(1999), 413–432
10. Zhang M., Tang J., Mujumdar A.S. and Wang S; Trends in microwave-related drying of fruits and vegetables. Trends in Food and Tech, 17(2006), 524–534
11. Ozdemir M; Effect of microwave power, air velocity and temperature on the final drying of osmotically dehydrated bananas. Food Eng, 81(2008), 79-87
12. Thuwapanichayanan R., Prachayawarakorn S., Kunwisawa J. and Soponronnarit S; Determination of effective moisture diffusivity and assessment of quality attributes of banana slices during drying. Food Sci and Tech, 44(2011), 1502-1510
13. Funebo T. and Ohlsson T; Microwave-assisted air dehydration of apple and mushroom. Food Eng, 38(1998), 353-367
14. Medeni M; Microwave/air and microwave finish drying of banana. Food Eng, 44(2000), 71-78

15. Maroulis Z.B., Kiranoudis C.T. and Marinoskouris D; Heat and mass transfer modeling in air drying of foods. J of Food Eng, 26(1995), 113–130
16. Madamba P.S., Driscoll R.H. and Buckle K.E; The thin layer drying characteristic of garlic slices. J of Food Eng, 29(1996), 75–97
17. Sharma G.P. and Prasad S; Effective moisture diffusivity of garlic cloves undergoing microwave-convective drying. J of Food Eng, 65(2004), 609–617
18. Yongsawatdigul J. and Gunasekaran S; Microwave-vacuum drying of cranberries: Part II. Quality evaluation. J of Food Proc and Pres, 20(1996), 145–156
19. Bakal S.B., Sharma P.G., Sonawan S.P. and Verma R.C; Kinetics of potato drying using fluidized bed dryer. J Food Sci Technol, DOI: 10.1007/s13197-011-0328-x (2011)
20. Senadeera W., Bhandari B.R., Young G. and Wijesinghe B; Influence of shapes of selected vegetable materials on drying kinetics during fluidized bed drying. J Food Eng, 58 (2003), 277–283
21. McMinn W.A.M., Khraisheh M.A.M. and Magee T.R.A; Modelling the mass transfer during convective, microwave and combined microwave-convective drying of solid slabs and cylinders. Food Res Int, 36(2003), 977–983
22. Hatamipour M.S., Kazemi H., Nooralivand A. and Nozarpoor A; Drying characteristics of six varieties of sweet potatoes in different dryers. Food and Biopro Proc, 85(2007), 171–177
23. Krokida M.K., Karathanos V.T., Maroulis Z.B. and Marinos-Kouris D; Drying kinetics of some vegetables. J Food Eng, 59(2003), 391–403
24. Aghbashlo M, Kianmehr M.H. and Arabhosseini A; Modeling of thin-layer drying of potato slices in length of continuous band dryer. J Energ Convers Manag, 50(2009), 1348–1355
25. Zarein M., Banakar A. and Khafajeh H; Mathematical modeling, energy consumption and thin layer drying kinetics of carrot slices under microwave oven. Int J of Agri and Crop Sci, 5(2013), 2057-2063
26. Zarein M., Samadi S.H. and Ghobadian B; Investigation of microwave dryer effect on energy efficiency during drying of apple slices. J of the Saudi Soc of Agri Sci, DOI: http://dx.doi.org/10.1016/j.jssas.2013.06.002 (2013)
27. Crank J; The Mathematics of Diffusion. 2nd ed. Oxford (UK): Clarendon Press; 1975
28. Ozbek B. and Dadali G; Thin-layer drying characteristics and modelling of mint leaves undergoing microwave treatment. J Food Eng, 83(2007), 541-549
29. Soysal A., Oztekin S. and Eren O; Microwave drying of parsley: modelling, kinetics, and energy aspects. Biosys Eng, 93(2006), 403–413
30. Darvishi H. and Zarein M; Thermal conductivity of sunflower seed as a function of moisture content and bulk density. World App Sci J 18(2012), 1321-1325

Global Journals Inc. (US) Guidelines Handbook 2015

www.GlobalJournals.org

FELLOWS

FELLOW OF ASSOCIATION OF RESEARCH SOCIETY IN SCIENCE (FARSS)

Global Journals Incorporate (USA) is accredited by Open Association of Research Society (OARS), U.S.A and in turn, awards "FARSS" title to individuals. The 'FARSS' title is accorded to a selected professional after the approval of the Editor-in-Chief/Editorial Board Members/Dean.

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

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.

The following benefits can be availed by you only for next three years from the date of certification:

FARSS designated members are entitled to avail a 40% discount while publishing their research papers (of a single author) with Global Journals Incorporation (USA), if the same is accepted by Editorial Board/Peer Reviewers. If you are a main author or co-author in case of multiple authors, you will be entitled to avail discount of 10%.

