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Discovering Thoughts, Inventing Future

Volume 13 Issue 3 Version 1.0

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Expression of Traits of Barley (Hordeium Vulgare L.) Landrace Crosses Under Waterlogged and Free Drainage Conditions

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EXPRESSION OF TRAITS OF BARLEY HORDEIUM VULGARE L. LANDRACE CROSSES UNDER WATERLOGGED AND FREE DRAINAGE CONDITIONS

Strictly as per the compliance and regulations of :

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Alemayehu Assefa[α] & M.T. Labuschagne[σ]

Abstract - Estimates of genetic parameters are useful since they provide information on the inheritance of characters and help to predict the value of crosses. If the value of crosses cannot be predicted, many crosses need to be made which results in each cross having a small population size, fewer progenies in later generations and a lower probability of recovering good genotypes from each cross. The objectives of this study were therefore i) to estimate genetic parameters from diallel crosses involving five inbred lines: Feres Gama(37), Feleme(68), Mage(07), 1153(28) and 1182(44) that vary for different agronomic characters and ii) to determine the breeding value of the parents so that the progeny performance from crosses involving the best parents could be predicted. Data for agronomic characters were obtained from parents and F1 progenies evaluated in a greenhouse under waterlogged and free drainage conditions. The results highlighted the importance of additive gene action for spike length, number of seeds spike^{-1} and grain yield spike^{-1} under free drainage conditions and for days to heading and days to maturity at both treatment levels. Both additive and non-additive gene action were important in the control of grain yield under free drainage conditions. By contrast, estimates of genetic parameters for yield and yield components (except spike length) were very low or negative under waterlogged conditions. Among the parents, Feres Gama(37) and 1153(28) contributed the highest positive GCA effects and comparable SCA variances for yield and yield components under free drainage conditions. Hence, these parents shall be tested thoroughly in order that maximum use of their superior combining ability can be made in future crossing programs for environments free of waterlogging stress. A separate crossing and selection program is suggested for the respective environmental conditions if resources permit.

I. Introduction

Pure line selection within locally adapted germplasm is one of the easiest and cheapest methods of improvement (Ceccarelli & Grando, 1996; Lakew et al., 1997). However, pure line selection within landraces is only a short-term strategy and, in the long-term, the best pure lines should be used in the crossing program either with other pure lines from landraces or with non-landrace material to cope with the unpredictable variability of abiotic stresses (Ceccarelli & Grando, 1996). To this effect, estimates of genetic parameters for quantitative traits are very useful since they provide information on the inheritance of traits and help to identify appropriate breeding methods (Dudley & Moll, 1969; Muehlbauer et al., 1995). Genetic variance can be subdivided into additive, dominance and epistatic effects of genes (Muehlbauer et al., 1995; Falconer & Mackay, 1996). The additive component of genotypic variance is very important because it is the chief source of resemblance between relatives, and also the chief determinant of observable genetic properties of the population and of the response of the population to selection (Dabholkar, 1992; Falconer & Mackay, 1996). Therefore, the effectiveness of selection is based on the utilization of additive gene effects (Sprague, 1966) and should be utilized as fully as feasible before undertaking an expensive and time consuming crossing program.

Methods are available for the partitioning of either means or variances that provide information as to the presence or absence of genetic variability and, in addition, provide information on the type of gene action involved (Sprague, 1966; Fehr, 1987; Dabholkar, 1992). Estimation of additive and dominance variances can be obtained through use of a nested design or from diallel crosses (Sprague, 1966). Information from diallel crosses can be used to characterize crossing relationships among a group of varieties or lines with the goal of identifying crosses which would be expected to be good source material for selections (Matzinger, 1963). If the variance is primarily of the additive type, that is, if the parents have a high degree of general combining ability, superior selfed families can be identified on the basis of their crossbred performance and be incorporated into a varietal development program (Baker, 1978).

An important point in estimating combining ability and genetic parameters is the environment in which the test of the progenies was carried out (i.e. stress vs optimum). Gouis et al. (2002) reported differences in general combining ability effects of parents when evaluated under low and high levels of nitrogen and concluded that results obtained at a high N level would not allow identification of parents and that specific experiments at low N level will be necessary. The assumption that in high yielding conditions there is

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more efficient control of environmental variation, better expression of genetic differences, and hence higher heritabilities than in stress environments (Roy & Murty, 1970) was also argued and it has been shown that it is not always true that heritability is higher in high-yielding than in low-yielding environments (Singh et al., 1993; Ceccarelli, 1994, 1996). Shibin et al. (1996) for instance, observed high heritability (71.5 %) of waterlogging tolerance from analysis of F1 diallel crosses of common wheat which negates the view that heritability is low in stress environments. Moreover, it was noted that measurements made on the same genotypes in two different environments should be regarded as separate and the relative effectiveness of selection strategies depends on the genetic correlations between performances in the two contrasting environments (Falconer, 1981). Hence, the genetic correlation coefficient has to be considered before deciding which the optimum environment for selection is (Ceccarelli, 1994) because partial differences in alleles that control high grain yield in high-yielding and low-yielding environments were also indicated (Ceccarelli et al., 1992).

In Ethiopia, although crossing program started early in 1968, it was not designed to allow estimates of combining abilities and genetic variances from a landrace based crossing programs so that information in this regard is not available. The lack of such information will not permit the identification of superior varieties to be used as parents for hybridisation and also pinpoint cross-combinations likely to yield desirable segregates (Dabholkar 1992; Witcombe & Virk, 2001). The objectives of this study were therefore i) to estimate genetic variances, heritability and genetic correlation of characters from crosses between adapted inbred barley landrace lines selected based on their merits and ii) to determine the breeding value of the parents under contrasting environments (free drainage vs waterlogged) so that the progeny performance from crosses involving the best parents could be predicted.

II. Materials and Methods

a) Plant Materials

Five parents (Feres Gama(37), Feleme(68), 1153(28), 1182(44) and Mage(07) were selected based on their agronomic attributes and differences in response under waterlogging stress. Feres Gama(37) has long spikes (7.8 cm to 8.4 cm), white seeds, gives very good yield but it is late maturing and takes about 88 to 91 days to heading and 142-145 days to mature. Feleme(68) has relatively short spikes (6.5 cm), white seeds, reaches heading in about 80 to 83 days and matures in about 124 days. Line 1153(28) is an early maturing landrace comparable to Feleme(68) and has comparably long spikes to Feres Gama(37) with black seed colour. Mage(07) is a random selection from a local cultivar grown predominantly on low-lying “guie” fields where waterlogging due to excessive rainfall in the main rain season is a problem in north Shewa. It is early in heading and maturity, has irregular spikes with dull white seeds and has good early vegetative growth. Line 1182(44) is a pure line landrace characterized by very short and dense spike, stiff straw and is early as well compared to Feres Gama(37).

b) Crossing

The five landrace lines were crossed in all possible combinations (excluding reciprocals) to generate 10 F_1 progenies. Crossing was done in an open field at Holetta Research Centre in 2001 by hand emasculation with pollination by the approach-cross method.

c) Experimental Design

Two sets of experiments each consisting the five parents and the 10 F_{1s} were set up in a greenhouse. In set I the parents and the crosses were planted in 3 litre size pots perforated at the bottom. Six seeds were planted per pot and thinned later to four uniformly germinated seedlings per pot. The experimental layout was a randomised complete block in four replications. Fertilizer (2: 3: 2 (22) of N: P: K) was applied at the rate of 378.4mg/pot N, 567.6mg P and 378mg K. Pots were watered to field capacity every day for normal growth and development of plants. Insecticide was sprayed, whenever necessary, to control aphids. Set II experiment was conducted with the same parents and crosses to evaluate their response to waterlogging stress. Seedlings were germinated in a similar manner to set I experiment. When seedlings reached three-leaf stage, putting the pots with seedlings in other larger sized pots imposed waterlogging. The larger pots were filled with water until the water level in the pots containing the seedlings reached nearly 10mm above the soil surface. This level of water was maintained for three weeks and thereafter the excess water was drained and plants were allowed to grow until maturity without the waterlogging stress.

d) Measurements

Days to heading, days to maturity, plant height, spike length, number of seeds spike^{-1}, total productive heads per pot, grain yield per main spike, average kernel mass of main spikes (grain yield per main spike divided by the total number of seeds per main spikes) and grain yield per pot were recorded from the parents and F1.

III. Statistical Methods

a) Analysis of Combining Ability

Analysis of combining ability was carried out according to Griffing’s (1956b) method II (parents and F_1 progenies without reciprocals) and Model I (where genotypes are considered as fixed effects). It may be assumed that the landrace lines used as parents are random selections from populations and thus Model II has to be used. This view, however, is not universally shared (Mayo, 1987) and it is only from the statistical geneticists point of view that variance of combining ability can be considered as population parameters (Sprague, 1966). The breeder is more interested in gene action within a given set of selected inbred lines for which inference is going to be made and hence Model I is preferred to Model II for this experiment. Therefore, the statistical analysis method of Griffing (1956b) as detailed for method II Model I was applied. The analyses of combining abilities were performed using the Agrobase 2000 computer program.

The ratio of mean square components associated with GCA and SCA effects were calculated according to Baker (1978) to estimate the relative importance of GCA in explaining progeny performance. Statistical testing for GCA effects of parents was done as S.E (Gi) x 1.96 and differences between parents for GCA effects was done as S.E (G_i-G_j) x 1.96. Testing the significance of differences for SCA effects of corsses with one common parent was done as S.E (S_{ij}-S_{jk}) x 1.96 and S.E (Sij-Skl) x 1.96 for crosses with no parent in common (Dabholkar, 1992).

b) *Estimation of Variance Components*

Variance of GCA (δ^2gca) was calculated as (*MSgca - MSsca)/n+2* while variance of SCA (δ^2sca) as MSsca-MSe where MSgca, MSsca and MSe stand for mean square of the GCA, SCA, and error, respectively and n is number of parents (Griffing, 1956b). Then, the additive genetic variance (δ^2_A) is twice the GCA variance (2δ^2gca) while the dominance variance (δ^2_D) is the δ^2sca. The total genetic variance (δ^2_g) was calculated as $\delta^2_g = \delta^2_A + \delta^2_D$ and the phenotypic variance (δ^2_p) = $\delta^2_g + \delta^2_e$. The GCA and SCA effects were also used to calculate the estimates of GCA and SCA variances associated with each parent, $\delta_{\hat{g}i}{}^2$ and $\delta_{\hat{s}i}{}^2$, respectively according to the method suggested by Griffing (1956b).

c) *Estimation of Heritability (h^2)*

Determination of heritability is one of the first objectives in the genetic study of a metric character. The extent to which individuals' phenotypes are determined by the genotypes is called broad sense heritability *(h^2_b)* and is expressed as the ratio the genotypic variance (δ^2_g) to phenotypic variance (δ^2_p). Hence $h^2_b=\delta^2_g/\delta^2_p$. The extent to which phenotypes are determined by the genes transmitted from the parents is called narrow sense heritability *(h^2_n)* and is obtained as the ratio of additive genetic variance (δ^2_A) to phenotypic variance *(δ^2_p)* expressed as $h^2_n = \delta^2_A/\delta^2_p$ (Falconer and Mackay, 1996).

IV. Results and Discussion

a) *Agronomic Performance of F1 and Parents*

Waterlogging remarkably delayed days to heading by 11 to 26 days and on average by 18 days (Table 1). The effect was very pronounced on all progenies involving the susceptible parent Feres Gama (37). Accordingly, the difference in days to heading under free drainage and waterlogged conditions of crosses involving this parent was very high. The mean days to heading pooled over parents and progenies was 82 days under free drainage conditions while it was 99 days under waterlogged conditions. The effect was comparatively less on days to maturity. The mean difference in maturity of progenies and parents between control and waterlogged treatments was almost a week.

Although plants under waterlogged conditions had delayed heading and maturity days, they achieved almost equivalent plant height to those of the plants in the free drainage experiment. This was probably because under waterlogged conditions productive tillers were reduced significantly and the surviving tillers might have taken advantage of reduced competition effects for available nutrients that allowed recovery and growth maintenance. Hence, at the end, spike length, number of seeds spike^{-1} and grain yield spike^{-1} of the waterlogged plants was comparable and even in some cases greater than plants in the free drainage experiment. There was a marked difference for grain yield, however, and this was expected because waterlogged and free drainage plants had apparent differences in total productive tillers. The difference in grain yield spike^{-1} between the free drainage and waterlogged plants of Feres Gama (37) is wider (1.24g spike^{-1}) than for Mage(07) that showed a mean difference of only 0.21 g spike^{-1}. Similarly, number of seeds spike^{-1}and grain yield pot^{-1} of the susceptible Feres Gama(37) decreased by 22 and 3.84 g, respectively while the corresponding values for the tolerant Mage(07) was only 5 and 2.0 which indicates differences in the relative sensitivity of the landraces to waterlogging stress. Moreover, all crosses involving the tolerant parent, Mage(07) had higher grain yield spike^{-1} and grain yield pot^{-1} under waterlogged conditions than all crosses involving Feres Gama(37) as their parent (Table 1). The reverse is true under free drainage conditions. This indicates differences between landraces and their progenies in the expression of their genetic potential under drained and waterlogged situations.

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Table 1 : Performance under waterlogged and free drainage growth conditions of parents and F1 progenies from a pot experiment in a greenhouse

Parents	DHE			DMA			PLH			SPL			NS/SP			GY/SP			GY/Plot		
	WL	FD	D	WL	FD	D	WL	FD	D	WL	FD	D	WL	FD	D	WL	FD	D	WL	FD	D
F.Gama(37)	116a	102a	14	165	152a	13	88	89	-1	6.4b	7.1a	-0.7	22	44a	-22	1.04	2.28a	-1.24	4.03	7.87	-3.84
Feleme(68)	95bc	81b	15	144	138b	6	79	82	-3	6.2b	5.5c	0.7	38	28c	10	1.80	1.39b	0.40	7.0 5	8.76	-1.72
Mage(07)	91c	77b	14	144	132c	12	79	83	-4	6.1b	5.7c	0.4	32	27c	5	1.69	1.48b	0.21	5.32	7.32	-2.00
1182(44)	97b	75b	22	142	137bc	5	81	82	-1	3.9c	4.2d	-0.3	26	28c	-2	1.13	1.45b	-0.31	4.64	6.29	-1.65
1153(28)	96bc	81b	16	142	132c	10	82	82	0	6.9a	6.3b	0.6	30	37b	-7	1.73	2.00a	-0.27	5.56	9.23	-3.66
$LSD_{0.05}$	5.8	5.6		4.3	5.2		NS	NS		0.5	0.47		NS	6.25		NS	0.29		NS	NS	
C.V (%)	6.2	7.1		3.0	3.9		7.7	6.1		8.6	8.6		35.0	19.9		33.5	17.8		44.1	18.9	
	DHE			DMA			PLH			SPL			NS/SP			GY/SP			GY/Plot		
F1progenies	WL	FD	D	WL	FD	D	WL	FD	D	WL	FD	D	WL	FD	D	WL	FD	D	WL	FD	D
P1 X P2	110	84	26	144	141	3	79	80	-1	7.4	6.6	0.8	34	42	-8	1.58	2.21	-0.63	5.29	9.16	-3.87
P1 X P3	104	87	17	152	141	11	87	84	3	7.0	6.6	0.4	41	44	-3	1.87	2.01	-0.14	7.49	9.29	-1.80
P1 X P4	106	81	25	151	136	15	78	91	-13	7.1	7.1	0.0	27	47	-20	1.54	2.48	-0.94	6.15	10.25	-4.10
P1 X P5	107	88	19	153	142	11	81	89	-8	6.9	7.6	-0.7	29	41	-12	1.65	2.34	-0.69	7.61	10.82	-3.21
P2 X P3	92	81	11	142	137	5	86	81	5	6.6	5.6	1.0	38	33	5	2.02	1.55	0.47	7.87	8.65	-0.78
P2 X P4	94	78	16	142	133	9	78	79	1	6.4	6.2	0.2	37	31	6	1.63	1.64	-0.01	6.31	7.61	-1.30
P2 X P5	99	81	18	139	143	-4	78	83	-5	6.6	6.6	0.0	29	33	-4	1.63	1.65	-0.02	6.49	9.91	-3.42
P3 X P4	101	79	22	143	132	11	92	-	-	7.1	6.5	0.6	40	33	7	2.22	1.64	0.58	7.90	8.55	-0.65
P3 X P5	92	75	17	138	135	3	84	80	4	6.8	6.5	0.3	41	31	10	2.10	1.73	0.37	8.26	8.14	0.12
P4 X P5	93	79	15	139	131	8	81	85	-4	6.4	6.2	0.2	37	43	-6	2.09	1.97	0.12	8.07	10.57	-2.50
$LSD_{0.05}$	6.9	3.8		5.3	5.2		NS	NS		NS	0.46		NS	7.2		NS	0.37		NS	1.52	

DHE=days to heading; DMA = days to maturity; PLH = plant height (cm); NS/SP = number of seeds spike^{-1}; GY/SP = grain yield spike^{-1}; GY/plot = grain yield plot^{-1}; D = difference; P1 to P3 are symbols representing parents listed in order in the table.

b) Combining Ability Effects

Under waterlogging conditions, the analysis of variance showed significant mean square values of general combining ability (GCA) for days to heading, days to maturity, number of seeds spike^{-1} and grain yield spike^{-1}, but not the specific combining ability (Table 2) implying additive genetic mechanisms might be important in determining these characters. Consistent with the free drainage treatment, GCA for days to heading, days to maturity, and grain yield spike^{-1} were significant under conditions of waterlogging. Both GCA and SCA mean square values were highly significant for spike length under both treatment levels, however, suggesting the importance of both additive and dominant gene action for this character. However, a GCA/SCA ratio higher than unity demonstrates that this character is predominantly under the control of additive gene action. In the free drainage treatment, grain yield appeared to be determined both by additive and dominant gene action as observed from the low GCA/SCA ratio.

Several combining ability studies in barley (Hockett et al., 1993; Bhatnagar & Sharma, 1995; Schittenhelm et al., 1996; Bhatnagar & Sharma, 1997; Hanifi & Gallais, 1999) indicated that GCA effects are more important in determining grain yield and yield components in environments free of stress. Phogat et al. (1995b), however, reported that both GCA and SCA are important for yield and yield components. A genetic study for tolerance to waterlogging in barley is lacking and a comparison with other studies is not possible. Based on the result from the free drainage experiment, it can be deduced that in absence of significant SCA effects the performance of the crossed progenies could be predicted based on GCA estimates of the parents because the parents with higher GCA estimates would be expected to produce superior cross bred progenies. In this regard Feres Gama(37) and 1153(28) were found to be good combiners. It was reported, however, that crosses between good general combiners would not always result in good F_1 combinations (Wells & Lay, 1970; Shriva stava & Seshu, 1983).

Table 2 : Combining ability analysis of F_1s and parents in a 5 x 5 diallel crosses of barley landrace lines evaluated under freely drained (FD) and waterlogged (WL) conditions in a greenhouse

Source of variation	Expt.	DF	Agronomic characters						
			DHE	DMA	PLH	SPL	NS/SP	GY/SP	GY
GCA	FD		134.511***	92.253***	26.051	1.314***	107.730***	0.361***	1.852*
	WL		153.167***	148.853***	6.854	0.877***	39.421	0.173	1.467
SCA	FD	10	10.219	12.680	7.628	0.381***	20.401	0.037	1.497*
	WL	10	10.294	11.155	19.786	0.582***	30.042	0.083	2.040
Residual	FD	42	5.684	6.656	8.203	0.061	12.758	0.034	0.654
	WL	42	12.397	6.961	13.864	0.086	19.252	0.066	1.528
GCA/SCA	FD		13.16	7.270	3.415	3.450	5.280	9.750	1.240
	WL		14.88	13.940	-	1.507	-	2.080	

Expt.=experiment; FD=free drainage; WL=waterlogged; DHE=days to heading & DMA= days to maturity; PLH=plant height; SPL=spike length;

NS/SP=number of seeds Spike^{-1}; GY/SP=grain yield spike^{-1} and GY=grain yield. * and ****= significantly different at P<0.05 and P<0.001, respectively.

