

JAR ABSTRACTS BULLETIN
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JAR ABSTRACTS BULLETIN VOL. 3 (2014)

JAR Vol.52 No.1-4

Plant Breeding & Genetics

1. Khan, A. A., N. C. D. Barma, M. M. Hasan, M. A. Alam and M. K. Alam. Correlation study on some heat tolerant traits of spring wheat (*Triticum aestivum* L.) under late sowing conditions. *J. Agric. Res. Vol. 52(1): 11-23 (available online www.jar.com.pk).*

Abstract: Twenty five spring wheat genotypes were evaluated in three replicated trials under optimum and late sowing conditions during 2009-10 at Regional Wheat Research Centre, BARI, Gazipur Bangladesh. Effect of heat tolerant traits on grain yield and their association were studied in late sowing environment. Biomass and grain filling rate were found positively correlated (0.652**) with each other and also with grain yield (0.919** and 0.800**). The significant positive correlation of ground coverage with grain yield (0.478*) suggests that higher ground coverage at early stage will lead to increase in yield. Chlorophyll content of flag leaf both at anthesis and 21 days after anthesis showed significant negative association with canopy temperature (-0.487* and -0.570**, respectively) and grain filling rate (-0.506** and -0.570**, respectively) while it was found positively correlated with grain filling duration (0.538** and 0.508**, respectively). The association of anthesis days with grain filling duration (-0.501*) and grain filling rate such that the genotypes would show tolerance to high temperature if it had filled grain at higher rate in a shorter time. Spikes number m⁻² had highly significant positive correlation with grain yield (0.721**). Highly significant negative association (-0.649**) between grains number per spike and 1000-grain weight indicates a competitive demand of both sinks for photosynthates from a common source. Significant negative correlation of heat stress susceptibility indices with days to anthesis, ground coverage, biomass and grain filling rate suggests that these parameters can be useful for discriminating genotypes that have lower susceptibility to heat stress condition. The significant negative association with grain yield also offers solo importance in differentiating heat tolerant genotypes.

Keywords: *Triticum aestivum*; genotypes; spring wheat; sowing time; heat tolerance; agronomic characters; Bangladesh.

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2. Ali, S. S., S. I. Yasin, T. Latif and C. M. Rafiq. Genetic control of grain length and shape in basmati lines of rice (*Oryza sativa* L.). *J. Agric. Res. Vol. 52(1): 25-34 (available online www.jar.com.pk).*

Abstract: Understanding the genetics of grain length and grain shape is the prerequisite for developing premium quality Basmati varieties/lines. Two short grain with bold *Japonica* shape, one long grain slender Basmati shape and two extra long grain slender Basmati shape parental lines were used in the study. All the parents, F₁'s and F₂ generations were raised during kharif 2008 at Rice Research Institute, Kala Shah Kaku, Pakistan. Grain length and shape was measured with a micrometer and were categorized following the Standard Evaluation System for Rice (IRRI, 1996). Chi square was used to compute the number of genes controlling the rice grain length and shape. All F₁'s of crosses involving extra long grain Basmati parents resulted in long grain and Basmati shape. No segregation for grain length and shape was observed in F₂ of crosses involving extra long grain and long grain Basmati and non Basmati parents. F₁ of long grain Basmati line 00521 showed short and bold shaped *Japonica* grains. The F₂'s of 99417 / TN1 segregated into 63:1 for grain length, indicating 3 dominant genes responsible for extra long grain length in 99417. However, Pusa Basmati / TN1 segregated for grain length as 1023:1 indicating thereby 5 dominant genes for extra long grain length in Pusa Basmati. F₂ generation of both the extra-long grain parents i.e., Pusa Basmati and 99417, showed no genetic segregation revealing that the genes responsible for grain length may be same in Pusa Basmati and 99417. The F₂ of 00521 x King Dang Potang segregated into 1:67 for grain length indicating three recessive genes for Basmati grain length in 00521. A single dominant gene for Basmati grain shape in Pusa Basmati / TN1 and three recessive genes for Basmati shape in 00521 x King Dang Potang were observed.

Keywords: *Oryza sativa*; *japonica*; *indica*; grain length, grain shape, Basmati rice, segregating generations; Pakistan.