Once FARSB title is accorded, the Fellow is authorized to organize a symposium/seminar/conference on behalf of Global Journal Incorporation (USA). The Fellow can also participate in conference/seminar/symposium organized by another institution as representative of Global Journal. In both the cases, it is mandatory for him to discuss with us and obtain our consent.

You may join as member of the Editorial Board of Global Journals Incorporation (USA) after successful completion of three years as Fellow and as Peer Reviewer. In addition, it is also desirable that you should organize seminar/symposium/conference at least once.

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 FARSS can go through standards of OARS. You can also play vital role if you have any suggestions so that proper amendment can take place to improve the same for the benefit of entire research community.

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.

The FARSS members can avail the benefits of free research podcasting in Global Research Radio with their research documents. After publishing the work, (including published elsewhere worldwide with proper authorization) you can upload your research paper with your recorded voice or you can utilize chargeable services of our professional RJs to record your paper in their voice on request.

The FARSS member also entitled to get the benefits of free research podcasting of their research documents through video clips. We can also streamline your conference videos and display your slides/ online slides and online research video clips at reasonable charges, on request.

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.

The FARSS member is eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get remuneration of 15% of author fees, taken from the author of a respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account.

MEMBER OF ASSOCIATION OF RESEARCH SOCIETY IN SCIENCE (MARSS)

The ' MARSS ' title is accorded to a selected professional after the approval of the Editor-in-Chief / Editorial Board Members/Dean.

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%.

As MARSS, you will be given a renowned, secure and free professional email address with 30 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.

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)

Global Journals Incorporation (USA) is accredited by Open Association of Research Society, U.S.A (OARS) and in turn, affiliates research institutions as "Institutional Fellow of Open Association of Research Society" (IFOARS).

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.

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.

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.

Disbursement of 40% Royalty earned through Global Journals : Researcher = 50%, Peer Reviewer = 37.50%, Institution = 12.50% E.g. Out of 40%, the 20% benefit should be passed on to researcher, 15 % benefit towards remuneration should be given to a reviewer and remaining 5% is to be retained by the institution.

We shall provide print version of 12 issues of any three journals [as per your requirement] out of our 38 journals worth $ 2376 USD.

Other:

The individual Fellow and Associate designations accredited by Open Association of Research Society (US) credentials signify guarantees following achievements:

- 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 :

"

- 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.

(B) If you are using Internet Explorer, then Direct Submission through Homepage is also available.

(C) If these two are not conveninet , and then email the paper directly to dean@globaljournals.org.

Offline Submission: Author can send the typed form of paper by Post. However, online submission should be preferred.

Preferred Author Guidelines

MANUSCRIPT STYLE INSTRUCTION (Must be strictly followed)

Page Size: 8.27" X 11'"

- Left Margin: 0.65
- Right Margin: 0.65
- Top Margin: 0.75
- Bottom Margin: 0.75
- Font type of all text should be Swis 721 Lt BT.
- Paper Title should be of Font Size 24 with one Column section.
- Author Name in Font Size of 11 with one column as of Title.
- Abstract Font size of 9 Bold, "Abstract" word in Italic Bold.
- Main Text: Font size 10 with justified two columns section
- Two Column with Equal Column with of 3.38 and Gaping of .2
- First Character must be three lines Drop capped.
- Paragraph before Spacing of 1 pt and After of 0 pt.
- Line Spacing of 1 pt
- Large Images must be in One Column
- Numbering of First Main Headings (Heading 1) must be in Roman Letters, Capital Letter, and Font Size of 10.
- Numbering of Second Main Headings (Heading 2) must be in Alphabets, Italic, and Font Size of 10.

You can use your own standard format also.
Author Guidelines:

1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

1. GENERAL

Before submitting your research paper, one is advised to go through the details as mentioned in following heads. It will be beneficial, while peer reviewer justify your paper for publication.

Scope

The Global Journals Inc. (US) welcome the submission of original paper, review paper, survey article relevant to the all the streams of Philosophy and knowledge. The Global Journals Inc. (US) is parental platform for Global Journal of Computer Science and Technology, Researches in Engineering, Medical Research, Science Frontier Research, Human Social Science, Management, and Business organization. The choice of specific field can be done otherwise as following in Abstracting and Indexing Page on this Website. As the all Global

Journals Inc. (US) are being abstracted and indexed (in process) by most of the reputed organizations. Topics of only narrow interest will not be accepted unless they have wider potential or consequences.

2. ETHICAL GUIDELINES

Authors should follow the ethical guidelines as mentioned below for publication of research paper and research activities.