Table 3 : General combining ability (GCA) effect of parents and mean performance for agronomic traits of barley landrace lines from evaluation of a diallel cross under free drainage conditions

Parents	DHE		DMA		PLH		SPL		NS/SP		GY/SP		GY(g/pot)	
	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA
F.Gama(37)	102a	7.636**	152a	5.943**	89	2.957	7.1a	0.619**	44a	6.378**	2.27a	0.352**	7.88	0.305
Feleme(68)	81b	-0.900	138b	1.014	82	-2.293	5.5c	-0.252**	28c	-3.121**	1.38b	-0.187**	8.76	-0.016
Mage(07)	77b	-2.150**	132c	-2.628**	83	-0.829	5.7c	-0.152	27c	-3.086*	1.47b	-0.180**	7.32	-0.492
1182(44)	75b	-3.436**	137bc	2.378**	82	0.386	4.2d	-0.464**	28c	-0.978	1.44b	-0.079	6.29	-0.509
1153(28)	81b	-1.150	132c	-1.950*	82	-0.221	6.3b	0.251**	37b	0.807	2.00a	0.095	9.22	0.680*
$LSD_{0.05}$	5.7		5.2		NS		0.47		6.2		0.29		NS	
C.V(%)	7.1		3.9		6.0		8.6		19.9		17.8		18.9	
Gi		1.579		1.709		NS		0.163		2.366		0.122		0.536
Gi-Gj		2.498		2.703		NS		0.258		3.742		0.192		0.847

Table 4 : General combining ability (GCA) effect of parents and mean performance for agronomic traits of barley landrace lines from evaluation of a diallel cross under waterlogged conditions

Parents	DHE		DMA		PLH		SPL		NS/SP		GY/SP		GY(g/pot)	
	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA
F.Gama(37)	116a	8.207**	165a	8.214**	88	1.064	6.3b	0.296**	22	3.028	1.04	0.222	4.03	0.674
Feleme(68)	95bc	-1.686	144b	2.571**	79	2.007	6.2b	0.039	38	1.614	1.80	0.023	7.05	0.106
Mage(07)	91c	3.543**	144b	-1.393	79	1.957	6.1b	0.078	32	3.043	1.69	0.185	5.32	0.442
1182(44)	97b	-1.078	142b	-2.107*	81	0.257	3.9c	-0.607**	26	-0.528	1.13	0.077	4.64	0.228
1153(28)	96bc	-1.900	145b	-2.143*	82	0.757	6.9a	0.193	30	-1.100	1.73	0.091	5.56	0.354
$LSD_{0.05}$	5.8		4.3		NS		0.48		NS		NS		NS	
C.V(%)	6.2		3.0		7.7		8.6		35.0		33.5		44.0	
Gi		2.333		1.748		NS		0.194		NS		NS		NS
Gi-Gj		3.688		2.764		NS		0.307		NS		NS		NS

DHE=days to heading & DMA= days to maturity; PLH=plant height; SPL=spike length; NS/SP=number of seeds spike^{-1}; GY/SP=grain yield spike^{-1} and GY=grain yield. * and **= significantly different at P=0.05 and P=0.01, respectively; NS = none significant.

The patterns of GCA effects of parents for days to heading and days to maturity are similar for the free drainage and waterlogging treatments in that the three early lines, Mage(07), 1182(44), and 1153(28), all had negative GCA effects for days to heading and maturity and Feres Gama(37) had positive GCA effects at both treatments (Tables 8.5 & 8.6). Earliness is a desirable feature and crosses involving these lines are expected to provide on average early heading and maturing progenies regardless of the waterlogging or free drainage treatments. Mage(07) and 1182(44) had negative GCA effects on yield and yield components, however, and are not the desired parents if the aim is to improve grain yield for environments where waterlogging is not a problem. However, yield stability is more important than high grain yield under stress environments and Mage(07) may be the preferred parent because it has consistently higher positive GCA effects for yield and yield components than all other parents under waterlogged conditions. The non-significant GCA mean square values for yield and yield components except spike length put the importance of this line in question, however. Under the free drainage environment, among the early lines, 1153(28) had positive GCA effects for all yield components and implicated the possibility of combining earliness and high grain yield. Feres Gama(37), on the other hand, is very late compared to the other three lines and accordingly demonstrated positive GCA effects for days to heading and maturity. Moreover, the GCA effects of Feres Gama(37) is higher than GCA effects of the other parent lines in all cases and the effects were significant for all characters observed under free drainage condition (Table 3).

Generally, under free drainage conditions, Feres Gama(37) and 1153(28) contributed the highest positive GCA effects for yield and yield components (spike length, number of seeds spike^{-1} and grain yield spike^{-1}). They were found to be good combiners for yield and yield components and accordingly the cross between these two parents gave the highest mean spike length, grain yield spike^{-1} and grain yield than all crosses. This cross is also among the top in number of seeds spike^{-1} in the free drainage experiment (Table 5). The facts that GCA effects of 1153(28) for number of seeds spike^{-1} and grain yield spike^{-1} were not significant imply, however, that this parent is not as good a combiner as Feres Gama(37) for these characters. The difference between the GCA effects of the two parents for spike length is significant denoting that both parents are desirable whereas the difference in GCA effects for grain yield is not significant.

Although Feres Gama(37) had significant positive GCA effects for days to heading and maturity, under free drainage experiment, all crosses with this parent showed negative SCA effects for days to heading and maturity except that of Feres Gama(37) x Mage(07) and Feres Gama(37) x 1153(28) which had positive SCA effects for days to maturity (Table 5). SCA mean square values were not significant, however, for these characters under both treatment levels. Hence, it is not important to discuss SCA effects. Therefore, restricting the discussion to spike length and grain yield in which both GCA and SCA mean square values were significant in the free drainage experiment (Table 2), high and positive SCA effects with improved spike length was observed in crosses of Feres Gama(37) x 1182(44), Feres Gama(37) x 1153(28) and Mage(07) x 1182(44) in which spike length of these crosses is above the high parent of the respective crosses. Higher SCA effects for grain yield were also observed in these three crosses and 1182(44) x 1153(28) in which grain yield crosses and 1182(44) x 1153(28) in which grain yield was far above the high parent value of the respective parents (Table 5). In this of experimental set, some of the crosses which showed significant positive SCA effects for spike length (Feres Gama(37) x 1182(44) and for grain yield (Feres Gama(37) x 1182(44) and 1182(44) x 1153(28) involved one good and one poor general combiner for these characters. According to Singh et al. (1985) such crosses would be expected to produce desirable transgressive segregants if the additive genetic system present in the good combiners (1153(28) and Feres Gama(37) and complementary epistatic effects present in the F_1 act in the same direction to maximize the desirable attributes. Under waterlogging conditions only spike length appeared to have significant SCA mean squares and the highest positive SCA effects were noted for crosses between Feres Gama(37) x Feleme(38), Mage(07) x 1182(44) and Feres Gama(37) x 1182(44). The highest mean spike lengths, among all F1, were also observed from these crosses.

Table 5 : Mean agronomic performance and specific combining ability effects of F1 progeny from diallel crosses of landrace lines evaluated under free drainage conditions in a greenhouse

Crosses	DHE		DMA		SPL(cm)		NS/SP		GY/SP(g)		GY (g/pot)	
	Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA
F.Gama(37) xFeleme(68)	84	-4.369	141	-3.190	6.5	-0.107	42	2.976	2.21	0.164	9.15	-0.019
F.gama(37) x Mage(07)	87	-0.369	141	0.952	6.6	-0.107	44	4.190	2.01	0.087	9.29	0.631
F.gama(37) x 1182(44)	81	-5.083	136	-4.298	7.1	0.682 *	47	5.583	2.48	0.332	10.25	1.598 *
F.Gama(37) x 1153(28)	88	-0.369	142	1.274	7.6	0.439 *	41	-2.702	2.34	0.020	10.82	0.983
Feleme(68) x Mage(07)	81	2.167	137	1.131	5.6	-0.285	33	2.690	1.55	0.041	8.65	0.672
Feleme(68) x 1182(44)	78	0.452	133	-3.119	6.2	0.603 *	31	-0.667	1.64	0.028	7.61	-0.750
Feleme(38) x 1153(28)	81	0.917	143	6.702	6.6	0.311	33	-0.952	1.65	0.006	7.90	0.355
Mage(07) x 1182(44)	79	2.702	132	-0.274	6.5	0.853 *	33	0.798	1.64	0.018	8.55	0.700
Mage(07) x 1153(28)	75	-3.833	130	-2.905	6.5	0.061	31	-2.488	1.73	-0.065	8.14	-0.899
1182(44) x 1153(28)	79	1.452	132	-1.405	6.2	0.125	43	6.905	1.97	0.169	10.56	1.540 *
Mean	82		137		6.3		36		1.85		8.83	
$LSD_{0.05}$	6.8		8.6		0.7		10		0.54		2.46	
$LSD_{0.01}$	9.1		11.5		0.9		14		0.72		NS	
C.V (%)	5.82		4.4		7.8		19.8		19.90		19.40	

DHE & DMA= days to heading and maturity, respectively; SPL= spike length; NS/SP=number of seeds per spike; GY/SP=grain yield per spike
GY=grain yield; *=significantly different at 0.05 probability.

In the free drainage experiment, GCA and SCA variance estimates associated with each parent (Table 6) indicated that Feres Gama(37) and 1153(28) had comparable SCA variances for yield and yield components suggesting that both parents transferred uniformly their potential to improve yield and yield components to their progeny. However, the relatively lower SCA variance for spike length associated with 1153(28) indicated that the potential for improved spike length was transferred better by this parent than Feres

Gama (37). Under waterlogged conditions, neither yield nor yield components had significant GCA and SCA mean square values except spike length which was also the case in ordinary analyses of variance. Hence a comparison of GCA and SCA variances associated with each parent would not be fair and results are not presented. A parent with comparatively lower SCA variance for a particular trait is said to transfer its potential uniformly to all the F_1 progeny (Griffing, 1956b; Boghi & Perenzin, 1994). Hence, these parents, Feres Gama(37) and 1153(28), shall be tested thoroughly in order that maximum use of their superior combining ability can be made in future crossing programs for environments free of waterlogging problem.

Table 6 : Estimates of GCA variance ($\delta_{\hat{g}i}^2$) and SCA variance ($\delta_{\hat{s}i}^2$) of parents for the different agronomic characters from a diallel cross of barley landrace lines evaluated under free drainage conditions in a greenhouse

Parents	Variance	DHE	DMA	PLH	SPL	NS/SP	GY/SP	GY
F.Gama(37)	$\delta_{\hat{g}i}^2$	56.788	33.543	6.557	0.36	37.284	0.115	-0.081
	$\delta_{\hat{s}i}^2$	11.276	5.955	7.525	0.186	13.123	0.026	0.871
Feleme(68)	$\delta_{\hat{g}i}^2$	-0.706	-0.746	3.069	0.047	6.341	0.026	- 0.174
	$\delta_{\hat{s}i}^2$	4.487	17.596	4.194	0.144	-2.690	-0.013	-0.055
Mage(07)	$\delta_{\hat{g}i}^2$	3.107	5.135	-1.501	0.007	6.119	0.023	0.068
	$\delta_{\hat{s}i}^2$	5.152	-0.871	-1.562	0.234	2.035	-0.018	0.281
1182(44)	$\delta_{\hat{g}i}^2$	10.288	3.883	- 2.038	0.201	-2.444	-0.003	0.085
	$\delta_{\hat{s}i}^2$	-3.703	5.646	4.117	0.484	18.139	0.024	1.557
1153(28)	$\delta_{\hat{g}i}^2$	-0.193	2.027	-2.138	0.047	-2.751	0.000	0.288
	$\delta_{\hat{s}i}^2$	2.136	14.547	0.066	0.062	12.187	-0.012	0.989

$\delta_{\hat{g}i}^2$, $\delta_{\hat{s}i}^2$= general combining ability and specific combining ability variance of each parent, respectively

c) Estimates of genetic parameters

Genetic parameters of agronomic characters were estimated from F_1 progenies and parents evaluated under free drainage and waterlogging stress. Estimates of the parameters from the respective experiments are presented in Table 7 and 8. The results from the free drainage experiment elucidated that of the total genotypic variance ($\delta^2 g = \delta^2_A + \delta^2_D$), the additive genetic variance portion is very high for all characters except for grain yield in which the δ^2_D is greater than the δ^2_A and spike length that showed comparable values of δ^2_A and δ^2_D. Spike length was the only character that displayed significant SCA mean squares hence relatively higher δ^2_D. However, the additive genetic variance was lower than the dominance variance (δ^2_D) under waterlogged conditions. The fact that the GCA: SCA ratio was relatively higher may lead to the assertion that additive gene action is more important than the non-additive portion in the inheritance of this character. Dabholkar (1992), however, indicated that it is erroneous to conclude that additive or non-additive gene action is predominant on the basis of relative magnitude of significant GCA and SCA mean square values without considering the respective GCA and SCA variances. This is true because the variance of general combining ability is equal to the additive variance and the variance of specific combining ability is equal to the non-additive variance (Falconer & Mackay, 1996). Hence in view of this, it may be assumed that spike length is not under the control of additive gene action under waterlogging stress since the GCA variance (δ^2gca) is lower than SCA variance (δ^2sca) suggesting low genetic advance by selection for this character.

The predominant role of non-additive gene action in the inheritance of grain yield (Kudla & Kudla, 1995; Bouzerzour, & Djakoune, 1997), the importance of additive gene action in determining grain yield spike^{-1} and heading date (Kudla & Kudla, 1995; Esparza-Martinez & Foster, 1998), and number of seeds spike^{-1} (Bouzerzour, & Djakoune, 1997) has been reported in environments free of stress. In this study, although grain yield appeared to be governed both by additive and non-additive gene actions under free drainage conditions, yield components were found to be under the effects of additive gene action that is in harmony with most of the above studies. By contrast, the importance of both additive and non-additive gene actions for yield and yield components (Bhatnagar & Sharma, 1995; Phogat et al., 1995a) and for days to heading and maturity (Singh & Singh, 1990a) have been reported which is in contrast to this experiment under free drainage conditions. Under waterlogging stress, the additive genetic variance (δ^2_A) for days to heading and days to maturity were very high in contrast to their respective dominance variance (Table 8) indicating the importance of additive gene actions in the expression of these characters which was consistent with the results from the free drainage experiment.

Table 7 : Estimates of genetic parameters for seven agronomic characters of F1s from a diallel cross of barley landrace lines evaluated under free drainage conditions in a greenhouse

Character	GCA	SCA	δ^2_e	δ^2_{gca}	δ^2_{sca}	δ^2_A	δ^2_D	δ^2_g	δ^2_p	h^2_b	h^2_n	PR
DHE	134.511	10.219	5.684	18.404	4.535	36.807	4.535	41.343	47.026	0.88	0.78	0.89
DMA	92.253	12.680	6.656	12.228	6.024	24.456	6.024	30.480	37.136	0.82	0.66	0.80
PLH	26.051	7.628	8.203	2.549	-0.575	5.099	-0.575	4.524	12.727	0.35	0.40	1.13
SPL	1.314	0.381	0.061	0.179	0.320	0.358	0.320	0.678	0.739	0.92	0.48	0.53
NS/SP	107.730	20.401	12.758	13.567	7.643	27.134	7.643	34.777	47.535	0.73	0.57	0.78
GY/SP	0.361	0.037	0.034	0.047	0.003	0.093	0.003	0.096	0.130	0.71	0.72	0.97
GY	1.852	1.497	0.654	0.171	0.843	0.342	0.843	1.185	1.839	0.64	0.19	0.29

Table 8 : Estimates of genetic parameters for the different agronomic characters of F1s and parents from a diallel cross of barley landrace lines evaluated under situations of waterlogging for three weeks in a greenhouse pot experiment

Variable	MSgca	MSsca	δ^2e	δ^2gca	δ^2sca	δ^2_A	δ^2_D	δ^2g	δ^2p	h^2b	h^2n	PR	GCA: SCA
DHE	153.167***	10.294	12.397	20.410	-2.103	40.82	-2.10	38.72	51.11	0.76	0.79	1.05	14.88
DMA	148.853***	11.155	6.961	19.671	4.194	39.34	4.19	43.54	50.49	0.86	0.78	0.90	12.34
PLH	16.854**	19.786	13.864	-0.419	5.922	-0.84	5.92	5.08	18.95	0.27	-0.04	-0.16	-
SPL	0.877***	0.582***	0.086	0.042	0.496	0.08	0.49	0.580	0.67	0.87	0.13	0.15	1.51
NS/SP	39.421	30.042	19.252	1.339	10.790	2.68	3.07	5.75	25.00	0.23	0.11	0.19	-
GY/SP	0.173*	0.083	0.066	0.013	0.017	0.026	-2.10	-2.08	-2.01	1.03	-0.01	0.60	2.08
GY	1.467	2.040	1.528	-0.082	0.512	-0.16	0.02	-0.15	1.38	-0.10	-0.12	-0.47	-

*, *** = significantly different at $P < 0.05$ and $P < 0.001$, respectively. – represents GCA:SSA ratio not calculated because neither GCA nor SCA mean square values were significant

Estimates of broad sense heritability (h^2b) were in the range of 0.35 for plant height to 0.92 for spike length under free drainage condition and 0.00 for grain yield to 1.03 for grain yield spike^{-1} under waterlogged conditions. Values for narrow sense heritability (h^2n) were in the range of 0.19 for grain yield to 0.78 for days to heading in the free drainage experiment while it was 0.00 for grain yield to 0.79 for days to heading in the case of waterlogging experiment. Heritabilities for the reproductive characters (number of seeds spike^{-1}, grain yield spike^{-1} and grain yield) were very low to moderate in the free drainage experiment whereas both h^2b and h^2n were moderate to very high for the phonological characters for both treatment levels. Higher heritability estimates reported for days to heading (Frey, 1954; Singh & Singh, 1990a; Cai et al., 1993), and number of estimates reported for days to heading (Frey, 1954; Singh & Singh, 1990a; Cai et al., 1993), and number of seeds spike^{-1} (El-Hennawy, 1997) and low heritability for grain yield (Grafius et al., 1952; Cai et al., 1993; Bailey & Wolfe, 1994; Phogat, et al., 1995) in barley are in agreement with results obtained from the free drainage experiment.

It is obvious that heritability in the broad sense may be regarded as an estimate of the upper bound of heritability in the narrow sense since it includes both the additive and non-additive genetic variances. Hence, it should not be preferred if h^2n is available because it is the h^2n which expresses the extent to which the phenotypes are determined by the genes transmitted from the parents (Bos & Caligari, 1995). Moreover, heritability in the narrow sense being the ratio of the additive genetic variance to the phenotypic variance is a scale-independent quantity and plays an important role in predicting the response to selection. In view of this, the very low additive variance compared to the dominance variance and the consequently very low h^2n for grain yield in the free drainage experiment (Table 7) imply that genetic advance by selecting for this character is expected to be low. On the other hand, because of the absence of the dominant genetic variance for grain yield per spike, higher h^2n was observed. Hence, it is possible to select barley plants with a desirable grain yield per spike in early generations, and indirect selection for grain yield through selection for grain yield per spike appears to be feasible under free drainage environment. It's predictability (PR=0.97) was also higher compared to all other yield components.

The waterlogged experiment was generally characterized by negative estimates of genetic parameters that were not the case with data from the free drainage experiment. Miller et al. (1958) discussed negative estimates of genetic parameters and attributed it to sampling error and the negative estimates shall be regarded as zero values. Hogarth (1971) indicated that negative estimates of genetic parameters are meaningless, but they should be presented for illustrative purpose, the values being taken as zero, or in order to contribute to the accumulation of knowledge (Dudley & Moll, 1969). Maluf et al. (1983) put his notion, however, that negative value of genotypic variance is most likely the result of low magnitude of genotypic variance in relation to variance of error (δ^2_e) and not because of the non-existence of genetic variation; or because of situations where characters in the parental means are very close so that variance estimates in the hybrid population will be close to zero (Haddad, 1982). Hence, the resulting negative heritability values shall be considered as very low rather than zero.

Lack of precision in an experiment was also considered as a major factor for negative variances. Comstock and Moll (1963) showed that well replicated experiments in time and space would improve precision or repeated experimentation involving the same character in related populations will give estimates, which when averaged, approach a true value (Dudley & Moll, 1969). However, Hogarth (1971) obtained negative estimates of genetic parameters despite the high precision in his experiment as judged by the coefficient of variation and he coined the issue with his view that it is a major problem in quantitative genetic studies. Considering all these views, the negative estimates of genetic parameters observed in this study under waterlogged conditions shall be treated with caution.

Table 9 : Comparisons of mean performance of F1 progenies under free drainage condition and statistical significance for the difference between the progenies and their respective mid-parent values

Crosses	DHE			DMA			SPL			NS/SP			GY/SP			GY/pot		
	F1	MP	t-test	F1	MP	t-test	F1	MP	t-test	F1	MP	t-test	F1	MP	t-test	F1	MP	t-test
P1 x P2[a]	84	91	**	141	145	NS	6.6	6.3	NS	42	36	NS	2.21	1.83	NS	9.15	8.34	NS
P1 x P3	87	90	NS	141	142	NS	6.7	6.4	NS	44	36	NS	2.01	1.88	NS	9.30	7.59	NS
P1 x P4	81	89	**	136	144	*	7.1	5.7	**	47	36	*	2.48	1.86	**	10.25	7.08	**
P1 x P5	88	91	NS	142	141	NS	7.6	6.7	**	41	41	NS	2.35	2.14	NS	10.82	8.55	*
P2 x P3	81	79	NS	137	135	NS	5.6	5.6	NS	33	28	NS	1.55	1.43	NS	8.65	8.04	NS
P2 x P4	78	78	NS	133	137	NS	6.2	4.9	***	31	28	NS	1.64	1.42	NS	7.61	7.53	NS

P2 x P5	81	81	NS	143	135	*	6.6	5.9	*	33	33	NS	1.65	1.69	NS	9.91	8.99	NS
P3 x P4	79	76	NS	132	134	NS	6.5	4.9	***	33	28	NS	1.64	1.46	NS	8.55	6.80	NS
P3 x P5	75	79	NS	130	132	NS	6.5	6.0	NS	31	32	NS	1.73	1.72	NS	8.14	8.27	NS
P4 x P5	79	78	NS	132	134	NS	6.2	5.3	**	43	33	*	1.97	2.00	NS	10.57	7.76	**

Table 10 : Comparisons of mean performances of F1 progenies under waterlogged condition and statistical significance of the differences between the progenies and their respective mid-parent values

Crosses	DHE			DMA			SPL			NS/SP			GY/SP			GY/pot		
	F1	MP	t-test	F1	MP	t-test	F1	MP	t-test	F1	MP	t-test	F1	MP	t-test	F1	MP	t-test
P1 x P2[a]	110	106	NS	144	155	***	7.4	6.3	***	34	30	NS	1.58	1.42	NS	5.29	5.54	NS
P1 x P3	104	104	NS	152	155	NS	7.0	6.2	*	41	27	*	1.87	1.36	NS	7.49	4.67	NS
P1 x P4	106	107	NS	151	154	NS	7.1	5.1	***	27	24	NS	1.54	1.08	NS	6.15	5.33	NS
P1 x P5	107	106	NS	153	155	NS	6.9	6.6	NS	29	26	NS	1.65	1.38	NS	7.61	4.79	NS
P2 x P3	92	93	NS	142	144	NS	6.6	6.1	NS	38	35	NS	2.02	1.74	NS	7.87	6.18	NS
P2 x P4	94	96	NS	142	143	NS	6.4	5.1	***	37	32	NS	1.63	1.46	NS	6.31	5.84	NS
P2 x P5	99	96	NS	139	144	NS	6.6	6.5	NS	29	34	NS	1.63	1.76	NS	6.49	6.30	NS
P3 x P4	101	94	NS	143	143	NS	7.1	5.0	**	40	29	NS	2.22	1.41	*	7.90	4.98	NS
P3 x P5	92	94	NS	138	145		6.8	6.5	NS		31	NS	2.10		NS	8.26	5.44	NS
P4 x P5	93	97	NS	139	144	NS	6.4	5.4	**	37	28	NS	2.09	1.43	NS	8.07	5.10	NS

P1=Feres Gama(37), P2=Feleme(68), P3=Mage-07, P4=1184(44), & P5=1153(28); *, **, & *** indicate significantly different values at 0.05, 0.01 & 0.001 probability levels, respectively. MP=Mid-parent value

V. Conclusions

The fact that there are two contrasting barley production environments in north Shewa (areas prone to waterlogging and areas free of waterlogging stress) and because there is evidence that genetic variances, genetic correlations between characters and effectiveness of selection differ in stress and non stress environments prompted the evaluation of the F1 progenies under conditions of free drainage and waterlogging stress. The results elucidated the importance of general combining ability (GCA) for days to heading and days to maturity at both treatment levels and for number of seeds spike^{-1} and grain yield spike^{-1} in the free drainage experiment only indicating the significance of additive gene effects for these characters. In free drainage conditions, grain yield appeared to be determined both by additive and dominant gene actions, however. Both GCA and SCA were significant for spike length at both treatment levels but the higher GCA:SCA ratio and the higher GCA variance (δ^2gca) in the free drainage experiment indicated that this character is also under the control of additive gene action. By contrast, although GCA:SCA ratio was higher for this character in the waterlogging experiment, SCA variance (δ^2sca) was greater than the δ^2gca. Hence, spike length is not under the control of additive gene action under waterlogging stress.

The patterns of GCA effects of parents for days to heading and days to maturity are similar for both treatment levels but different for the other characters. Among the parents, the two late and early maturing lines, Feres Gama(37) and 1153(28), respectively contributed the highest positive GCA effects for yield and yield components in the free drainage experiment. Accordingly, the cross between these two parents gave the highest mean spike length, grain yield spike^{-1} and grain yield than all crosses and is among the top in number of seeds spike^{-1}. The fact that GCA effects of 1153(28) for number of seeds spike^{-1} and grain yield spike^{-1} were not significant imply that this parent is not as good a combiner as Feres Gama(37) for these characters, but it is as good as Feres Gama(37) in its combining ability for spike length. Moreover, the difference for GCA effects of the two parents for spike length is significant denoting that both parents are equally desirable. In conditions of waterlogging, Mage(07) had consistently higher positive GCA effects for yield and yield components than all other parents. The non significant GCA mean square values for yield and yield components except spike length under waterlogged conditions put the importance of this line in question, however.

GCA and SCA variance estimates associated with each parent also indicated that Feres Gama(37) and 1153(28) had comparable SCA variances for yield and yield components in the free drainage experiment suggesting that both parents transferred their genetic potential for yield and yield components effectively to their progeny. However, the relatively lower SCA variance for spike length associated with 1153(28) indicated that this parent transferred its genetic potential to its progeny better than Feres Gama(37). Under waterlogged conditions, neither yield nor yield components had significant GCA and SCA mean square values except spike length which was also the case in ordinary analyses of variance. Hence a comparison of GCA and SCA variances associated with each parent would not be fair. The negative estimates of genetic parameters observed for most characters under waterlogged conditions except for days to heading and maturity imply the difficulty in achieving the anticipated progress through selection for quantitative characters. By the same token, the non significant GCA effects of parents under waterlogged conditions also illustrated the difficulty in predicting the performance of progenies under waterlogged conditions.

It can be generalized that Feres Gama(37) and 1153(28) were found to be good combiners and they shall be tested thoroughly in order that maximum use of their superior combining ability can be made in future crossing program aimed at improving yield and yield components for environments free of waterlogging problems. Grain yield spike^{-1} is highly heritable and predictable under free drainage conditions so that good progress can be expected from effective selection for this character. By contrast, the very low heritability (0.19) for grain yield implies that it is very difficult to make progress by selection for grain yield *per se*. Therefore, grain yield spike^{-1} can serve as indirect selection for genotypes with high grain yield since it has highly significant positive genotypic and phenotypic correlation with grain yield also. An important point to note is that the estimates of genetic variances and heritability values were from one experiment in one year. Therefore, the values are likely to be biased upward due to confounding effects of genotype x location, genotype x year and genotype x location x year interaction components. Nevertheless the estimates provide an indication of the relative ease of making progress through breeding.

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Influence of Fumigants and Number of Fumigation on Seed Quality and Storability of Groundnut *(Arachis Hypogaea L)*

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Abstract - Groundnut is a self pollinated crop grown worldwide for its edible oil and vegetable protein. Production of quality seed not only involves technical skill, labour and finance but the produced seed needs to be properly saved until next planting time. Hence the experiment was carried out to study the influence of fumigants and number of fumigation on seed quality parameters during storage. The results revealed that, groundnut ssed fumigated with ethylene dibromide at 30 and 90 days after harvest retained satisfactory germination (70%) and higher values for all seed quality parameters up to six months, whereas the seeds fumigated with aluminium phosphide for four times recorded lowest groundnut beetle population at the end of ten months of storage.

Keywords : fumigation, groundnut, aluminium phosphide, ethylene dibromide.

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INFLUENCE OF FUMIGANTS AND NUMBER OFFUMIGATION ON SEED QUALITY AND STORABILITY OFGROUNDNUTARACHIS HYPOGAEA L

Strictly as per the compliance and regulations of :

Influence of Fumigants and Number of Fumigation on Seed Quality and Storability of Groundnut *(Arachis Hypogaea L)*

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Abstract - Groundnut is a self pollinated crop grown worldwide for its edible oil and vegetable protein. Production of quality seed not only involves technical skill, labour and finance but the produced seed needs to be properly saved until next planting time. Hence the experiment was carried out to study the influence of fumigants and number of fumigation on seed quality parameters during storage. The results revealed that, groundnut ssed fumigated with ethylene dibromide at 30 and 90 days after harvest retained satisfactory germination (70%) and higher values for all seed quality parameters up to six months, whereas the seeds fumigated with aluminium phosphide for four times recorded lowest groundnut beetle population at the end of ten months of storage.

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I. Introduction

Groundnut *(Arachis hypogaea L.)* "King of oilseed crops", is believed to be native of Brazil (South America). It was introduced to India during first half of the sixteen century. It belongs to the family leguminaceae and sub family papilonoceae. It is a unique crop, combining the attributes of both oil seed crop and legume crop in the farming system of Indian Agriculture. It is a valuable crop planted in dry areas of Asia, Africa, Central and South America, Australia and Caribbean in view of its economic, food and nutritional value. It is the 13th most important food crop, 4th most important source of edible oil and 3rd most important source of vegetable protein in the world. Groundnut posses high oil content (44-50%) and protein (25%) and are also a valuable source of vitamins E, K and B. It is a richest plant source of thiamine and also in niacin, which is low in cereals. The plants, kernels, oil and cakes are economically used in one or the other way.

The success of crop depends on the use of quality seed sown in commercial crop production. Among several seed quality attributes, the storage potential of seed plays an important role in meeting out the demand for commercial crop production programme. Protection of seed from insect attack is of great importance until it is sown in next season or year. During storage, quality of groundnut seed gets deteriorated due to several reasons, out of which, storage pest infestation contributes its major share. The loss in seed quality may be quantitative or qualitative or both. Damage by *Caryedon serratus* in groundnut seeds to the extent of 45 per cent results in 65 per cent loss of dry weight of damaged seeds (Kapadia, 1994).

During storage, quality of seed can be maintained for a longer period by adopting several prophylactic control measures *viz.,* disinfestation of storage room, physical and chemical treatments, fumigation, *etc.* The insecticidal seed protectants do not offer complete protection against storage pests and it may be difficult to treat the large quantity of seeds. The fumigation of seeds has advantages over seed treatment with insecticides since it not only controls the storage pests completely but it is also cheap and easy to treat large quantity of seeds without impairing the seed quality. The efficacy of fumigants on control of storage pest and seed quality depends on several factors *viz.,* moisture content, RH, dosage, exposure period. The present investigation was under taken to study the influence of type of fumigants and number of fumigations on seed quality and storability of groundnut seeds.

II. Materials and Methods

Laboratory experiments was conducted with groundnut cv. GPBD-4 at the Department of Seed Science and Technology, College of Agriculture, University of Agricultural Sciences, Raichur. The experiment consisted of 13 treatment combinations involving two fumigants (F) *viz.,* Aluminium phosphide (0.9g/q) and Ethylene dibromide (3ml/q) and eleven number of fumigations. The calculated quantities of fumigants were placed in the plastic bag (700 gauge) along with the pods and the bags were sealed with cellophane tape and exposed to 120 hours. After the required exposure period, the pods were removed from the bags and were stored in aerated gunny bags under ambient storage conditions and the same process is repeated at different intervals *viz.* Fumigation at 30, 90, 150 and 210, days after harvest (DAH), Fumigation at 30 and 90 DAH, Fumigation at 30 and 150 DAH, Fumigation at 30 and 210 DAH, Fumigation at 90 and 150 DAH, Fumigation at 90 and 210 DAH, Fumigation at

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150 DAH, Fumigation at 90 and 210 DAH, Fumigation at 30, 90 and 150 DAH, Fumigation at 30, 90, 150 and 210 DAH. The seed quality parameters like 100 seeds weight, germination percentage, speed of germination, shoot, vigour index (SVI=germination percentage x seedling length in cm), seedling dry weight, beetle population, dehydrogenase activity and electrical conductivity were recorded bimonthly. The germination test was conducted as per ISTA rules (Anon., 1999), SVI as per Abdul-Baki and Anderson (1973), speed of germination using the formula suggested by Maguire (1962) and dehydrogenase activity by Kittock and Law, 1968. The data were statistically analyzed for completely randomized block design with four replications (Sundararajan *et al.*, 1972).

III. Results and Discussion

The results of the present study revealed that, the seeds fumigated with EDB recorded higher seed quality parameters namely germination (51.13%), vigour index (380), seedling dry weight (1.64 g seedlings^{-10}) and dehydrogenase enzyme activity (0.092) and less seed leachate value (1.253 dSm^{-1}) than the seeds fumigated with aluminium phosphide at the end of ten months of storage (*Table 1-5)*. The better performance of EDB is due to its lesser penetration into seeds and its vapours are non-inflammable. So, it did not react with constituents of food reserves and hence reduced residual effect on seed was observed which is also confirmed by Agarwal *et al.* (1987) in maize. The seeds fumigated with aluminium phosphide noticed less (6.08) number of groundnut beetle (*Table 6)*population compared to ethylene dibromide (9.33) at the end of ten months of storage which clearly indicated that aluminium phosphide had more toxicity than EDB which combated the pest population effectively and conversely drastic reduction in seed quality parameters were noticed throughout the storage. Aluminium phosphide fumigated seeds could maintain the satisfactory seed germination (70%) up to four months with less pest population. The present findings are in agreement with the findings of Lindgren *et al.,* (1962).

In many instances, single fumigation is not sufficient for control of storage pest. The fumigant may lose its concentration with the advancement of storage period and reoccurrence of the pest in storage is found several times. It is essential to combat the storage pest during entire storage period for which repeated fumigation could be adopted at definite intervals between the fumigations. Repeated fumigation has cumulative injury to seeds and some residue of fumigants retained after first fumigation again gets accumulated in each subsequent fumigation which led to drastic reduction in seed quality parameters like germination, vigour and viability of seeds. But, effective control of storage pest may be achieved by adopting exact number of fumigations and groundnut seeds can tolerate with a particular fumigant but the time gap between the repetitions of fumigation needs to be ascertained. The present investigations revealed that the seeds which received two fumigations at 30 and 90 days after harvest (N_5) registered significantly higher germination (52.96%), root length (4.26 cm), shoot length (4.25 cm), seedling dry weight (1.88 g/10 seedlings), seedling vigour index (452) and speed of germination (17.98) with less electrical conductivity of seed leachate (1.264 dSm^{-1}) at the end of storage period (Table).

The satisfactory germination of 70 per cent was maintained up to four months of storage in the seeds which received twice fumigated at 30 and 90 days after harvest which is followed by single fumigation either at 30, 90, 150 or 210 days after harvest. While, the above parameters were significantly affected in the seeds which received thrice and four time fumigations at 30, 90, 150 or 210 days after harvest (DAH). This indicates that, fumigating the seeds repeatedly reduced the seed quality due to higher residual effect of fumigants and also might be due to phosphorrylation activity leading to the blocking of glycolysis with repeated fumigation (Shadi *et al.,* 1978). Similar decrease in seed quality by repeated fumigations with ethylene dibromide and aluminium phosphide were also reported by Yadav *et al.* (1968) in wheat, paddy and maize seeds; Raghunathan *et al.* (1969) in sorghum, Yadav and Mookherjee (1974) and Kirsur (1985) in maize and Ramazan and Chahal (1989), Rathod (2002) in wheat and Vijayanna (2006).

Once fumigated seeds noticed the highest (13.00) number of groundnut beetle while, it was lowest (2.50) in seeds given with four fumigations at 30, 90, 150 or 210 DAH at the end of ten months of storage. The present findings are in agreement with findings of Gupta and Kashyap (1995) in pulses.

In the interaction effect between the fumigants and number of fumigations, the seeds fumigated with EDB twice at 30 and 90 days after harvest (F_2N_5) performed better by recording higher quality parameters like germination (53.30%), seedling dry weight (2.00 g/10 seedlings), dehydrogenase enzyme activity (0.105) and seedling vigour index (463) and lower electrical conductivity of seed leachate (1.212 dSm^{-1}). While, converse values for the above seed quality parameters were recorded in the seeds fumigated thrice with aluminium phosphide at 30, 90, 150 and 210 days after harvest at the end of ten months of storage period. Better seed quality in this treatment combination (F_2N_5) followed by the F_2N_1 may be due to less residual effect and high insect control of fumigants. The findings of present study are in conformity with the reports of Yadav et *al.* (1968) in wheat, paddy and maize seeds; Raghunathan *et al.* (1969) in sorghum, Yadav and Mookherjee (1974) and Kirsur (1985) in maize; Umapathy (1988), Ramazan and Chahal (1989) in wheat and Vijayanna (2006) in groundnut.

The seeds fumigated with EDB once at 30 DAH (F_2N_1) recorded highest (16.00) number of groundnut beetle population while, it was lowest (2.00) in seeds given with four fumigations of aluminium phosphide at 30, 90 150 and 210 DAH (F_1N_{11}) at the end of ten months of storage. Conversely all the seeds quality parameters were affected due to F_1N_7 treatment combination

Table 1 : Influence of fumigants and number of fumigations on seed germination (%) in groundnut

Treat	Months after storage														
	Two			Four			Six			Eight			Ten		
	F_1	F_2	Mean	F_1	F_2	Mean	F_1	F_2	Mean	F_1	F_2	Mean	F_1	F_2	Mean
N_0	78.00 (62.23)*	78.00 (62.23)	78.00 (62.23)	66.00 (54.33)	71.97 (56.00)	68.98 (55.17)	63.00 (52.54)	66.30 (54.00)	64.65 (53.27)	52.00 (46.15)	58.97 (48.00)	55.48 (47.07)	46.67 (42.00)	52.63 (44.84)	49.65 (43.42)
N_1	80.80 (64.02)	79.63 (63.17)	79.13 (62.82)	70.63 (57.19)	73.29 (58.88)	71.96 (58.04)	64.63 (53.50)	67.30 (54.07)	65.96 (53.79)	57.63 (49.39)	60.30 (50.00)	58.96 (49.69)	51.63 (45.93)	52.97 (46.70)	52.30 (46.32)
N_2	79.63 (63.17)	80.97 (64.13)	80.97 (63.65)	69.30 (56.35)	72.30 (58.24)	70.80 (57.30)	63.63 (52.91)	66.97 (54.92)	65.30 (53.91)	57.30 (49.20)	60.30 (49.95)	58.80 (49.57)	51.97 (46.13)	52.63 (46.51)	52.30 (46.32)
N_3	79.63 (63.17)	81.97 (64.87)	80.80 (64.02)	71.30 (57.60)	73.63 (59.10)	72.46 (58.35)	64.30 (53.31)	64.97 (53.71)	64.63 (53.51)	56.97 (49.00)	59.30 (50.36)	58.13 (49.68)	51.63 (45.24)	51.30 (45.74)	51.46 (45.49)
N_4	78.30 (62.23)	80.63 (63.89)	79.46 (63.51)	71.30 (57.60)	72.63 (58.45)	71.96 (58.03)	63.30 (52.71)	65.96 (54.31)	64.63 (53.51)	56.63 (48.81)	58.30 (49.78)	57.46 (49.29)	49.63 (44.46)	49.97 (44.98)	49.80 (44.72)
N_5	78.63 (62.46)	79.33 (62.93)	78.96 (62.70)	70.63 (57.18)	70.97 (57.40)	70.80 (57.29)	64.63 (53.51)	70.30 (56.97)	67.80 (54.51)	57.63 (49.39)	59.30 (50.36)	58.46 (49.87)	52.63 (46.51)	53.30 (46.89)	52.96 (46.70)
N_6	78.30 (62.23)	79.30 (62.93)	78.74 (62.58)	70.30 (56.97)	73.63 (59.10)	71.96 (58.04)	62.63 (52.31)	64..96 (53.71)	63.80 (53.01)	56.63 (48.81)	58.30 (49.78)	57.46 (49.29)	50.97 (45.55)	52.63 (46.51)	51.80 (46.03)
N_7	78.30 (62.23)	79.63 (63.17)	78.96 (62.70)	71.30 (57.60)	73.63 (59.10)	72.46 (58.35)	63.96 (53.11)	66.97 (54.92)	65.47 (54.01)	56.30 (48.62)	58.00 (49.60)	57.15 (49.11)	51.30 (45.74)	51.63 (45.93)	51.46 (45.84)
N_8	76.33 (61.09)	80.97 (64.13)	78.80 (62.61)	70.63 (57.18)	72.63 (58.45)	71.63 (57.82)	62.30 (52.12)	64.63 (53.50)	63.46 (52.81)	55.63 (48.23)	57.63 (49.39)	56.63 (48.81)	49.97 (44.98)	51.30 (45.74)	50.63 (45.36)
N_9	79.33 (62.93)	80.63 (63.89)	79.96 (63.41)	70.30 (56.97)	72.63 (58.45)	71.46 (57.71)	64.29 (52.46)	67.30 (55.12)	65.80 (53.79)	55.97 (48.43)	57.63 (49.39)	56.80 (48.91)	49.66 (44.81)	50.30 (45.17)	49.99 (44.99)
N_{10}	78.63 (62.46)	78.30 (62.23)	78.46 (62.35)	69.63 (56.56)	71.90 (57.99)	70.76 (57.27)	61.97 (51.92)	54.63 (52.00)	58.30 (51.96)	55.30 (48.04)	56.30 (48.62)	55.80 (48.33)	48.30 (44.02)	48.30 (44.02)	48.30 (44.02)
N_{11}	78.33 (62.23)	78.30 (62.23)	78.30 (62.23)	69.30 (56.35)	71.63 (57.81)	70.46 (57.08)	61.63 (51.72)	63.63 (50.00)	62.63 (50.86)	54.97 (47.85)	55.30 (48.04)	55.13 (47.95)	46.30 (42.88)	46.66 (43.08)	46.48 (42.98)
Mean	78.34 (62.30)	80.07 (63.28)	79.21 (62.79)	70.05 (56.83)	72.57 (58.25)	71.31 (57.54)	63.33 (52.68)	65.05 (53.76)	64.20 (53.22)	56.08 (48.49)	58.30 (49.44)	57.19 (48.96)	50.05 (44.85)	51.13 (45.51)	50.59 (45.18)

	S.Em±	CD (5%)	S.Em±	CD (5%)	S.Em±	CD (5%)	S.Em±	CD (5%)	S.Em±	CD (5%)
F	0.023	0.064	0.023	0.066	0.084	0.238	0.035	0.101	0.063	0.180
N	0.055	0.157	0.057	0.161	0.205	0.584	0.087	0.247	0.155	0.440
F x N	0.078	0.222	0.080	0.228	0.290	0.825	0.123	0.349	0.219	0.622

* Figures in the parenthesis indicates arc sign transformed values.