Papers are accepted on strict understanding that the material in whole or in part has not been, nor is being, considered for publication elsewhere. If the paper once accepted by Global Journals Inc. (US) and Editorial Board, will become the copyright of the Global Journals Inc. (US).

Authorship: The authors and coauthors should have active contribution to conception design, analysis and interpretation of findings. They should critically review the contents and drafting of the paper. All should approve the final version of the paper before submission

The Global Journals Inc. (US) follows the definition of authorship set up by the Global Academy of Research and Development. According to the Global Academy of R&D authorship, criteria must be based on:

1) Substantial contributions to conception and acquisition of data, analysis and interpretation of the findings.

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.

Permissions: It is the author's responsibility to have prior permission if all or parts of earlier published illustrations are used in this paper.

Please mention proper reference and appropriate acknowledgements wherever expected.

If all or parts of previously published illustrations are used, permission must be taken from the copyright holder concerned. It is the author's responsibility to take these in writing.

Approval for reproduction/modification of any information (including figures and tables) published elsewhere must be obtained by the authors/copyright holders before submission of the manuscript. Contributors (Authors) are responsible for any copyright fee involved.

3. SUBMISSION OF MANUSCRIPTS

Manuscripts should be uploaded via this online submission page. The online submission is most efficient method for submission of papers, as it enables rapid distribution of manuscripts and consequently speeds up the review procedure. It also enables authors to know the status of their own manuscripts by emailing us. Complete instructions for submitting a paper is available below.

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.

4. MANUSCRIPT'S CATEGORY

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.

Structure

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

Title: The title page must carry an instructive title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) wherever the work was carried out. The full postal address in addition with the e-mail address of related author must be given. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining and indexing.

Abstract, used in Original Papers and Reviews:

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.

Tables, Figures and Figure Legends

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.

Preparation of Electronic Figures for Publication

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).

For scanned images, the scanning resolution (at final image size) ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs) : >350 dpi; figures containing both halftone and line images: >650 dpi.

Color Charges: It is the rule of the Global Journals Inc. (US) for authors to pay the full cost for the reproduction of their color artwork. Hence, please note that, if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a color work agreement form before your paper can be published.

Figure Legends: Self-explanatory legends of all figures should be incorporated separately under the heading 'Legends to Figures'. In the full-text online edition of the journal, figure legends may possibly be truncated in abbreviated links to the full screen version. Therefore, the first 100 characters of any legend should notify the reader, about the key aspects of the figure.

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).

6.1 Proof Corrections

The corresponding author will receive an e-mail alert containing a link to a website or will be attached. A working e-mail address must therefore be provided for the related author.

Acrobat Reader will be required in order to read this file. This software can be downloaded

(Free of charge) from the following website:

www.adobe.com/products/acrobat/readstep2.html. This will facilitate the file to be opened, read on screen, and printed out in order for any corrections to be added. Further instructions will be sent with the proof.

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

As changes to proofs are costly, we inquire that you only correct typesetting errors. All illustrations are retained by the publisher. Please note that the authors are responsible for all statements made in their work, including changes made by the copy editor.

6.2 Early View of Global Journals Inc. (US) (Publication Prior to Print)

The Global Journals Inc. (US) are enclosed by our publishing's Early View service. Early View articles are complete full-text articles sent in advance of their publication. Early View articles are absolute and final. They have been completely reviewed, revised and edited for publication, and the authors' final corrections have been incorporated. Because they are in final form, no changes can be made after sending them. The nature of Early View articles means that they do not yet have volume, issue or page numbers, so Early View articles cannot be cited in the conventional way.

6.3 Author Services

Online production tracking is available for your article through Author Services. Author Services enables authors to track their article - once it has been accepted - through the production process to publication online and in print. Authors can check the status of their articles online and choose to receive automated e-mails at key stages of production. The authors will receive an e-mail with a unique link that enables them to register and have their article automatically added to the system. Please ensure that a complete e-mail address is provided when submitting the manuscript.

6.4 Author Material Archive Policy

Please note that if not specifically requested, publisher will dispose off hardcopy & electronic information submitted, after the two months of publication. If you require the return of any information submitted, please inform the Editorial Board or dean as soon as possible.

6.5 Offprint and Extra Copies

A PDF offprint of the online-published article will be provided free of charge to the related author, and may be distributed according to the Publisher's terms and conditions. Additional paper offprint may be ordered by emailing us at: editor@globaljournals.org .

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.

Criterion for Grading a Research Paper (Compilation) by Global Journals Inc. (US)

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals Inc. (US).

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

INDEX

Global Journal of Science Frontier Research

Visit us on the Web at www.GlobalJournals.org | www.JournalofScience.org
or email us at helpdesk@globaljournals.org

ISSN 9755896