Fumigants (F)

F_1 : Aluminium phosphide

F_2 : Ethylene dibromide

Number of fumigation (N)

N_0 : No fumigation (control)

N_1 : Fumigation at 30 days after harvest

N_2 : Fumigation at 90 days after harvest

N_3 : Fumigation at 150 days after harvest

N_4 : Fumigation at 210 days after harvest

N_6 : Fumigation at 30 and 150 days after harvest

N_7 : Fumigation at 30 and 210 days after harvest

N_8 : Fumiation at 90 and 150 days after harvest

N_9 :Fumigation at 90 and 210 days after harvest

N_{10}: Fumigation at 30, 90 and 150 days after harvest

Table 2 : Influence of fumigants and number of fumigations on vigour index in groundnut

Treatments	Months after storage														
	Two			Four			Six			Eight			Ten		
	F_1	F_2	Mean	F_1	F_2	Mean	F_1	F_2	Mean	F_1	F_2	Mean	F_1	F_2	Mean
N_0	1772	1851	1812	1192	1355	1274	881	957	919	513	648	580	311	382	346
N_1	1854	1976	1915	1311	1460	1386	943	1051	997	619	710	665	394	431	412
N_2	1851	1976	1913	1252	1425	1339	764	1026	895	603	700	652	343	417	380
N_3	1852	2034	1943	1306	1464	1385	899	978	938	598	681	640	372	404	388
N_4	1774	2000	1887	1302	1431	1366	914	1010	962	561	642	601	342	324	333
N_5	1848	1991	1920	1315	1402	1358	953	1052	1003	622	685	654	440	463	452
N_6	1825	1991	1908	1291	1434	1363	867	956	912	572	650	611	373	427	400
N_7	1826	1975	1900	1299	1450	1375	917	1046	981	531	651	591	340	371	356
N_8	1792	2005	1898	1280	1413	1346	833	932	882	521	612	566	355	401	378
N_9	1849	1999	1924	1273	1410	1341	907	1051	979	506	601	553	308	346	327
N_{10}	1814	1934	1874	1250	1396	1323	801	771	786	496	574	535	304	313	309
N_{11}	1831	1927	1879	1230	1381	1306	756	873	814	451	520	485	261	285	273
Mean	**1824**	**1971**	**1898**	**1275**	**1419**	**1347**	**870**	**975**	**922**	**549**	**640**	**594**	**345**	**380**	**363**
	S.Em ±	CD (5%)		S.Em±	CD (5%)		S.Em±	CD (5%)		S.Em±	CD (5%)		S.Em±	CD (5%)	
F	1.902	5.408		1.600	4.550		9.391	26.703		2.252	6.404		3.310	9.412	
N	4.659	13.247		3.919	11.144		23.003	65.409		5.516	15.686		8.108	23.054	
F x N	6.589	18.734		5.543	15.760		32.531	NS		7.801	22.183		11.466	NS	

NS – Non significant

Fumigants (F)

F_1 : Aluminium phosphide

F_2 : Ethylene dibromide

Number of fumigation (N)

N_0 : No fumigation (control)

N_1 : Fumigation at 30 days after harvest

N_2 : Fumigation at 90 days after harvest

N_3 : Fumigation at 150 days after harvest

N_4 : Fumigation at 210 days after harvest

N_5 : Fumigation at 30 and 90 days after harvest

N_6 : Fumigation at 30 and 150 days after harvest

N_7 : Fumigation at 30 and 210 daysafter harvest

N_8 : Fumigation at 90 and 150 days after harvest

N_9 : Fumigation at 90 and 210 days after harvest

N_{10}: Fumigation at 30, 90 and 150 days after harvest

N_{11}: Fumigation at 30, 90, 150 and 210 days after harvest

Table 3 : Influence Of Fumigants And Number Of Fumigations On Seedling Dry Weight (G) In Groundnut

Treatments	Months after storage														
	Two			Four			Six			Eight					Ten
	F_1	F_2	Mean	F_1	F_2	Mean	F_1	F_2	Mean	F_1	F_2	Mean	F_1	F_2	Mean
N_0	2.13	2.17	2.15	2.08	2.09	2.09	2.07	2.04	2.05	1.82	1.87	1.84	1.52	1.65	1.58
N_1	2.33	2.47	2.40	2.19	2.37	2.28	2.15	2.33	2.24	1.98	2.09	2.04	1.68	1.85	1.77
N_2	2.27	2.45	2.36	2.10	2.25	2.18	2.15	2.20	2.17	1.93	2.09	2.01	1.66	1.77	1.71
N_3	2.33	2.45	2.39	2.23	2.35	2.29	2.12	2.30	2.21	2.00	2.07	2.04	1.64	1.80	1.72
N_4	2.30	2.43	2.37	2.26	2.33	2.30	2.16	2.30	2.23	1.87	2.00	1.94	1.61	1.67	1.64
N_5	2.33	2.50	2.42	2.25	2.37	2.31	2.16	2.35	2.26	2.05	2.20	2.13	1.75	2.00	1.88
N_6	2.29	2.38	2.34	2.22	2.33	2.27	2.13	2.21	2.17	1.97	2.08	2.03	1.50	1.83	1.67
N_7	2.35	2.38	2.36	2.20	2.30	2.25	2.14	2.09	2.12	1.60	1.78	1.69	1.48	1.57	1.53
N_8	2.34	2.45	2.40	2.23	2.33	2.28	2.11	2.15	2.13	1.80	1.98	1.89	1.45	1.47	1.46
N_9	2.36	2.39	2.37	2.21	2.31	2.26	2.02	2.07	2.05	1.50	1.62	1.56	1.20	1.38	1.29
N_{10}	2.34	2.38	2.36	2.20	2.30	2.25	2.09	2.10	2.10	1.30	1.88	1.59	1.28	1.53	1.41
N_{11}	2.30	2.28	2.29	2.13	2.25	2.19	1.82	1.95	1.89	1.20	1.37	1.28	1.00	1.15	1.08
Mean	2.31	2.39	2.35	2.19	2.30	2.25	2.09	2.18	2.13	1.82	1.87	1.84	1.48	1.64	1.56

	S.Em±	CD (5%)	S.Em±	CD (5%)	S.Em±	CD (5%)	S.Em±	CD (5%)	S.Em±	CD (5%)
F	0.007	0.020	0.008	0.022	0.005	0.014	0.006	0.017	0.015	0.043
N	0.017	0.048	0.019	0.054	0.012	0.035	0.015	0.043	0.037	0.106
F x N	0.024	0.068	0.027	NS	0.017	0.049	0.021	0.060	0.053	NS

Fumigants (F)

F_1 : Aluminium phosphide
F_2 : Ethylene dibromide

Number of fumigation (N)

N_0 : No fumigation (control)
N_1 : Fumigation at 30 days after harvest
N_2 : Fumigation at 90 days after harvest
N_3: Fumigation at 150 days after harvest
N_4: Fumigation at 210 days after harvest
N_5: Fumigation at 30 and 90 days after harvest
N_6 : Fumigation at 30 and 150 days after harvest
N_7 : Fumigation at 30 and 210 days after harvest
N_8 : Fumigation at 90 and 150 days after harvest
N_9 : Fumigation at 90 and 210 days after harvest
N_{10}: Fumigation at 30, 90 and 150 days after harvest
N_{11}: Fumigation at 30, 90, 150 and 210 days after harvest

Table 4 : Influence of fumigants and number of fumigations on dehydrogenase enzyme activity (OD value) in groundnut

Treatments	Months after storage														
	Two			Four			Six			Eight			Ten		
	F_1	F_2	Mean	F_1	F_2	Mean	F_1	F_2	Mean	F_1	F_2	Mean	F_1	F_2	Mean
N_0	0.360	0.457	0.409	0.348	0.372	0.360	0.235	0.235	0.235	0.127	0.131	0.129	0.085	0.099	0.092
N_1	0.525	0.534	0.530	0.378	0.398	0.386	0.255	0.265	0.260	0.136	0.148	0.142	0.097	0.102	0.099
N_2	0.518	0.533	0.526	0.370	0.385	0.378	0.250	0.245	0.248	0.136	0.144	0.140	0.090	0.100	0.095
N_3	0.516	0.535	0.526	0.378	0.395	0.387	0.237	0.258	0.248	0.120	0.144	0.132	0.093	0.095	0.094
N_4	0.517	0.531	0.524	0.377	0.395	0.386	0.258	0.250	0.254	0.134	0.140	0.137	0.088	0.092	0.090
N_5	0.531	0.545	0.538	0.372	0.397	0.384	0.330	0.275	0.303	0.140	0.151	0.146	0.102	0.105	0.103
N_6	0.512	0.533	0.523	0.372	0.382	0.377	0.237	0.248	0.243	0.125	0.146	0.136	0.095	0.101	0.098
N_7	0.524	0.532	0.528	0.375	0.382	0.379	0.248	0.257	0.252	0.130	0.129	0.130	0.080	0.090	0.085
N_8	0.522	0.532	0.527	0.362	0.368	0.365	0.230	0.243	0.237	0.110	0.120	0.115	0.082	0.093	0.088
N_9	0.525	0.531	0.528	0.363	0.368	0.366	0.241	0.242	0.242	0.128	0.122	0.125	0.079	0.083	0.081
N_{10}	0.525	0.531	0.528	0.352	0.360	0.356	0.225	0.240	0.233	0.124	0.115	0.119	0.053	0.078	0.066
N_{11}	0.524	0.527	0.526	0.328	0.333	0.331	0.210	0.220	0.215	0.116	0.110	0.113	0.042	0.065	0.053
Mean	0.508	0.527	0.518	0.365	0.378	0.371	0.246	0.248	0.247	0.127	0.133	0.130	0.082	0.092	0.087

	S.Em±	CD (5%)	S.Em±	CD (5%)	S.Em±	CD (5%)	S.Em ±	CD (5%)	S.Em±	CD (5%)
F	0.0101	0.0287	0.0011	0.0030	0.0051	0.014	0.0003	0.0010	0.0005	0.0014
N	0.0247	NS	0.0026	0.0073	0.0124	NS	0.0008	0.0023	0.0012	0.0034
F x N	0.0350	NS	0.0036	NS	0.0176	NS	0.0012	0.0033	0.0017	0.0048

NS – Non significant

Fumigants (F)

F_1 : Aluminium phosphide
F_2 : Ethylene dibromide

Number of fumigation (N)

N_0: No fumigation (control)
N_1: Fumigation at 30 days after harvest
N_2: Fumigation at 90 days after harvest
N_3:Fumigation at 150 days after harvest
N_4:Fumigation at 210 days after harvest
N_5:Fumigation at 30 and 90 days after harvest
N_6 : Fumigation at 90 and 210 days after harvest
N_7 : Fumigation at 30 and 150 days after harvest
N_8 : Fumigation at 30 and 210 days after harvest
N_9 :Fumigation at 90 and 150 days after harvest
N_{10}: Fumigation at 30, 90 and 150 days after harvest
N_{11} : Fumigation at 30, 90, 150 and 210 days after harves

Table 5 : Influence of fumigants, number of fumigations on electric conductivity (dSm^{-1}) in groundnut

Treatments	Months after storage														
	Two			Four			Six			Eight			Ten		
	F_1	F_2	Mean	F_1	F_2	Mean	F_1	F_2	Mean	F_1	F_2	Mean	F_1	F_2	Mean
N_0	0.823	0.787	0.805	0.905	0.898	0.900	1.102	0.946	1.024	1.282	1.195	1.239	1.388	1.253	1.321
N_1	0.816	0.782	0.799	0.902	0.895	0.900	0.994	0.917	0.955	1.252	1.193	1.223	1.320	1.221	1.271
N_2	0.815	0.775	0.795	0.909	0.896	0.903	0.985	0.922	0.954	1.263	1.195	1.229	1.353	1.233	1.293

N_3	0.815	0.777	0.796	0.917	0.894	0.906	1.104	0.955	1.029	1.292	1.200	1.246	1.353	1.231	1.292
N_4	0.813	0.775	0.794	0.918	0.893	0.906	1.107	0.917	1.012	1.292	1.207	1.250	1.380	1.300	1.340
N_5	0.816	0.794	0.805	0.918	0.894	0.906	0.955	0.930	0.943	1.265	1.197	1.231	1.317	1.212	1.264
N_6	0.818	0.794	0.806	0.928	0.899	0.914	1.115	0.972	1.043	1.268	1.200	1.234	1.330	1.250	1.290
N_7	0.817	0.794	0.806	0.920	0.896	0.908	1.115	0.920	1.017	1.278	1.231	1.255	1.363	1.297	1.330
N_8	0.816	0.776	0.796	0.921	0.896	0.909	1.117	0.982	1.050	1.287	1.231	1.259	1.360	1.282	1.321
N_9	0.820	0.775	0.797	0.930	0.899	0.914	0.788	0.985	0.886	1.285	1.251	1.268	1.379	1.294	1.337
N_{10}	0.817	0.793	0.805	0.920	0.894	0.907	1.157	0.983	1.070	1.277	1.230	1.254	1.260	1.294	1.277
N_{11}	0.820	0.794	0.807	0.935	0.928	0.931	1.197	0.988	1.093	1.289	1.250	1.270	1.404	1.304	1.354
Mean	**0.817**	**0.785**	**0.801**	**0.919**	**0.898**	**0.909**	**1.070**	**0.951**	**1.010**	**1.278**	**1.215**	**1.246**	**1.388**	**1.253**	**1.321**

	S.Em±	CD (5%)	S.Em±	CD (5%)	S.Em±	CD (5%)	S.Em±	CD (5%)	S.Em±	CD (5%)
F	0.0005	0.0014	0.0017	0.0047	0.020	0.057	0.001	0.003	0.008	0.022
N	0.0012	0.0034	0.0041	0.0116	0.049	NS	0.003	0.007	0.019	0.054
F x N	0.0017	0.0048	0.0058	0.0164	0.069	NS	0.004	0.011	0.027	NS

NS – Non significant

Fumigants (F)
F_1 : Aluminium phosphide
F_2 : Ethylene dibromide

Number of fumigation (N)
N_0 : No fumigation (control)
N_1 : Fumigation at 30 days after harvest
N_2: Fumigation at 90 days after harvest
N_3: Fumigation at 150 days after harvest
N_4: Fumigation at 210 daysafter harvest
N_5 : Fumigation at 30 and 90 days after harvest
N_6 : Fumigation at 30 and 150 days after harvest
N_7 : Fumigation at 30 and 210 days after harvest
N_8: Fumigation at 90 and 150 days after harvest
N_9: Fumigation at 90 and 210 days after harvest
N_{10}: Fumigation at 30, 90 and 150 days after harvest
N_{11}:Fumigation at 30, 90, 150 and 210 days after harvest

able 6 : Influence of fumigants, number of fumigations on beetle population in groundnut

Treatments	Months after storage														
	Two			Four			Six			Eight			Ten		
	F_1	F_2	Mean	F_1	F_2	Mean	F_1	F_2	Mean	F_1	F_2	Mean	F_1	F_2	Mean
N_0	4.00	5.00	4.50	5.00	7.00	6.00	7.00	10.00	8.50	12.00	16.00	14.00	15.00	25.00	20.00
N_1	0.00	0.00	0.00	2.00	3.00	2.50	4.00	9.00	6.50	7.00	13.00	10.00	10.00	16.00	13.00
N_2	2.00	2.00	2.00	0.00	0.00	0.00	2.00	4.00	3.00	5.00	8.00	6.50	8.00	14.00	11.00
N_3	2.00	3.00	2.50	4.00	6.00	5.00	0.00	0.00	0.00	1.00	3.00	2.00	3.00	7.00	5.00
N_4	3.00	3.00	3.00	4.00	7.00	5.50	5.00	10.00	7.50	0.00	0.00	0.00	3.00	3.00	3.00
N_5	0.00	0.00	0.00	0.00	0.00	0.00	2.00	3.00	2.50	5.00	7.00	6.00	9.00	13.00	11.00
N_6	0.00	0.00	0.00	1.00	4.00	2.50	0.00	0.00	0.00	2.00	4.00	3.00	7.00	10.00	8.50
N_7	3.00	4.00	3.50	5.00	8.00	6.50	8.00	11.00	9.50	0.00	0.00	0.00	2.00	3.00	2.50
N_8	2.00	3.00	2.50	0.00	0.00	0.00	0.00	0.00	0.00	3.00	4.00	3.50	6.00	9.00	7.50
N_9	3.00	4.00	3.50	0.00	0.00	0.00	2.00	3.00	2.50	0.00	0.00	0.00	3.00	4.00	3.50
N_{10}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	3.00	2.50	5.00	6.00	5.50
N_{11}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	3.00	2.50
Mean	1.58	2.00	1.79	1.75	2.92	2.33	2.50	4.17	3.33	3.08	4.83	3.96	6.08	9.33	7.71

NS – Non significant

Fumigants (F)
F_1 : Aluminium phosphide
F_2 : Ethylene dibromide

Number of fumigation (N)
N_0 :No fumigation (control)
N_1 : Fumigation at 30 days after harvest
N_2 :Fumigation at 90 days after harvest
N_3:Fumigation at 150 days after harvest
N_4:Fumigation at 210 days after harvest
N_5: Fumigation at 30 and 90 days after harvest
N_6 : Fumigation at 30 and 150 days after harvest
N_7 : Fumigation at 30 and 210 days after harvest
N_8 : Fumigation at 90 and 150 days after harvest
N_9 : Fumigation at 90 and 210 days after harvest
N_{10} :Fumigation at 30, 90 and 150 days after havest
N_{11} : Fumigation at 30, 90, 150 and 210 days after harvest

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A Linear Programming Approach to Combination of Crop, Monogastric Farm Animal and Fish Enterprises in Ohafia Agricultural Zone, Abia State, Nigeria

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A LINEAR PROGRAMMING APPROACH TO COMBINATION OF CROP, MONOGASTRIC FARM ANIMAL AND FISH ENTERPRISES IN OHAFIA AGRICULTURAL ZONE, ABIA STATE, NIGERIA

Strictly as per the compliance and regulations of :

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Abstract - Linear Programming technique was applied to farm data of a representative sample of farmers involved in arable crop farming in combination with monogastric farm animals and fish farming. Thirty farmers were selected from three villages within three circles in a chosen block by means of multi-stage stratified random sampling technique. Primary data were collected using well structured questionnaire on resource use and availability, input and output prices, types of enterprise combination etc. of the representative farms using the cost-route approach in Ohafia zone of Abia State, during the 2010 farming season. Data were analyzed using linear programming. The study was to solve a maximization problem of gross margin among combination of existing enterprises by this category of farmers. The programme recommended yam (0.29ha), cassava (0.02ha) and cassava/maize/cocoyam (0.13ha), broiler I – August – December (70.00 birds), fish I (220.00 fish) and layers (205.00 birds) enterprises for an average farmer in Ohafia to optimize gross margin given the available resources. Optimum gross margin for Ohafia was 72.90% greater than obtained in the existing plan. Yam/melon had the least shadow price of N428.34 in the study area. It was only feed that constrained the attainment of the objective function. When land was increased by 50% of what was available, gross margin obtained was insensitive. Based on the findings of the study therefore, given more lands to the farmers would not make for increased gross margin. It is rather policies that will improve extension services for the farmers in their livestock management and livestock input subsidy that could help farmers to maximize gross returns less the variable costs of production. Adopting the prototype enterprise combination has tremendous implication on improving the family income of an average sampled farmer in the study area.

Keywords : linear programming, gross margin, enterprises, existing plan, optimum plan.

I. Introduction

The use of linear programming in management and decision making originated in the 1940s during World War II, when a team of British scientists applied it in decisions among the military regarding the best utilization of war material (Taha, 2011). Generally, mathematical programming tools have afterwards been employed variously covering wide range of activities like crop farming, mixed farming, horticultural crops, livestock alone, various breeds and varieties, all sorts of combinations of different activities (Mehta, 1992). In a regional/inter-regional framework, linear programming approach has been used for studies in optimum resource allocation and resource requirements in many countries (Alam *et al.*, 1995; Sama, 1997; Alam, 1994; Onyenweaku, 1980; Shipper *et al.*, 1995). Within Nigeria, application of linear programming models to farm enterprises in various states has also been reported (Osuji, 1978; Tanko, 2004; Igwe *et al.*, 2012). However, arable crop based farms or the livestock component particularly animals whose production cycles last within a year are yet to be fully targeted.

Hassan *et al.* (2005) reported that farmers profit cannot be maximized without optimum cropping patterns, which ensure efficient utilization of available resources; and so the use of LP makes it possible to devise equilibrium solution, which include the specification of products levels, factor and product prices. Developing a prototype enterprise cropping plan in arable crop production would be useful in the extension education package for use by extension workers. This is because how the farmers are to use any developed technologies and incentives would depend on their effective and efficient utilization of their productive resources (Furton and Clark, 1982). The prototype enterprise combination expected from this study shall thus assist in answering many resource allocation problems that would enhance farm productivity.

Achieving self-sufficiency in food crops among other things requires that, for the indigenous food crops and livestock enterprises perhaps, in which Nigeria has a comparative advantage over other nations of the world, significant increases are experienced given the prevailing socio-cultural and economic circumstances of Nigeria. Effective combination of measures aimed at increasing the level of farm resources and making

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efficient use of the food sub-sector is one of the strategies advocated to achieve significant increases in food production (Heady, 1952). Developing optimum farm plan for small-holder farmers for this category of food crops could lead to the resolution of the food crises given that the Nigerian farmer does not seem to exploit fully her opportunities for capital formation, improved resource base, higher productivity, innovation and improved management techniques (Olayemi, 1980). Given that the farmer is faced with the challenge of rationing his scarce resources among intended activities as well as optimizing the result of the rationing (Olayemi and Onyenweaku, 1999), require the choice of approximate mix of crop activities and analysis of planning of mixed enterprises to achieve a well defined technical relationship between inputs and outputs (Sama, 1997). This therefore creates an allocation problem which the findings of the study shall address.

Generally, allocation problems are concerned with the utilization of limited resources to best advantage (Lucey, 2002). If there were no resource constraints, the farmer perhaps could allocate without optimizing or optimize without considering the allocation implication but not both (Olayemi and Onyenweaku, 1999). Greater emphasis upon efficient utilization of the existing resources and combination of enterprises in an optimal manner in the food crop sub-sector is paramount.

Although some of the decision techniques employed required converting allocation problems to mathematical form, making comprehension complex and beyond the farmers' comprehension. Such complexities have been found to be overcome by Punjab farmers in India over time (Mehta, 1992). Thus, with the passage of time just as was in the case of Punjab farmers in India, the arable crop farmers would pick up the essentials and thus the farmers would amongst the various possible solutions so obtained, be able to select the 'most efficient' solution, and make their own decisions.

Besides all these, information from this study would be of benefit to decision makers, and managers; in both private and public firms, students and researchers who need literature from where to draw from in their work. In this way, it shall contribute in the improvement of efficiency of arable crop production in the study area and consequent reduction of poverty as the farmers' earning capability would be improved upon if the recommendations derived from the study are adhered to.

Inspite of all the food crop production programmes of FGN over the years, the food deficit has exacerbated leading to rapid increases in domestic food prices and increased importation of food which the worsening position of the balance of payments in recent years could no longer sustain (Tanko, 2004). Therefore, the need for the practicing farmers who suffer from a dearth of valuable information and are struggling to optimize their objective function subject to their resource constraints given a complex mixture of many variables has led to the appropriateness of the following research questions:

1. What is the optimum cropping plan for arable crop and some selected livestock enterprises in Ohafia zone of Abia State?
2. Given the resource restraints and possible alternative combinations to choose from, how should the respective farmer allocate his/her resources to optimize gross returns?
3. Which crop or livestock enterprises should farmers in the study area produce so as to attain the highest level of returns consistent with the level of demand?
4. Which of the factors of production is/are most limiting in the study area for each of the arable crop and the selected livestock enterprises and what is/are their implication(s)?
5. What is the minimum hectarage/stock size required for each of the farmers to maximize returns?
6. What is the nature of competition of activities which did not enter the optimum plan over those which did?
7. How would increasing or decreasing one or more resources affect the optimum mix of activities and the value of the programme?
8. Is the optimum plan different from the existing crop-livestock farm plans for farmers?

a) Objectives of the Study

The broad objective of the study was to determine using linear programming technique the combination of arable crop and selected animal enterprises in Ohafia Agricultural zone.

The specific objectives were to:

1. examine the various enterprises, crops and selected livestock operated by farmers in Ohafia zone;
2. analyze the farmers resource levels and other constraints in their crop and livestock farm production;
3. develop optimum enterprise combination for sole crop/livestock and mixed crop/animal mixtures considering the farmers' resources that would maximize the gross margin of farms in the study area;
4. determine which of the resources/factors of production is/are limiting in the study area;
5. compare existing and optimum farm plans for farmers in terms of activities and resource utilization;
6. Carry out sensitivity analysis

II. Methodology

a) Study Area

The study area was Ohafia agricultural zone of Abia State, located within the South East agro ecological zone of Nigeria, whose rural population accounts for about 60% that engage in agriculture (Iloka and Anuebunwa, 1995; Unamma *et al.*, 1985). Ohafia zone is located in Abia State and has a tropical climate that is humid all year round, with the rainy season that starts from March-October and dry season that occurs from November-February. Annual rainfall ranges from 2000mm-2500mm and temperature ranges between 22° C and 31° C (FOS, 1999). The agriculture is rain fed and the rainfall pattern bio-model with peaks in July and September respectively (Tanko and Opara, 2006).

The zone comprises Ohafia, Arochukwu, Bende, Isiukwuato and Umunneochi Local Government Areas. There are however twelve blocks within this agricultural zone. As a result of the nature of data collection only one block, Ohafia West block was chosen for the study. The major engagement of the inhabitants is crop farming with very minor livestock farming as in other South-East states (Unamma *et al.*, 1985). Arable crops usually cultivated in the state include cassava, yam, maize, melon, cocoyam, vegetable and fruits, and these crops are grown on small holder plots usually, in mixtures of at least two simultaneous crops (FOS, 1999; World Bank, 2000).

Within the rural communities, male youths engage in off-farm activities such as 'Okada' riding while the middle-aged who do not fancy that engage in hunting. Petty trading is predominant in the area as well, particularly among the women folk.

b) Sampling Procedure

A multi-stage stratified random sampling technique was used to sample for thirty farmers in Ohafia. This first stage involved listing all the blocks in the zone which are thirteen and randomly selecting one. Ohafia West Block was incidentally chosen. The second stage involved randomly sampling three circles within the block, and Ohafia LGA, Ihenta and Otulu circles were chosen. The third stage involved the selecting a village (farming community) in each of the circles. The farm household which is made up the man, his wife or wives and other dependents was the primary unit from which data were collected. Ten potential arable crop - based farmer were identified with the assistance of the village heads and the extension agents in each of the nine villages so chosen across the three zones. A total of thirty respondents who engage in arable crop farming and along side poultry, piggery and fisheries production enterprises assumed to be the major livestock enterprises undertaken in the study area were randomly sampled for the study.

The objective function set for the study for the crop and livestock enterprises was to maximize the return over variable cost (gross margin), where the return represented the product term of average yield of enterprise and its unit price patterned following Uddin et al., (1994) with modification by incorporation of the livestock enterprises majorly monogastrics or non-ruminants. The variance therefore is the absence of irrigation farming and tractor hiring and the integration of selected livestock in the model. In order to maintain uniformity, the output prices were taken as the harvest price and input prices as the actual market prices at the time of application of inputs following Alam et al. (1995) and Tanko (2004).

c) The Structure of the Model

The general deterministic LP model of the study is a gross margin maximization model designed to find out the optimum solutions. The farm household which is the firm in this case is to maximize an objective function by planting various combinations of selected arable crops either in mixtures or as soles alongside selected livestock mainly monogastrics. The model is specified mathematically as:

$$\text{Maximize } Z = \sum_{j=1}^{m} P_j X_j - \sum_{i=1}^{n} \sum_{j=1}^{m} C_{ij} X_{ij} \quad \dots 1$$

Subject to:

$$\sum_{j=1}^{n} a_{ij} X_j \leq b_i$$

$$X_j \geq 0 \dots 3$$

$\sum f_k X_j \geq F_{ic}$(min) (minimum subsistence farm-family tuber/cereal crop requirement) ... 4

$\sum f_{kc} X_j \geq F_{ia}$(min) (minimum subsistence farm-family protein requirement) ... 5

Where: $i = 1,2...m$, $j = 1,2,...n$

Z = Gross margin of total output, X_j = Decision variable, for instance the number of hectares the farmer devoted to the production of a crop or a combination of crops or a combination of crops or livestock capacities *produced by farm, P_j = The gross value per hectare of* the jth activity be it crop or per livestock capacity for livestock enterprises, C_{ij} = Cost per unit of ith input used in the production of the jth activity, X_{ij} = Quantity of ith input in jth activity, a_{ij} = the amount "a" of the resource "i" used in the production o one unit of "j", b = level of

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available resources, b_i = the level ''b'' at which resources ''i'' is available, m = number of activities in the programme, $F_{ic(min)}$ = Minimum quantity of root/tuber crops required by the farm family per annum in tons (i=1,2,3...n), F_{ia}(min) = Minimum quantity of protein required by farm family per annum in tons (i = 1,2,3,...n)

III. Results and Discussion

a) *Socio-economic Characteristics of Respondents*

A summary of the statistics of farmers in the study area on age, sex, marital status, household size, educational experience and farming experience and for their farm size are presented in Table 1.

Table 1 : Summary of Descriptive Statistics of Some Selected Socioeconomic Characteristics of Respondents in Ohafia Zone

Variable	Sample Size	Minimum	Maximum	Mean	Standard Deviation
Age	30	31.00	76.00	54.73	12.66
Sex	30	0.00	1.00	0.73	0.45
Marital status	30	0.00	1.00	0.97	0.32
Education	30	0.00	22.00	7.33	4.21
Experience	30	8.00	45.00	20.63	12.17
Household size	30	1.00	12.00	6.80	3.10
Off-farm Income	30	12,600.00	462,000.00	141,466.53	2.25E+12

Source : Field Survey, 2010

The study further showed that the mean age was 55 years. Agricultural work in the study area not being mechanized fully yet is labour intensive. Therefore, it is expected that the farmers within this age can readily provide a lot of physical strength required for farm work. Nwaru (2004) had earlier opined that the ability of a farmer to bear risk, be innovative and able to do manual work decreases with age. However, there is need to motivate and stimulate more youths to take up agriculture to stabilize this age gap. For the selected enterprises, the males are more into agriculture than their female counterparts in the study.

This agrees with the findings of Olaleye (2000), that small-scale farming are being carried out mostly by males while the females involve in light farm operations such as processing, harvesting and marketing. The finding tends to suggest therefore that in zone, the males are the active participants in agricultural production than the females. However, it is principally because land is not owned by women going by the culturally setting of the study area.

The result of study showed that the level of illiteracy among farmers in the study area is gradually decreasing given that the mean level of educational attainment of the farmers was 7 years for Ohafia. It implies that an average farmer in the area can no longer be termed illiterate. It has implication on extension services to the area.

b) *Arable Land holdings of Farmers in the Study Area*

The farm size of the respondents for arable farm holdings is presented in Table 2.

Table 2 : Frequency Distribution of Farmers According to the Farm size in Ohafia Agricultural Zone

Range	Frequency	Percentage	Mean	Variance	Standard deviation
0.13-0.27	7	23.33	0.38	0.04	0.20
0.28 – 0.42	8	26.67			
0.43 – 0.57	6	20.00			
0.58 – 0.72	8	26.67			
0.73 – 0.87	1	3.33			
Total	30	100			

Source : Field Survey Data, 2010

The table also show that farmers in Ohafia zone were operating at a subsistent level of farming so high to permit large scale production. In other words are referred to as small holder farmers (peasant farmers) given the mean farm size to be 0.38.

c) *Existing and Optimum Cropping/Enterprise Patterns across Agricultural Zones*

The existing and optimum enterprise patterns for Ohafia agricultural zone for the sampled farmers are presented in Table 3. The study prescribed 0.29 ha of yam, 0.02 ha of cassava and 0.13 ha of cassava/maize/cocoyam for crop enterprises while 0.14 of 500 birds (70 birds) broiler II done August – December, 0.22 of 1000 fish (220 fish) of fish I done January – June and 0.41 of 500 birds (205) of Layer for the livestock enterprises in the study area to maximize gross margin.

There were more sole crops that entered the plan for the crop category than the crop mixtures implying that the sole crops were in a better competitive position. The optimum plan further favoured the monogastric farm animals given that both the broiler and the layer enterprises appeared in the plan.

Table 3 : Existing and Optimum Cropping/Enterprise Patterns in Ohafia Agricultural Zone, Abia State, Nigeria

Cropping/Enterprise pattern	Existing plan (ha)		Optimum plan (ha)	
	Size of farm	Percentage	Size of farm	Percentage
1. Yam	0.18	5.94	0.29	65.91
2. Cassava	0.14	13.53	0.02	4.55
3. Yam/ Melon	0.18	5.94	-	-
4. Yam/ Maize	0.34	11.22	-	-
5. Cassava/Maize	0.24	7.92	-	-
6. Cassava/ Melon	0.22	7.26	-	-
7. Cassava/ Maize/ Cocoyam	0.64	21.12	0.13	29.55
8. Cassava/Maize/Melon	0.22	7.26	-	-
9. Cassava/Maize/Yam	0.41	13.53	-	-
10. Yam/Maize/Melon	0.19	6.27	-	-
11. Broilers 1 Jan-May	0.19	22.89	-	-
12. Broiler 11 Aug- Dec	0.24	28.92	0.14	25.46
13. Fish 1-Jan-June	0.80	57.14	0.22	100
14. Fish 11 July-Dec	0.60	42.86	-	-
15. Layers	0.40	48.19	0.41	74.55
Total Cropped Area	3.03		0.44	-
% Sole Crops		19.47		70.46
% Crops Mixture		80.53		29.55
Total poultry	0.83		0.55	
% Broilers		51.81		25.55
% Layers		48.19		74.55
Total Fish	1.40		0.18	
% Fish		100		100

Source : Field Survey Data, 2010

d) Labour Utilization

Labour utilization for the different agricultural zone is presented in Table 4.

Table 4 : Labour Utilization in Ohafia Agricultural Zone

PLAN:	Existing	Optimum
Crop		
LPP	60	9.86
1st Weeding	70	14.36
2nd Weeding	80	12.34
Harvesting	90	22.25
Total	**300**	**58.81**
Livestock		
Feeding	210	114.34

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Cleaning	180	44.83
Sorting	15	2.65
Harvesting	5	0.44
Total	**410**	**162.26**

Source : Field Survey Data, 2010

N/B: LPP = Land preparation and planting

e) Gross margin among various plans

The gross margins for the existing and optimum plans for selected farmers in are presented in Table 5.

Table 5 : Gross Margin (in Naira) for Existing and Optimum Plans for the Selected Farmers in Ohafia Zone

Existing Plan	Optimum Plan	Increase/Decrease	Over Existing Plan %
222,056.32	383,941.60	161,885.28	72.90

Source : Field Survey Data, 2010

Results in Table 5 indicate that optimum plans resulted in an increase in gross margin over the existing plan by 72.90%. The findings are very high relative to values obtained among similar category of farmers for an average farmer in Abia State (Igwe *et al.*, 2012). The implication was that an average farmer in Ohafia zone has the potential to maximize gross margin more than an average counterpart at the state level. Tanko and Baba (2010) on the other hand had gross margin very much lower than was obtained for an average farmer in Ohafia zone of Abia State. The introduction of livestock enterprises among the crop enterprises may explain for the relatively high optimum values relative to studies where only crop enterprises were evaluated.

f) Shadow Prices of Excluded Activities among Selected Farmers in Ohafia

Shadow prices are marginal returns to investments of available resources. In a maximization problem, they are income penalties; indicating the amount by which farm income would be reduced if any of the excluded activities is forced into the programme. Olayemi and Onyenweaku (1999) had earlier reported that any resource that is abundant, that is not used up by a programme, is not a limiting resource and has a zero shadow price as it does not constrain the attainment of a programme's objective and vice versa. Usually however, only the excluded activities have positive shadow prices. For the included activities, shadow prices are zero. The higher the shadow price of an excluded activity, the lower is its chance of being included in the final plan. The shadow prices of excluded activities obtained as by-products of the linear programme solution are presented in Table 6. Results in these tables indicate the amount by which farm gross income would be reduced if any of the activities appearing in the table is forced into the programme.

The selected mixed crop enterprises for two crop mixtures were in a better competitive position than the three crop mixture. This lends credence to previous findings (Adejobi et al, 2003, Tanko, 2004). However fish I, done usually between January and June has the least propensity to depress income among the selected farmers.

Table 6 : Shadow Prices (in Naira) of Excluded Activities in Linear Programming Solution for Farmers in Ohafia Agricultural Zone

S/N	Excluded Activity	Shadow Price
1.	Yam/Melon	428.34
2.	Yam/Maize	3580.17
3.	Cassava/Maize	27,272.41
4.	Cassava/Melon	17,856.38

5.	Cassava/Maize/Melon	40,710.45
6.	Cassava/Maize/Yam	47,552.86
7.	Yam/Maize/Melon	28,583.50
8.	Broiler I – Jan – May	11,986.23
9.	Fish I – Jan – June	84,599.59

Source : Field Survey Data, 2010

Cocoyam	0.34	0.39	0.05
Broiler	0.18	0.83	0.63
Fish	0.15	0.68	0.53
Layer	0.08	0.33	0.25

Source : Field Survey Data, 2010

g) Shadow Prices of Limiting Resources in the Optimized Plans in the Zone

Any resource that is abundant, that is not used up by the programme, is not a limiting resource and has a zero shadow price as it does not constrain the attainment of a programme's objective and vice versa (Olayemi and Onyenweaku, 1999). The status therefore of the available resources in the optimized plans that constrained the attainment of the objective programme for the zone is presented in Tables 7.

Table 7 : Shadow Prices (in Naira) of Limiting Resources across Zones

Resource	Status	Shadow Price
Feed	Tight	228.73

Source : Computed from Field Survey Data, 2010

h) Minimum Staple Food/Livestock Requirements

The staple foods for farmers in the area are tubers and cereals for the crops; and to meet their protein needs, certain amounts of their livestock were consumed. Results of the minimum staple and protein requirements by households (in tons) in existing and optimum plans are presented in Table 8. Indication in the table is that a typical farm household required about 2.27 tons of tubers for farmers. The optimum plans for these minimum requirements were satisfied adequately.

Table 8 : Minimum Staple and Animal Protein Requirements by Households (in tons) in the Plans

Commodity	Existing Plan	Optimum Plan	Increase over Existing
Yam	1.34	8.79	7.45
Cassava	1.61	10.69	9.08
Maize	0.12	0.16	0.04

i) Sensitivity Analysis

The sensitivity analysis of the plans to changes in some production variables was observed. Usually as has been established by many researchers in the past, land and labour are variables of utmost interest in such analysis (Osuji, 1978; Tanko, 2004). In the first scenario, land resource was therefore increased by a unit, which is 1 hectare, to see their effect on the optimum plan. In the second scenario, labour was increased by a unit in each zone to see its effect on the optimum plan, and finally, in the third scenario, wage was fixed at the respective mean of the various peaks for crops and livestock across zones as well as least of the crops while peaks of livestock were held constant.

j) Effect of Increasing Area under Cultivation

The effect on farmers in Ohafia agricultural zone when land was increased by 50% showed no increment on the gross margin obtained.

Table 9 : Comparing the Optimum Gross Margins when Land was increased 25%

Previous Optimum (N)	Present Optimum (N)	Increase (N)	% Change
383,941.60	383,941.60	0.00	0.00

Source : Computed from Field Survey Data, 2010

k) Effect of Labour Use on the Optimum Gross Margin

Labour use was increased by 25 % across the crops and livestock respectively to see their effect on the optimum gross margin and this is presented in Table 10.

Table 10 : Comparing the Optimum Gross Margins when Labour was increased by 25 percent

Previous Optimum (N)	Present Optimum (N)	Increase (N)	% Change
383,941.60	383,941.60	0.00	0.00

Source : Computed from Field Survey Data, 2009/2010

Result of increasing labour by a man day in both crops and livestock showed increase of 0.07% Ohafia.

l) Effect of Varying Labour Wages on the Optimum Gross Margin

The average prevailing wage rate across various labour peaks for both crops and livestock respectively was determined for each zone and used to evaluate their effect on the optimum gross margin. This is shown in Table 9.

Table 11 : Comparing the Optimum Gross Margins when Wage rate was reduced by 50% across Crops and Livestock

Zone	Previous Optimum (N)	Present Optimum (N)	Inc./Dec. (N)	% Change
Ohafia	383,941.60	383,941.60	0.00	0.00

Source : Computed from Field Survey Data, 2010

m) Effect of Varying the Quantity of Feed used for Livestock production

When feed consumed by livestock was increased by 25%, a very marginal change was observed across in Ohafia. Gross margin became responsive to sensitivity analysis. However, the Layer production activity increased from 0.41 units (205 birds) to 0.52 units (260 birds). It had however a very marginal effect on the gross margin. Table 12 show the effect of varying quantity of feed given to livestock and on the optimum gross margins recommended by the LP.

Table 12 : Comparing the Optimum Gross Margins when Feed intake available to farmers was increased by 25%

Zone	Previous Optimum (N)	Present Optimum (N)	Inc./Dec. (N)	% Change
Ohafia	383,941.60	384,170.30	228,70	0.06

Source : Computed from Field Survey Data, 2010

IV. Conclusion

The study concludes that farm resources were not optimally allocated in the existing plan. The study area has great potential for future commercialization of agriculture given that all the sole crops appeared in the optimal plan. The inclusion of livestock enterprises among selected arable crops gives a fair representation of what obtains in the study area given that the generality of the farmers do not necessarily hands off from either category of enterprises completely. The combination of crop and livestock enterprises contributed in improving the gross returns to the farmers in the study area. Results showed that the generality of the farmers can no longer be termed illiterates having attended at least primary school. The average number of years spent in school was 7 in the zone. Farmers with more years of formal education are expected to be more efficient in harnessing available resources.

Based on the findings arising from the study, the farm income of the farmers would be improved upon if the prototype combination of crop and livestock enterprises that emanated from the LP could be integrated in the extension education package for Ohafia Agricultural Development Project (ADP).

Given that land was not shown to be the major limiting factor in the study area, giving more arable land may not necessarily improve crop production. It is rather in the area of feed availability that could significantly improve the existing gross margin of an average farmer in the category. Adequate supply of farm inputs in favour of livestock production particularly and improved extension services that would educate these farmers on efficient allocation of their resources should be built in when developing a good extension package for the zone.

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Keywords : sustainable, residue management, NPK, yield, organic carbon (o.c.), soil quality.

GJSFR-D Classification : FOR Code: 620103, 620101, 050304

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Strictly as per the compliance and regulations of :

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I. Introduction

Rice and wheat are currently grown in rotation on almost 26 million hectares of South and East Asia under diverse climatic and soil condition (Timsina and Connor, 2001), contributing 72, 85, 92, 100 and 71% of the total cereal pool of China, India, Pakistan, Bangladesh and Nepal, respectively (Singh and Paroda, 1994). Rice-wheat is the dominant cropping system of Indo-Gangetic plains of India. With the development of high yielding, photo-insensitive cultivars of rice and increased irrigation facilities, the rice cultivation has extended to non-traditional areas of North India where wheat was dominant crop in winter. Similarly, cultivation of wheat extended to some of the traditional rice areas due to development of high yielding, semi-dwarf wheat varieties responsive to nutrient and water. Recently it has been observed that the system is showing sign of fatigue and the crop yield is either stagnating or the factor productivity has fallen down thereby suggesting the requirement of more input to produce the same grain yield. Declining soil fertility resulting from depletion of nutrients, their imbalance application and reduced recycling of organic matter, water-induced degradation of soil and water resources leading to spread of salinity and water balance aberrations, increase in the incidence of pest and disease and loss in biodiversity are some of the factors that adversely affect the sustainability of the production system. There are substantial areas under rice which are combined harvested and also increasing tendency among the farmers to harvest the crop just near the ear-head, leaves behind enormous quantity of nearly 3/4th of the crop residue amounting a million of tonnes is disposed off by burning. The primary reason for burning rather than incorporation for enriching the soil is absence of any suitable residue management practice. The total nutrient value of residues are half of the total contents because it is known that only about 50% of the nutrients are mineralized in the soil on decomposition of crop residues. Their conservative estimates reveal that about 1.6 million tonnes of nutrients from crop residues in rice-wheat system are available for recycling. Besides NPK, cestimated to be about 4.8 mt, which can replace about 30% of the total fertilizer consumption in the country with the intensification of agriculture especially in rice-wheat growing regions of the country. The significance of recycling the organic resources for replacement of plant nutrients and the residues also contain appreciable amount of secondary and micronutrients. Based on the above assumptions, it is estimated that about 43 and 37 million tonnes of straw is in utilization from rice and wheat crop, respectively. The total nutrient value (in terms of NPK) of these crop residues is maintenance of soil health has already been established. However, the limited availability of organic manures and almost nil possibility of in-situ green manuring for wheat after the harvest of rice, the only alternative left is the direct incorporation as rice crop residue to maintain soil organic carbon.

II. Materials and Methods

The experiment was conducted at the Brahmanand Mahavidyalaya Agricultural Research Farm, Post-Rath, District Hamirpur, State-Uttar Prad-

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esh (India) during the winter (*rabi*) season of 2007-08 and 2008-09. The soil of experimental field was 'parwa' (A category of red soil) with slightly alkaline in reaction (pH 7.6) which was low in available nitrogen (200.83 N_2O kg ha^{-1}), medium in available phosphorus (29.28 P_2O_5 kg ha^{-1}) and high in available potassium (474.16 K_2O kg ha^{-1}) and ranging 0.56% organic carbon content. The trial was laid out in randomized block design with three replications having 14 treatment combinations of within recommended dose (T1- Sowing wheat without incorporation of rice residue and recommended NPK (Control), T2- Rice residue incorporation + recommended NPK in wheat sowing, T3- 15% of N at rice residue incorporation + rest in wheat sowing, T4- 30% of N at rice residue incorporation + rest in wheat sowing, T5- 15% of NP at rice residue incorporation + rest in wheat sowing, T6- 30% of NP at rice residue incorporation + rest in wheat sowing, T7- 15% of NPK at rice residue incorporation + rest in wheat sowing, T8- 30% of NPK at rice residue incorporation + rest in wheat sowing) and over dose and above recommended dose (T9- 15% N + recommended NPK, T10- Addition of 30% N + recommended NPK, T11- Addition of 15% NP + recommended NPK, T12- Addition of 30% NP + recommended NPK, T13- Addition of 15% NPK + recommended NPK, T14- Addition of 30% N PK + recommended NPK). NPK dose in wheat crop were applied half as basal dressing and half as top dressing after 35 days stage of crop. Field was prepared and transplanted the rice seedling in plot for commercial rice cultivation along with recommended package of practices. In rice crop, a pre-harvest irrigation was applied. Rice residue were incorporated as per the treatment (residue removed from T_1 plots) wheat was sown in lines at 22.5 cm apart using a seed rate of 100 kg ha^{-1} on 10 Oct and harvested on 30 March. In rice residue removed and incorporated field conventional tillage practices were used, for the rice residue removed plot (T_1), the field was ploughed with desi plough and left of 7 days, thereafter, one pre-sowing irrigation was applied to the field. At the right tilth, 4 cross ploughing were done with desi plough. The planking was done invariably after each cross ploughing in order to get fine seed bed. Field preparation worked out for residue incorporated plot, the residue incorporated with the help of disc harrow and then all practices were same as residue removed treatment. On the basis of plot size and treatment, doses of nitrogen, phosphorus and potassium through Urea, Single Super Phosphate and Murate of Potash were applied at all the treatment as basal dressing. Others practices viz. interculture, weeding and plant protection measures were applied as need based. The grain and straw samples collected at the time of harvest were dried in the oven and ground by sample grinder. After grinding, the samples were analysed chemically for nitrogen content by micro Kjeldahl's method, as given by (Jackson, 1973).

$$\text{Uptake of nutrient (kg ha}^{-1}) = \frac{\text{content (\%)}}{100} \times \text{yield (q ha}^{-1})$$

III. Results and Discussion

Various rice residue and nutrient management systems significantly affect the plant height with the age of wheat crop. Rice residue incorporation with 30% additional NPK + recommended NPK produced significantly taller plants over sowing of wheat without incorporation of rice residue+recommended NPK and rice residue incorporation + recommended NPK at wheat sowing during both the years. The increased plant height might be due to cumulative effect of narrow C:N ration, nutrients availability, soil health and good plant establishment, residue management treatment had the little effect on plant height as reported by Griffin *et al.* (1982). Meelu *et al.* (1994) also reported that incorporation of residue had beneficial effects on plant height. Significant variation in plant height might be also due higher levels of nitrogen resulted in more nitrogen uptake, which caused better metabolization of synthesized carbohydrates into amino acids and protein which in turn stimulated the cell division and cell elongation and thus allowed the plant to grow faster, which expressed morphologically an increase in plant height.

Number of tillers per running metre was affected significantly due to various rice residue and nutrient management systems at all the stages of the crop growth during both the years. It increased progressively upto 90th day stage and thereafter decreased. Significantly higher number of tillers per running metre was obtained with rice residue incorporated as compared to rice residue removed during both the years. This might be due to good LAI and root growth and development in the upper layer of soil surface where these got the good opportunity for nutrient uptake. This made possible with rice residue incorporation due to higher organic matter content in soil. Good pulverization of soil may be achieved as field was ploughed for residue incorporation. It increased the availability of nutrients, which resulted into increased tillering and thus, number of tillers per running metre. In relation to these findings, Meelu *et al.* (1994) also reported the higher number of tillers with incorporation of residue treatment in the soil. The higher number of tillers associated with increasing levels of nutrient might be due to less tiller mortality, enhanced photosynthetic area, proper nourishment, enhanced cell expansion and various metabolic processes in presence of abundant supply of nutrients which resulted into increased tillering and, thus, more number of shoots per running metre. These findings are in support to those of Malik (1981) who noted positive effect of nitrogen upto 240 kg ha^{-1} on the number of tillers in wheat.

Yield attributes viz. number of effective tillers running m^{-1}, length of ear head, number of spikelets spike^{-1} and 1000-grain weight is the resultant of good crop growth, photosynthesis and nutrient uptake, the highest values of these parameters were recorded with rice residue incorporation including 30% additional NPK application+recommended NPK, whereas the lowest values were found in application only recommended NPK having without any incorporation of rice residue. Additional fertilization pushed up the removal of nutrient and water from soil by the crop, which might have enhanced the photosynthesis and translocation of assimilate from source (leaves and stem) to sink vis-à-vis grain yield. Grain and straw yields affected significantly due to rice residue and nutrient management practices during both the years. The higher grain and straw yields were recorded when rice residue incorporation was coupled with application of 30% additional NPK + recommended NPK which was recorded more than other treatments during both the years. It might be due to the addition of crop residue and additional fertilization which might have improved the soil health and consequently higher uptake of available nutrients from the soil and increased the number of effective tillers running m^{-1}, length of ear head, number of spikelets spike^{-1} and 1000-grain weight, which ultimately attributed to increase in grain yield. Crop residue on decomposition released nutrients slowly throughout the growth period, which resulted better plant growth and higher straw yield. Incorporation of wheat straw and burning both had higher grain and straw yield of rice over the straw removed (Maskina *et al.*, 1987). Under the clay loam soil incorporation of rice straw increased the wheat yield over sandy loam soil as reported by Singh *et al.* (1992) and Bakht *et al.* (2009).

Nitrogen uptake by grain and straw influenced significantly by rice residue and nutrient management practices during both the years. Highest nitrogen uptake by grain and straw was recorded under the treatment when rice residue incorporated with 30% additional NPK + recommended NPK against sowing of wheat without incorporation of rice residue application + recommended NPK and rice residue incorporation + recommended NPK. Increase in nitrogen uptake by grain and straw may be due to better root establishment which resulted in better translocation of absorb nutrients from soil and its translocation to plant and seed which may cause higher plant growth, grain and straw yields and ultimately increased the uptake of nitrogen. Adequate supply of nutrient in the root zone increased the movement of nutrient in soil solution and ultimately their greater absorption and utilization by the growing plants. Kumar *et al.* (1995) reported that each increment of nitrogen level from 60 to 180 kg ha^{-1} increased the grain and straw yields as well as N uptake under loamy soil condition at Karnal. Kumar *et al.* (2000) also reported that nitrogen uptake increased with increasing level of nitrogen upto 120 kg ha^{-1} under sandy loam soils of Bihar. Increased nitrogen uptake in residue incorporated treatment was mainly due to cumulative effect of better soil health, increased the availability of nutrients and better root and plant growth and development, which enhanced the crop yield. These results are in conformity to those reported by Dwivedi and Thakur (2000) under silt-clay loam soil that incorporation of rice straw increased the nitrogen uptake. Similar, findings were also reported by Das *et al.* (2001) in rice.

Rice residue and nutrient management significantly influenced the organic carbon content during both the years. Significantly higher organic carbon content was recorded with rice residue incorporation with application of 30% additional N+P+K + recommended NPK and rice residue incorporation with application of 15% additional N+P+K + recommended NPK against sowing of wheat without incorporation of rice residue + recommended NPK. It is probably due to the fact that addition of carbonaceous substances in soil which on decomposition added organic matter. Verma and Bhagat (1992) have also recorded the maximum soil build-up of organic carbon under the rice straw chopped and incorporated with animal manure, followed by animal manure and straw mulch, while minimum organic carbon under rice straw burnt and rice straw removed.

IV. Conclusion

Farmers of being practiced in rice-wheat system region may, therefore, be advised to adopt rice residue incorporation practice with 30% additional fertilizer under rice-wheat cropping system to get higher yield and benefits from wheat.

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Table 1 : Effect of varying rice residue management practices on plant height (cm) at various growth stages of wheat

Treatment	Plant height (cm)							
	30 DAS		60 DAS		90 DAS		At harvest	
	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
T_1	13.83	13.69	35.00	34.65	46.42	45.95	55.52	54.97
T_2	14.36	14.50	36.34	36.71	48.20	48.69	57.66	58.23
T_3	15.07	15.37	38.14	38.90	50.58	51.60	60.50	61.71
T_4	15.25	15.32	38.59	38.78	51.18	51.43	61.21	61.52
T_5	15.43	15.47	39.04	39.15	51.77	51.93	61.93	62.11
T_6	15.78	15.87	39.93	40.17	52.96	53.28	63.35	63.73
T_7	16.13	16.20	40.83	41.00	54.15	54.37	64.77	65.03
T_8	16.31	16.43	41.28	41.57	54.75	55.13	65.49	65.94
T_9	17.38	17.43	43.97	44.10	58.32	58.49	69.76	69.97
T_{10}	17.73	17.75	44.87	44.91	59.51	59.57	71.18	71.25
T_{11}	17.91	17.98	45.32	45.50	60.11	60.35	71.89	72.18
T_{12}	18.08	18.14	45.77	45.90	60.70	60.88	72.60	72.82
T_{13}	18.26	18.30	46.22	46.31	61.30	61.42	73.32	73.46
T_{14}	18.44	18.61	46.66	47.08	61.89	62.45	74.03	74.69
SEm$\pm$	0.52	0.57	1.32	1.45	1.75	1.92	2.09	2.30
CD at 5%	1.51	1.66	3.83	4.21	5.07	5.58	6.07	6.68

Table 2 : Effect of varying rice residue management practices on number of tillers per running metre at various growth stages of wheat

Treatment	Number of tillers running metre^{-1}							
	30 DAS		60 DAS		90 DAS		At harvest	
	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
T_1	21.22	21.01	44.96	44.51	49.22	48.73	42.93	42.50
T_2	22.44	22.66	47.53	48.01	52.04	52.56	45.38	45.84
T_3	25.77	26.29	54.60	55.69	59.77	60.97	52.13	53.17
T_4	26.08	26.21	55.24	55.51	60.48	60.78	52.74	53.01
T_5	26.38	26.46	55.88	56.05	61.18	61.36	53.36	53.52
T_6	26.98	27.15	57.16	57.51	62.58	62.96	54.58	54.91
T_7	27.59	27.70	58.45	58.68	63.99	64.25	55.81	56.03
T_8	27.89	28.09	59.09	59.51	64.69	65.15	56.42	56.82
T_9	29.71	29.80	62.95	63.13	68.91	69.12	60.10	60.28
T_{10}	30.32	30.35	64.23	64.29	70.32	70.39	61.33	61.39
T_{11}	30.62	30.75	64.87	65.13	71.02	71.31	61.94	62.19
T_{12}	30.93	31.02	65.51	65.71	71.73	71.94	62.56	62.74
T_{13}	31.23	31.29	66.16	66.29	72.43	72.57	63.17	63.30
T_{14}	31.53	31.82	66.80	67.40	73.13	73.79	63.78	64.36
SEm$\pm$	0.88	0.97	1.87	2.06	2.05	2.26	1.79	1.97
CD at 5%	2.57	2.83	5.44	6.00	5.96	6.56	5.20	5.73

Table 3 : Effect of varying rice residue management practices on number of effective tillers metre^{-2}, length of ear head and number of spikelets spike^{-1} in wheat

Treatment	Number of effective tillers metre^{-2}		Length of ear head (cm)		Number of spikelets spike^{-1}	
	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
T_1	218.05	215.87	7.01	6.94	11.48	11.37
T_2	230.51	232.82	7.41	7.49	11.94	12.06
T_3	264.78	270.07	8.52	8.69	13.01	13.27
T_4	267.89	269.23	8.62	8.66	13.17	13.23
T_5	271.01	271.82	8.72	8.74	13.32	13.36
T_6	277.24	278.90	8.92	8.97	13.63	13.71
T_7	283.47	284.60	9.12	9.15	13.93	13.99
T_8	286.58	288.59	9.22	9.28	14.09	14.18

T_9	305.27	306.19	9.82	9.85	15.00	15.05
T_{10}	311.50	311.81	10.02	10.03	15.31	15.33
T_{11}	314.62	315.87	10.12	10.16	15.46	15.52
T_{12}	317.73	318.68	10.22	10.25	15.62	15.66
T_{13}	320.85	321.49	10.32	10.34	15.77	15.80
T_{14}	323.96	326.88	10.42	10.51	15.92	16.07
SEm±	9.08	10.00	0.29	0.32	0.45	0.49
CD at 5%	26.39	29.08	0.85	0.94	11.48	1.43

Table 4 : Effect of varying rice residue management practices on test weight (g), Grain yield (q ha^{-1})and Straw yield (q ha^{-1}) of wheat

Treatment	Test weight (g)		Grain yield (q ha^{-1})		Straw yield (q ha^{-1})	
	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
T_1	30.27	29.97	35.99	35.63	43.19	43.32
T_2	31.48	31.80	38.05	38.43	46.04	45.84
T_3	34.31	34.99	43.71	44.58	53.76	54.32
T_4	34.71	34.88	44.22	44.44	53.51	54.62
T_5	35.11	35.22	44.74	44.87	54.58	55.43
T_6	35.92	36.14	45.76	46.04	56.29	57.62
T_7	36.73	36.87	46.79	46.98	58.49	58.78
T_8	37.13	37.39	47.31	47.64	58.66	59.84
T_9	39.55	39.67	50.39	50.54	61.48	62.00
T_{10}	40.36	40.40	51.42	51.47	62.22	62.71
T_{11}	40.76	40.93	51.93	52.14	63.88	64.15
T_{12}	41.17	41.29	52.45	52.61	63.46	63.65
T_{13}	41.57	41.65	52.96	53.07	66.20	66.73
T_{14}	41.97	42.35	53.48	53.96	66.31	67.31
SEm±	1.18	1.30	1.50	1.65	1.84	2.05
CD at 5%	3.43	3.78	4.36	4.80	5.36	5.95

Table 5 : Effect of varying rice residue management practices on nitrogen uptake in grain and straw of wheat

Treatment	Nitrogen uptake (kg ha^{-1})				O.C. (%)	
	Grain		Straw			
	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
T_1	59.18	58.00	20.73	20.59	0.27	0.27
T_2	63.31	64.58	23.20	23.33	0.32	0.32
T_3	73.59	76.56	27.42	28.26	0.32	0.33
T_4	75.33	76.09	27.61	28.32	0.32	0.33
T_5	77.09	77.56	28.49	29.02	0.33	0.33
T_6	80.68	81.65	30.06	30.95	0.33	0.33
T_7	84.34	85.02	31.94	32.22	0.33	0.33
T_8	86.21	87.42	32.38	33.26	0.33	0.33
T_9	97.82	98.41	36.15	36.57	0.34	0.34
T_{10}	101.85	102.06	37.33	37.66	0.35	0.35
T_{11}	103.90	104.73	38.71	39.03	0.35	0.35
T_{12}	105.97	106.60	38.84	39.07	0.35	0.35
T_{13}	108.06	108.49	42.50	42.93	0.36	0.36
T_{14}	110.16	112.16	42.97	44.01	0.36	0.36
SEm±	2.82	3.17	1.06	1.21	0.01	0.01
CD at 5%	8.20	9.23	3.07	3.52	0.03	0.03

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Genetic Analyses of Generation Means for a Cross between two Local Breeds of Chickens: II-Comparisons Between F3 and Backcrosses for Egg Production Traits

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Abstract - Comparisons between F3 and Backcross combinations derived from Gimmizah x Bandarah cross were used to estimate additive and dominance effects and the average level of dominance, which control the inheritance of egg production traits. Genetic variance components were estimated using Designs II and Ш. Both analysis determined that large positive additive genetic variations were found for age at sexual maturity 20.4, egg number at the first 90 d. of production 149.8 and egg number at 52 weeks of age 848.7 in backcross generations compared with the same traits in F3 generation (–52.0, 14.8 and 9.9), respectively. On the other hand small positive additive genetic variances were found for body weight at maturity (0.0144) and egg weight at maturity (0.281) in backcross generations, the corresponding values in F3 generation were – 0.018 and – 9.87, respectively. These results indicate that the parents Gimmizah and Bandarah contain a high proportion of additive genes for these traits, which accumulated in backcrosses. Furthermore, the F3 generation yielded higher positive dominance variance components for age at sexual maturity 287.7 and egg weight at maturity 48.6 than the corresponding variances in backcrosses 8.3 and 8.1, respectively.

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Genetic Analyses of Generation Means for a Cross between two Local Breeds of Chickens: II-Comparisons between F3 and Backcrosses for Egg Production Traits

R.Sh. Abou El-Ghar

Abstract - Comparisons between F3 and Backcross combinations derived from Gimmizah x Bandarah cross were used to estimate additive and dominance effects and the average level of dominance, which control the inheritance of egg production traits. Genetic variance components were estimated using Designs **II** and **III**. Both analysis determined that large positive additive genetic variations were found for age at sexual maturity 20.4, egg number at the first 90 d. of production 149.8 and egg number at 52 weeks of age 848.7 in backcross generations compared with the same traits in F3 generation (–52.0, 14.8 and 9.9), respectively. On the other hand small positive additive genetic variances were found for body weight at maturity (0.0144) and egg weight at maturity (0.281) in backcross generations, the corresponding values in F3 generation were – 0.018 and – 9.87, respectively. These results indicate that the parents Gimmizah and Bandarah contain a high proportion of additive genes for these traits, which accumulated in backcrosses. Furthermore, the F3 generation yielded higher positive dominance variance components for age at sexual maturity 287.7 and egg weight at maturity 48.6 than the corresponding variances in backcrosses 8.3 and 8.1, respectively. Contrary, backcrosses had higher dominance variances for early egg weight 8.7, egg number at the first 90 d. of production 165.8 and egg number at 52 weeks of age 20.5 than the corresponding variances in F3 generation – 15.3, - 39.9 and – 167.6, respectively. The results of the average level of dominance (d') showed that dominance was partial to over dominance for the majority of the loci controlling egg production traits in backcrosses, while over dominance was controlling the inheritance of these traits in F3 generation. Generally, these results showed the effects of natural selection on accumulation of additive genes for age at sexual maturity and egg number traits combined with relaxation of selection for body weight in the parents Gimmizah and Bandarah.

I. Introduction

Understanding the genetic basis of phenotypic variation is essential for predicting the direction and rate of phenotypic evolution of these traits. The methods used to estimate different kinds of gene action in cross populations are commonly performed by comparisons of the mean of backcrosses, F2 and F3 generations derived from the cross of two parental lines or breeds. The parental line Gimmizah was derived from crossing Dokki4 x White Plymouth Rock (Mahmoud et al., 1982) and Bandarah parental line was derived from crossing Gimmizah x White Cornish (Mahmoud et al., 1989). While Fayoumy crossed with Barred Plymouth Rock to produce Dokki4 chicken (El-Itriby and Sayed, 1966). On such a situation Fayoumi is considered a common ancestor for the two parental lines. Several reports have been discussed the relative importance of additive and non-additive variations upon productive traits in poultry (Hill and Nordskog, 1958; Goto and Nordskog, 1959; Merritt and Gowe, 1960; Redman and Shoffner, 1961; Yao, 1961 and Wearden et al., 1965) They reported that additive variance was the single most important source of genetic variations for most productive traits, but non-additive genetic variance may be important for some other traits. Comstock and Robinson (1948 &1952) presented and discussed three mating designs and the associated experimental procedures for estimating genetic variances of quantitative characters. These designs (I, II and III) utilize the covariances among full and half sibs for estimating the genetic parameters. However, only two genetic parameters, additive genetic variance and dominance variance, can be estimated from these designs. The aim of this study is to compare F3 with backcross generations of Gimmizah x Bandarah cross to estimate additive and dominance effects and the average level of dominance, which control the inheritance of egg production traits, what may help for developing the effective improvement programs.

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II. Materials and Methods

The present experiment had been carried out at El-Sabahiah Research Station, Animal Production Research Institute, Agriculture Research Center.

a) *Experimental Stock*

The parental lines in this experiment were derived from crossing Dokki4 x White Plymouth Rock to produce Gimmizah (Mahmoud et al., 1982) then crossing Gimmizah x White Cornish to produce

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Bandarah, (Mahmoud et al., 1989). The two parental lines were crossed to produce F1 hybrids. Random mating of F1 hybrids used to form the F2 generation. All F3 progeny derived from intercrossing the F2 families. At the same time the males of F2 generation were randomly chosen and backcrossed with females of the two parental breeds (Gimmizah and Bandara) to produce F2 backcross generations i.e. F2 x Gimmizah (BC1) and F2 x Bandara (BC2). Twenty-four families of this mating structure were produced and constituted the material to obtain estimates of genetic variances and covariances for the population, natural mating was used in the family pens (1 male per 12 females).

b) Management Procedures

Management conditions were similar as possible as throughout the experiment. Two hatches in each mating combinations were used, for each hatch eggs were collected from each pen throughout 7 d and incubated in full-automatic draft machine. At hatch, all chicks were wing-banded and weighed to the nearest gram. The chicks were fed *ad libitum* a commercial starter till 16 weeks of age then the ration was changed by commercial layer ration throughout the experiment. The egg production traits studied were age at sexual maturity (SM), body weight at sexual maturity (BW1), early egg weight at sexual maturity (EW1), egg number at the first ninety d. of production (EN90), mature body weight (BW2), mature egg weight (EW2) and egg number at 52 wk. of age (EN2), respectively.

c) Statistical Analysis

All data were first converted to Log. transformation prior to statistical analysis to avoid the effects of epistasis. Data of the traits under this study were analyzed using North Carolina Designs II and III (Comstock and Robinson, 1952) with the following model:

$$Yijklm = \mu + si + bij + mik + fil + (m \times f)ikil + eijklm$$

Where: $Yijklm$ is the kth observation on i x jth progeny, μ is the overall mean, si is the effect of ith set, bij is the effect of jth replication in ith set, mik is effect of the ith male, fil is effect of the jth female, $(m \times f)ikil$ is the interaction effect, and $eijklm$ is the random error. The degree of dominance was estimated according to Mather, (1949) as follows: $d' = (\sigma^2 D / \sigma^2 A)0.5$ Where: d' is the degree of dominance, $\sigma^2 D$ is the dominance variance and $\sigma^2 A$ is the additive genetic variance.

III. Results and Discussion

a) Means

As seen in Table (1) Backcross (BC1) which had Gimmizah dam was early reaching sexual maturity 193 d. than both backcross2, that had Bandarah dam (BC2) 194 d. and F3 generation 197 d., while BC2 had the lowest body weight at sexual maturity 1591 g. compared with BC1 and F3 generations 1642 and 1622 g., respectively. Early egg weights at sexual maturity were nearly similar in the two backcrosses and the corresponding F3 generation 45, 45 and 44.8 g., respectively. At the first 90 d. of production BC1 laid more eggs (46) than both BC2 and F3 generations (42 and 38 egg). Also BC1 gained the heaviest body weight at maturity 1667 g., while F3 generation ranked second 1564 g. and the BC2 had the lowest weight 1524 g. The contrasts are shown for egg weight at maturity, where F3 generation was the heaviest egg weight than those of BC1 and BC2 (49.8 vs. 49.0 and 49.0 g.). The same differences among generations for egg number at 52 wk of age were present, where the hens of the two backcrosses laid eggs more than of F3 generation 81 and 74 vs. 64 eggs, respectively. The previous results were in agreement with those reported by Abd El-Galil, (1993) who showed significant differences among local strains during all laying intervals studied. Also it could be concluded that the diversity of the two backcrosses shown in Table 1 may be due to the differences in maternal performance of the dams (Gimmizah and Bandarah). Same conclusion was reported by Jamison et al., 1975.

b) Generation Variances

Regarding the backcrosses variations, Table 2 shows insignificant differences between females for age at sexual maturity (SM); body weight at sexual maturity (BW1); early egg weight at sexual maturity (EW1) and egg weight at maturity (EW2). These results indicated that there were no significant differences between the two backcrosses in these traits. The contrasts are shown for egg number in the first 90 d. of production (EN1); body weight at maturity (BW2) and egg number at 52 wks of age (EN2), which showed highly significant differences between females. This means that the genetic variations associated with these traits, which were inherited from the parental strain Gimmizah, may be expressing most of variations in backcrosses families. The same findings were reported by Sheridan, (1986). Also the mean squares due to males were insignificant for (SM); (BW1); (EW1) and (EW2). Furthermore, highly significant differences between males were obtained for EN1 and EN2 traits in backcross generations, while BW2 had significant differences between males. In this regard, the M x F interaction components of variance are insignificant for all traits studied except for EN1 and BW2. They had highly significant differences. However, these analyses explained relatively little variation in some egg production traits.

Concerning the variations of F3 generation presented in Table 2, which shows insignificant differences between males in all traits studied. Early egg weight at sexual maturity (EW1) was significantly differed in between females, while the other traits had

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insignificant differences. Also, the M x F interaction components of variance were insignificant for SM, EW1, EN1, BW2 and EN2. The contrasts are shown for body weight at sexual maturity (BW1) and egg weight at maturity (EW2), which had highly significant differences. Generally, these results reflect the relatively small variation in egg production traits in F3 generations.

c) Components of the genetic variance

Estimates of additive and dominance variations in backcross presented in Table 3, pointed out that additive genetic variance $\sigma^2 A$ accounted a major part of the total genetic variance for SM (20.4) and EN2 (848.7), since the estimates of dominance variance $\sigma^2 D$ in these traits were relatively low 8.3 and 20.5, respectively. Obvious results indicate that additive genetic variance may be a common in the inheritance of these traits. These results were in agreement with those of (Fairfull et al., 1983). Contrarily, the estimates of $\sigma^2 D$ are larger than those of additive for BW1, EW1, EN1, BW2 and EW2 (0.009, 8.7, 165.8, 0.079 and 8.14, respectively), compared with those of additive mean squares $\sigma^2 A$ (-0.018, -2.98, 149.8, 0.014 and o.28, respectively), support the conclusion that both the two backcrosses contains a high proportion of non-additive genes from each parental breeds, controlling the inheritance of these traits. These findings dealt with those cited by Abou El-Ghar and Abdou, (2004) and Abou El-Ghar, (2005). In this regard, the negative direction of additive variance for BW1 and EW1 may be due to the presence of the genes with negative effects with the high frequencies. The same conclusion was reported by Mather, (1949) and Cannings et al., (1978).

The observed estimates of environmental variation for BW1, EW1 and EW2 traits (0.012, 4.36 and 3.31) suggested that non-additive genetic variation or the environmental effects may be masked the effects of additive genes. The same conclusion was cited by (Shebl et al., 1990 and Zaky, 2005). Further analysis fit the presence of dominance effects on BW1, EW1, EN1, BW2 and EW2 traits that the ratio of the mean square of dominance to the additive mean square (*d'*) were estimated to be -1.4, -1.7, 1.1, 2.4 and 5.4, respectively. Such results suggested that complete dominance is present in the inheritance of BW1, EW1 and EN1 and over dominance is controlling the inheritance of BW2 and EW2. On the other hand, partial dominance is important in both SM and EN2 traits. These results are around the figures reported by Robinson et al., 1956.

According to the genetic variations in F3 generation for the traits under consideration, it was notable from Table 3, that additive genetic variations in F3 generation were estimated to be -52.0, -0.035, -1.167, 14.8, -0.018, -9.87 and 9.94 for SM, BW1, EW1, EN1, BW2, EW2 and EN2, respectively. A simple explanation of the negative direction of additive variance for SM, BW1, EW1, BW2 and EW2 traits may be due to the presence of the genes with negative effects with higher frequencies. The same conclusion was reported by (Mather, 1949 and Cannings et al., 1978). Although, the mean squares due to additive genetic variance $\sigma^2 A$ were much larger than those for $\sigma^2 D$ -39.9 and -167.6 for both EN1 and EN2 indicating that additive genetic variation accounted for most of the variation among the variations components for these traits. The same findings were in agreement with those reported by Fairfull et al. 1983. On the other hand, there were considerable non-additive genetic variations $\sigma^2 D$ for SM, BW1, BW2 and EW2 (287.7, 0.124, 0.042 and 48.6, respectively). According to these results, it could conclude that dominance may control the inheritance of the majority of the loci for these traits. The same conclusion was reported by Robinson etal. 1956. The same findings were reported by Abou El-Ghar and Abdou, 2004 and Abou El-Ghar, 2005. In the same order environmental variations were estimated to be 8.95, 0.023, 5.61, 20.78, 0.024, 5.17 and 48.7 for SM, BW1, EW1, EN1, BW2, EW2 and EN2, respectively. Also, these results are dealing with those of the observed (*d'*) ratios were -3.3, -2.7, 5.1, -2.3, -2.2, -3.1 and -5.8 for SM, BW1, EW1, EN1, BW2, EW2 and EN2, respectively. According to these results, it could be conclude that over dominance is controlling the inheritance of these traits under consideration.

IV. Conclusion

Generally, the large positive additive variations $\sigma^2 A$ of SM (20.4), EN1 (149.8) and EN2 (848.7) traits in backcrosses compared with those of F3 (-52.0, 14.84 and 9.94, respectively), support the conclusion that both of the two backcrosses contains a high proportion of additive genes from each parental breeds, controlling the inheritance of these traits. On the other hand, it could be concluded that dominance was partial to over dominance for the majority of the loci for egg production traits. Generally, these results showed the effects of natural selection on accumulation of additive genes for age at sexual maturity and egg number traits a combined with relaxation of selection for body weight in the parents Gimmizah and Bandarah.

Table 1 : Means of different traits and generations

Traits	BC $_1$ *	BC $_2$ *	F $_3$ **
	Mean ± SE	Mean ± SE	Mean ± SE
SM	193 ± 3.8	194 ± 5.4	197 ± 5.7
BW1	1624 ± 195	1591 ± 175	1622 ± 218
EW1	45 ± 3.6	45 ± 3.8	44.8 ± 3.4
EN90	46 ± 7.2	42 ± 6.9	38 ± 6.3
BW2	1667 ± 230	1524 ± 211	1564 ± 214
EW2	49 ± 3.2	49 ± 3.5	49.8 ± 3.4
EN2	81 ± 13.8	74 ± 12.2	65 ± 10.1

*N= 54, ** N= 72, BC1 = backcross with Gimmizah, BC2 = backcross with Bandara, F3 = third generation, SM = age at sexual maturity, BW1 = body weight at sexual maturity, EW1 = early egg weight at sexual maturity, EN90 = egg number at the first ninety d. of production, BW2 = mature body weight, EW2 = mature egg weight and EN2 = egg number at 52 wk. of age.

Table 2 : Analysis of variance of the different traits in backcrosses and F3

Generations	Traits	Mean Squares			
		M	F	M x F	Error
Backcrosses	SM	48. 4 ^{NS}	34.4 ^{NS}	42.8 ^{NS}	17.8
	BW1	0.008 ^{NS}	0.029 ^{NS}	0.062 ^{NS}	0.035
	EW1	8.6 ^{NS}	15.6 ^{NS}	39.3 ^{NS}	13.1
	EN90	235.1 **	363.0 **	507.8 **	10.4
	BW2	0.027 *	0.552 **	0.245 **	0.005
	EW2	10.3 ^{NS}	11.3 ^{NS}	34.3 ^{NS}	9.9
	EN2	1341.8 **	1014.5 **	130.4 ^{NS}	68.9
F3	SM	5.6 ^{NS}	10 .9 ^{NS}	161.8 ^{NS}	17.9
	BW1	0.003 ^{NS}	0.017 ^{NS}	0.107 **	0.045
	EW1	0.556 ^{NS}	35.6 *	3.6 ^{NS}	11.2
	EN90	66.1 ^{NS}	56.2 ^{NS}	21.6 ^{NS}	41.6
	BW2	0.015 ^{NS}	0.008 ^{NS}	0.069 ^{NS}	0.049
	EW2	5.0 ^{NS}	18.9 ^{NS}	34.6 **	10.3
	EN2	43.6 ^{NS}	159.4 ^{NS}	13.7 ^{NS}	97.5

NS = insignificant differences, * = significant differences, ** = highly significant differences, Backcrosses degrees of freedom of M = 5, F = 1, M x F = 5, Error = 93, F3 degrees of freedom of M = 1, F = 5, M x F = 5, Error = 58

Table 3 : Variance components for different traits and generations

Traits	Backcrosses				F_3			
	σ^2A	σ^2D	σ^2E	d'	σ^2A	σ^2D	σ^2E	d'
SM	20.4	8.3	5.9	0.6	-52	287.7	8.95	-3.3
BW1	-0.018	0.009	0.012	-1.4	-0.035	0.124	0.023	-2.7
EW1	-2.98	8.72	4.36	-1.7	-1.17	-15.31	5.61	5.1

EN90	**149.8**	**165.8**	**3.46**	**1.1**	**14.84**	**-39.93**	**20.78**	**-2.3**
BW2	**0.014**	**0.079**	**0.002**	**2.4**	**-0.018**	**0.042**	**0.024**	**-2.2**
EW2	**0.281**	**8.14**	**3.31**	**5.4**	**-9.87**	**48.6**	**5.17**	**-3.1**
EN2	**848.7**	**20.52**	**22.95**	**0.16**	**9.94**	**-167.6**	**48.7**	**-5.8**

$\sigma^2 A$ = additive genetic variance, $\sigma^2 D$ = dominance genetic variance, $\sigma^2 E$ = environmental variance, d' = the degree of dominance.

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A Study on Organic Tomato Cultivation in Palamedu Panchayat, Madurai District

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Introduction - The main idea behind organic farming is 'zero impact' on the environment. The motto of the organic farming is to protect the earth's resources and produce safe and healthy crop. Organic farming is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local condition, rather than the use of inputs with adverse effects. Organic farming combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved. Organic farming is being practiced in 130 countries of the world. The ill effects of chemicals used in agriculture have changed the mindset of some consumers of different countries who are now buying organic with high premium for health. Policy makers are also promoting organic farming for restoration of soil health and generation of rural economy apart from making efforts for creating better environment. The global organic area is 26 million hectare roughly along with 61 standards and 364 certification bodies roughly. The world organic market is now $26 billion.

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A STUDY ON ORGANIC TOMATO CULTIVATION IN PALAMEDU PANCHAYAT, MADURAI DISTRICT

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A Study on Organic Tomato Cultivation in Palamedu Panchayat, Madurai District

Dr. Mrs. D.Fatima Baby

I. Introduction

The main idea behind organic farming is 'zero impact' on the environment. The motto of the organic farming is to protect the earth's resources and produce safe and healthy crop. Organic farming is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local condition, rather than the use of inputs with adverse effects. Organic farming combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved. Organic farming is being practiced in 130 countries of the world. The ill effects of chemicals used in agriculture have changed the mindset of some consumers of different countries who are now buying organic with high premium for health. Policy makers are also promoting organic farming for restoration of soil health and generation of rural economy apart from making efforts for creating better environment. The global organic area is 26 million hectare roughly along with 61 standards and 364 certification bodies roughly. The world organic market is now $26 billion. The organic area in India is 2.5 million hectare including certified forest area. (Ramesh, 2005)

a) Concept of organic farming

Organic farming is not new to Indian agriculture community. Several forms of organic farming are being successfully practiced in diverse climate, particularly in rain fed, tribal, mountains and hill areas of the country. Among all agriculture systems, organic farming is gaining wide attention among farmers, entrepreneurs, policy makers and agricultural scientists for varied reasons such as it minimizes the dependence on chemical inputs (fertilizers, pesticides, herbicides and other agro-chemicals) thus safe guards and improves the quality of resources, and it is labour intensive and provides an opportunity to increase rural employment and achieve long term improvements in the quality of resource base. (Mohan, 2002)

b) Organic farming at global level

According to the 2007 survey almost 31 million hectares are currently managed organically by more than 600000 farms worldwide. This constitutes 0.7 percent of the agriculture land of the countries covered by the survey. The continent with most organic land is Oceania with almost 11.9 million hectares, followed by Europe with almost 7 million hectares, America 5.8 million hectares, Asia almost 2.9 million hectares, North America 2.2 million hectares and Africa 0.9 million hectare. (Jeyakumar, 2010)

c) Organic farming in India

In Indian agriculture, organic manures have been used since Sir Albert Howard. A British agronomist way back in 1900 started the organic farming. The commercial organic farming, as practiced today, is still at a nascent stage. According to a survey of International Federation of Organic Agriculture movement and Stiftung Oekelogie and Landbou (SOEL) February 2005 India has about 76,326 hectare land under organic management. Which is only 0.05 per cent of total agricultural land According to this survey; there are about 5,147 certified organic farms in India. The Indian organic farming industry is estimated at us$20 million and almost entirely export oriented. Acceding to Agricultural and Processed food Products Export Development Authority (APEDA 2005), agency involved in promoting Indian organic products with a worth of rupees 72 million are being exported from India. (Ramesh, 2005)

Organic farming is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological, cycles and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs. This is accomplished by using, where possible, agronomic, and biological and mechanical methods, as opposed to using synthetic materials to fulfill any specific function in the system.

d) How to Grow Organic Tomatoes?

The important considerations while growing organic tomatoes include variety selection, crop rotation, soil fertility, pest control and weed control.

e) Variety of Tomatoes

The variety selection should be governed by market demand, nutritional value the resistance to

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diseases offered by various varieties. Suitability to the climatic conditions and the production technique should also be considered. The type of seed selected for organic tomato crop is very important.

f) Crop Rotation

For efficient organic tomato production, rotate tomato with non-solanaceae crops. Solanaceae group of plants include tobacco, morning glory, potato, pepper, and tomato. So don't rotate tobacco, morning glory, potato and other solanaceae plants with tomato.

g) Soil Fertility

Maintain a fertile soil by adding organic matter to it regularly. Rotate tomato with legumes once in a few years so that the soil is rich in nitrogen. Add compost, barnyard manures and poultry litter to further enrich the soil.

h) Pest Control

It has been observed that organic tomato plants have fewer pest and insect problems than the conventional chemically grown tomato plants. Moreover, if crop rotation is practiced, the lifecycle of insects and pests is broken and the pest menace can be minimised. Trap crops are also effective in controlling pests. An example of a trap crop is sweet corn. Sweet corn attracts tomato fruit worm and thus protects the tomato crop when inter-planted with it.

i) Weed Control

Weeds are a big nuisance as they take up the nutrients in the soil and can also harbor insects and diseases that cause harm to tomatoes. These weeds start growing four to five weeks after transplanting the tomato saplings. Hence focus on extensive weed control during this period and don't let the weeds grow in numbers. Organic weed control can be achieved by using organic matter and mulches as these restrict weed growth. Crop rotation, sanitation, and shallow tilling also help in controlling the weeds.

j) Organic Tomatoes Fetch a Higher Premium

Organic tomatoes fetch 10 per cent to 30 per cent higher price than conventional tomatoes do. This is a big incentive for any farmer to switch to organic farming of tomatoes. Tomato is one of the highest pesticide sprayed vegetable in the world. Hence, growing organic tomatoes gives farmers a satisfaction that they are not using harmful chemicals for growing the crop. But what concerns farmers are - normally organic food produce is little less than conventional food produce. Hence, will the organic tomato production in their farm be as much as the chemically grown produce? Yes, if efficient organic tomato farming techniques are employed, the production is comparable to that of chemically grown tomatoes.

k) Organic tomatoes are healthier

Organic tomatoes really are healthier than their conventionally grown counterparts, new research suggests. Despite being smaller, they are packed with higher amounts of vitamin C and compounds that may combat chronic diseases, the findings show. The reason for the difference is down to the organic plants' tough upbringing, it is claimed. Organic tomatoes are healthier Tomatoes grown on organic farms were 40% smaller than those produced conventionally. However, their concentrations of vitamin C were up to 57% higher, and ripe fruits contained well over twice the quantity of phenolic compounds. Plant phenols, such as falconoid, are largely responsible for the health-giving properties attributed to many fruits and vegetables. They help the body fight oxidative stress - a form of chemical damage linked to chronic conditions such as heart disease, cancer and dementia.

l) Favorable effects of organic farming on environment

Organic farming is much better for the environment than conventional farming. One of the greatest environmental problems today is energy consumption and organic farming. As a matter of fact, energy efficiency is around seven percent greater for the organic farming system. Other positive environmental aspects of organic farming include the use of much less fertilizer, and the complete avoidance of synthetic fertilizers, which are harmful to soil, water, animal and people. Also, the nitrate content of organic fields is significantly lower than on conventional farms due to the absence of soluble fertilizers. Organic farming focuses on preserving the habitats of all species and their surrounding environments, including the air and water. Organic farming releases much less carbon dioxide than does conventional farming. Carbon dioxide is the leading greenhouse gas that causes global warming.

II. Literature Review

Dr. Somnath Chakrabarthi (2010) did a study on “Consumer purchase behavior of organic food in Delhi NCR region”. To develop an understanding about the correlation between the numbers of brands purchased in the category with affective commitment score and to highlight factors limiting more organic food among regular buyers in India. Primary data was used for this study and correlation technique was applied. The study found the need for the marketers to develop a detailed understanding of the affective commitment of regular buyers and to plan a proper marketing campaign for them. The study highlight that perceived high price and limited availability are the main reasons for the slow place of expansion of organic food in India.

K. Guruswamy and K. Balanaga Guruna (2010) have done a study on “SWOT Analysis of organic farming management in India", to analyze the internal environment and identifying external opportunities. SWOT analysis of organic farming ,reveals that organic farming practices provide number of valuable benefits like poison less food, harmless water, soil restoration to the natural condition, creating friendlier environment and total employment for farmers.

S.S. Nagarajan (2010) in his article on "growing brinjal in the organic way" had highlighted that attempted to describe the cultivation of brinjal in the organic way. He discussed the produce is harvested when they are still tender and when they have attained a good size and when the surface is bright and glorry. He find that organic agriculture is an economically viable proposition and farmers can earn more income through the premium price for organic produce and they need fewer inputs to manage return.

Kuldeep Sharma, and Sudhir Pradhan (2011) in their article on "Organic farming: problems and prospects" mainly focused on problem in adopting large scale organic farming in a country like India. The factors like lack of awareness, marketing problems, shortage of biomass, inadequate supporting infrastructure, high input costs, lack of financial support and inability to meet the export demand had highly affected the Organic farming. Measures like inclusion of organic farming in the curriculum of under graduate and post graduate programmes at different agricultural universities and research institutes, standardization of mechanism for organic farming practices and dissemination of information were suggested to propagate organic farming.

S.Jeyakumar (2011) did a study on "organic agriculture – a good quality of life for all" to develop a sustainable agriculture system for guaranteed adequate food production and self-sufficient agriculture system, alternative strategy over chemical agriculture primary data was used for this study. The study found organic agriculture is a production system that sustains the health of soils ecosystems and people. It relies on ecological processes, biodiversity and cycles

Y.V.Singh and Dinesh Kumar (2011) in their article on "organic farming vis-a-vis Human Health and Environment" mainly focused on organic agriculture seems to be viable alternative because it enlivens the soil, strengthens the natural resource bare and sustains biological production at different levels. Export market can also be, tapped by the prospective farmers by growing organic crops. If organic agriculture is given the consideration on its merits, it has the potential to transform agriculture as the main tool for nature conservation they conclude farmers get premium price of their produce as the end result is healthier and more environment ally friendly food and it is well worth the higher price tag.

a) Statement of the Problem

Inorganic farming affects the environment in multiple ways. Pesticides sprayed on crops not only destroy pasts and contaminate the crops but also kill beneficial insects. The residue of these pesticides affects the health of human being. Organic farming on natural resources favours interactions with in the agro ecosystem that are vital for both agricultural production and nature conservation. Ecological services derived include oil farming and conditioning, soil stabilization and waste recycling. Organically grown food is dramatically superior in mineral content. So, a study on organic farming with special reference to tomato cultivation in Palamedu, Madurai district is undertaken.

b) Objectives of the Study

- To find out the cost and return of organic tomato cultivation.
- To study the motivational factors behind organic tomato cultivation.
- To identify the problems faced in tomato cultivation under organic farming.

c) Scop of the Study

This study would help the common people to understand the importance of organic farming. Study may also help the tomato cultivators to take up appropriate steps to increase their income by the application of various programmes given by the horticultural development board. This study would help the agricultural department and policy makers to understand the problems faced by the farmers who use organic farming, there by programmes can be designed by the Government to minimize the problem of the farmers.

III. Methodology

a) Sample design

Primary data required for this study were collected from selected sample farmers through personal interview method. The data was collected at Palamedu Town Panchayat in Madurai District, where there are 200 organic tomato cultivators. Fifty respondents were chosen from the list, using systematic random sampling method for in depth study

b) Tools of analysis

The collected data were analysed by using the statistical tools like cost and return and Garret ranking technique.

IV. Results and Discussion

a) Distribution of area under organic tomato cultivation

Land is the basic requirement for farming. Distribution of area under organic tomato cultivation is shown in Table No: 1.1

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Table No 1.1 : Distribution of area under organic tomato cultivation

Area Under tomato cultivation (cents)	No. of Respondent	Percentage
0 -50	25	50
50 – 100	12	24
100 – 150	10	20
150 – 200	3	6
TOTAL	50	100

Source : Primary data

It is evident form Table No: 1.1 that the area under tomato cultivation was 0-50 cents for 50 per cent of the respondents, 50-100 cents for 24 per cent of them, 100-150 cents for 20 per cent of them and 150-200 cents for 6 per cent of the respondents. Of the total respondents 36 per cent of them were owners and 64 per cent of them were tenants. The study reveals that majority of the respondents were tenants.

b) Sources of Finance

Finance is the life blood of any activity. The sources of finance is shown in Table No: 1.2

Table No 1.2 : Sources of finance of the respondents

Sources of finance	No of Respondent	Percentage
Own money	9	18
Money lender	21	42
Commercial Bank	15	30
Co – operative credit society	5	10
TOTAL	50	100

Source: Primary data

It is clear that out of the total respondents 42 per cent of them borrow money from the money lender, 30 per cent of them get money from the commercial bank, 18 per cent of them used their own money and 10 per cent of the respondents had borrowed from the co-operative credit society.

c) Sources of irrigation of the respondent

It is observed from the data that 40 per cent of the respondents were using bore well with oil engine, 26 per cent of them were using bore well with electric motor. 20 per cent of them depend upon the river water for irrigation and 14 per cent of them were depending on all the sources of irrigation.

d) Educational Qualification of the respondents

Education is an indicator of social and economic status of an individual. Out of the 50 respondents, 40 per cent of them were illiterate. 24 per cent of them had completed primary level and only 16 per cent of the respondents had completed higher secondary level. Majority of the respondents (40 per cent) were illiterate.

e) Cost and return of organic tomato cultivation (per acre)

The cost includes the amount of money spent on ploughing, bio-fertilizer, bio-pesticides, irrigation, sapling, rent on land, marketing, plucking cost and land tax.

Table No 1.3 : Cost and return of organic tomato cultivation (per acre)

COST	MEAN VALUE (Rs)
COST (A)	
a)Ploughing	2000.00
b)Bio – Fertilizer	1546.20
c)Bio – Pesticides	1250.10
d) Irrigation	2517.70
e) Sapling	3051.40
f) Rent on land	3440.00
g)Marketing	4380.00
h) Plucking Cost	7492.00
Total Cost A	25677.4
COST C	
Land tax	735.36
Total Cost	26412.76
YieldPerAcre (Tonnes)	25.80
Rs Per Kg	12.00
Gross return	36977.86
Net return	10565.1

Source: Primary Data

Out of the total cost, cost A constituted Rs 25677.4 i.e 97.1 per cent of the total cost and cost C was Rs 735.36 (2.9 per cent). Among the cost items, plucking cost was the major component, accounting for Rs 7492 (28.3per cent) of the total cost. Farmers were plucking the tomato once in 5 days. For one cent of land 10 labourers were engaged in the work. Both male and female labourers were engaged in the field, male labourers receive RS 75 per day while the female labourers received Rs 35 per day. The labourers work for 4 hours per day in the field. The marketing and rent on land cost accounted for second and third largest share of 16.6 per cent and 13 per cent respectively of the total cost. The farmers get sapling from agricultural department for Rs 4 per sapling. The percentage share of bio fertilizers, bio-pesticides, irrigation, sampling, rent on land and ploughing cost were Rs 1545.20 (5.9 per cent), Rs 1250.10 (4.7 per cent), Rs 2517.70 (9.5per cent), Rs 3051.40 (11.5per cent), Rs 3440 (13per cent) and Rs 2000 (7.6 per cent) respectively. Bio-fertilizers application and earthen up done on the first and second month after transplanting; bio-fertilizer should be compulsorily applied by the farmers once in 15 days in order to save the plant from the insects. If necessary, the farmers were using bio-pesticides once in 20 days. Irrigation was done at an interval of two or three days. Ploughing was done twice before planting the sapling. Farmers were using tractor for ploughing.

Cost C, the land tax was Rs 735.36 (2per cent). Total cost was Rs. **26,412.76.** Yield per acre was 25.8 tonne per acre and it was sold on an average for Rs 12.00 per Kg. Gross return was Rs. 36977.86 and Net return was Rs.10,565.10 per acre. The farmers normally sell the tomatoes through commission agents and contractors. During harvest season due to more availability of tomatoes, normally the price will be low. But during festival and rainy season demand for tomato increases and consequently its price also increases.

f) Motivational Factors

The second objective of the study was to find out the motivational factors behind the use of organic farming. Exhaustive ranking technique has been used. The factors which motivated the farmers to adopt organic methods to cultivate tomato in the study area are given in Table No.1.

Table No1.4 : Motivational factors

Motivational Factor	No.of Respondents	Rank
For better health	8	III
To protect the environment	11	II
Less expensive	7	IV
Availability of bio-fertilizers with in the village	3	VII
Better price for the product	4	VI
Easy preparation of bio fertilizers	5	V
To protect the fertility of the soil	12	I
TOTAL	50	

Source: Primary data

It is observed from Table No: 1.4 that 12 respondents were motivated towards organic tomato cultivation "to protect the fertility of the soil" (I Rank)., 11 respondents "to protect the environment" (II Rank), 8 respondents "for better health" (III Rank),5 respondents by the factor "Easy preparation of Bio - Fertilizer" (V Rank)..4 respondents by "better price of the product"(VI Rank) and 3 respondents were motivated by the factor "Availability of bio-fertilizers within the village" (VII Rank).

g) Sources of Motivation

The tomato growers in the study area were influenced by various sources to venture into organic

h) Sources of Motivation

The tomato growers in the study area were influenced by various sources to venture into organic farming. The sources of motivation are listed in Table No: 1.5

Table No.1.5 : Sources of Motivation

Sources of motivation	No of Respondents	Rank
Media	12	II
Agriculture department	20	I
Friend	3	V
N G O	5	IV
Agricultural exhibition	10	III
TOTAL	50	

Source: Primary data

It is evident from Table No.1.5 that 20 respondents were motivated by the programme conducted by "Agricultural Department"(I Rank),12 respondents through media like TV, Radio, Newspaper (II Rank),10 respondents by the "Agricultural exhibition" (III Rank),5 respondents by "NGO" (IV Rank)and 3 respondents were motivated by their friends (V Rank).

i) Problems faced in organic tomato cultivation

To study the third objective of the study namely the problems faced in organic tomato cultivation, Garret ranking technique has been used. Problems faced in tomato cultivation under organic farming are lack of irrigation, marketing problem, lack of storage facility, price fluctuation and lack of financial support. It is presented in Table No: 1.6

Table No1.6 : Problems faced in organic tomato cultivation

Problem	Total	Mean Score	Rank
Lack of irrigation	2755.36	55.10	III
Marketing Problem	1526.8	30.5	V
Lack of storage facility	2776.48	55.53	II
Price fluctuation	2644.96	52.89	IV
Lack of financial support	2956	59.12	I

Source: Primary data

It is understood from Table No.1.6 that "Lack of financial support" holds the I Rank. Majority of the farmers are illiterate, so they do not have knowledge to approach the bank for the loan. "Lack of storage facility" holds the II Rank. Tomato is a perishable product which gets spoiled quickly due to absence of storage facility. This affects their price and profit. "Lack of irrigation" holds the III Rank. Due to scanty rainfall and frequent power failure the plants were not watered adequately and on time. The problem of "Price fluctuation" holds the IV Rank and the problem of "Marketing" were ranked V.

V. Summary of Findings

- The area under tomato cultivation was 0-50 cents for 50 percent of the respondents
- Out of the total respondents 42 per cent of them borrow money from the money lenders only
- Of the total respondents 36 per cent of them were owners and 64 per cent of them were tenants. It is clear that majority of the respondents were tenants.
- It is observed from the data that 40 per cent of the respondents were using bore well with oil engine, 26 per cent of them were using bore well with electric motor, 20 per cent of them depend upon the river water for irrigation and 14 per cent of them were depending on all the sources of irrigation.
- Out of the 50 respondents, 40 per cent of them were illiterate
- Total cost of organic tomato cultivation per acre was Rs. 26412.76. Yield per acre was 25.8 tonne per acre and it was sold on an average for Rs 12.00 per Kg. Gross return was Rs. 36977.86 and Net return was Rs.10565.10 per acre.
- The farmers in the study area were motivated by various factors to adopt organic methods to cultivate tomato. Of the total, 12 respondents were motivated towards organic tomato cultivation "to protect the fertility of the soil", 11 respondents "to protect the environment", 8 respondents "for better health", 5 respondents by the factor "Easy preparation of Bio - Fertilizer", 4 respondents by "better price of the product" and 3 respondents were motivated by the factor "Availability of bio-fertilizers within the village".
- The tomato growers in the study area were influenced by various sources to venture into organic farming. 20 respondents were motivated by the programme conducted by "Agricultural Department", 12 respondents through media like TV, Radio, Newspaper, 10 respondents by the "Agricultural exhibition", 5 respondents by "NGO" and 3 respondents were motivated by their friends.
- Problems faced in organic tomato cultivation are lack of irrigation, marketing problem, lack of storage facility, price fluctuation and lack of financial support.

VI. Suggestions

- Farmers must be educated to apply the appropriate pesticides at the prescribed level and at the right climatic condition.
- The Government should establish at least one Cold storage centre for each major tomato selling market.
- The power supply should not be interrupted during the time of irrigation.
- Public and Private sectors should collaborate to establish the Research institutes for the research in organic farming.
- Government should conduct the awareness programme about the benefits of organic farming, the subsidies available for agriculture and the loan facilities meant for farmers.
- The farmers can be trained to prepare value added products of tomato like sauce, pickle, and jam etc to increase their profit.

VII. Conclusion

Tomato is one of the most important food crops and has wider use. Organic Tomato cultivation gives reasonable profit to the farmers and also provides employment opportunities to the rural people. Organic farming is becoming more popular because consumers are demanding healthy and environment friendly food. Organic farm products are, generally more expensive than inorganic crops. Yields drop sharply during the phase of conversion as it take some time for the soil and plants to reach equilibrium. However, yields rise again, once management systems get established. Organic Tomato cultivation is technically feasible, financially viable and bankable.

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- Two Column with Equal Column with of 3.38 and Gaping of .2
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- Paragraph before Spacing of 1 pt and After of 0 pt.
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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

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

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

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Research articles: These are handled with small investigation and applications

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

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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:

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(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.

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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.

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References

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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.

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

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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.

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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:

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To make a paper clear

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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
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In every sections of your document

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· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

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

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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.

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- What you account in an conceptual must be regular with what you reported in the manuscript
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- 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.
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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.

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

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