3. Akhtar, M., M. S. Akhtar and M. Rizwan. *Basmati-515: a new variety with extra long grain for productivity augmentation in Punjab, Pakistan. J. Agric. Res. Vol. 52(1): 35-42 (available online www.jar.com.pk).*

Abstract: Basmati 515 is an outcome of three way cross of F1 (Basmati 320 x 10486) with 50021 during 1995-96. The pedigree method of selection was continued up to five filial generations at Rice Research Institute Kala Shah Kaku, Pakistan. It was put in to observational trials, varietal yield trials, micro plot yield trials and regional adaptability trials (National Uniform Yield Trials) from 2002 to 2009. It was concluded that Basmati 515 showed higher paddy yield (3.72 t/ha) than Super Basmati (3.41 t/ha). The variety was additionally found to be moderately resistant to bakanae / foot rot and blast diseases. In physio-chemical tests conducted at Rice Research Institute, Kala Shah Kaku, its head rice recovery alongwith grain length was better (8.85% higher paddy yield) than Super Basmati. Especially elongation ratio (2.10) was better than most of the existing extra long grain varieties.

Keywords: *Oryza sativa*; new cultivar; agronomic characters, productivity; Punjab, Pakistan.

4. Ahmad, R., D. Ibrar, M. Y. Mirza, T. Mahmood, M. A. Khan, M. S. Iqbal and M. Ahmad. *Genetic variability, heritability and genetic advance in some genotypes of linseed *Linum usitatissimum* L. J. Agric. Res. Vol. 52(1): 43-52 (available online www.jar.com.pk).*

Abstract: Present study was conducted on 9 advanced linseed genotypes (LS-9, LS-10, LS-21, LS-22, LS-23, LS-37, LS-38, LS-39, LS-42 (*Linum usitatissimum* L.) and a check variety Chandni for genetic evaluation at NARC, Islamabad, Pakistan under Oilseeds Research Programme. These genotypes were sown in RCBD with three replications during rabi 2011-12 at research area. At maturity stage data of ten different yield and its related parameters were recorded. Genetic variability, heritability and genetic advance indicated that genotypic mean squares were highly significant for all the traits. Phenotypic variance was greater than genotypic variance that indicates influence of environment on the traits under study. Heritability estimate values ranged from 0.51% for oil content to 0.99% for days to flower initiation. Heritability estimates for different characters were found maximum (0.99) for days to flower initiation followed by days to maturity (0.96), 1000 seed weight (0.96), seed yield/plot (0.94) and days to flower completion (0.92). High heritability estimates indicated that improvement could be made through selection. Maximum relative expected genetic advance was recorded for seed yield/plot (22.75%) followed by number of primary branches/plant (20.10%). Genetic advance as percent of mean was calculated highest (22.75) for seed yield/plot followed by number of primary branches/plant (20.10) and number of capsules/plant (17.39).

Keywords: *Linum usitatissimum*; genotypes; genetic variability; heritability; genetic advance; agronomic characters; Pakistan.

5. Hussain, N., M. Yaqoob and A. Rashid. *Genetic competition of lentil (*Lens culinaris*) candidate lines for yield and yield components under rainfed conditions. J. Agric. Res. Vol. 52(1): 53-64 (available online www.jar.com.pk).*

Abstract: An experiment to evaluate performance of newly developed candidate lines of lentil (*Lens culinaris*) was conducted at Arid Zone Research Institute, PARC, Dera Ismail Khan, Pakistan during 2011-12. Fourteen candidate lines were tested against well existing lentil varieties namely, Punjab Masoor-09 and Markaz-09. The trial was laid out in RCBD with three replications. The results revealed that lentil lines involved in present study showed highly significant variability in all the major agronomic traits. Days to 50% flowering ranged from 80.67 to 114.67, plant height from 29.67 to 38.67 cm, number of secondary branches/plant from 4.67 to 8.67, number of pods/plant from 24.33 to 75, days to maturity from 147 to 162, 1000 seed weight from 19.57 to 32.50 grams and grain yield per plant from 13.80 to 27.95 grams. The line NARC-08-2 proved its superiority with some

desirable traits like, medium plant height (38.67 cm) and normal maturity period (155.67 days) and higher grain yield per plant (27.95 g). It was generally observed that plants with medium height, intermediary in flowering and maturity and with higher number of pods were quite pertinent for higher grain yield. The magnitudes of PCV were higher than GCV indicating the influence of environment on genotypes. Remarkable difference was observed between PCV and GCV for various traits under study. High heritability estimates (b.s) were calculated for number of branches (60.10%), 1000 seed weight (64.30%), days to maturity (85.30%) and seed yield (96.10%). The characters showing low broad sense heritability seem to be highly influenced by environmental effect. High h^2 coupled with high genetic advance (GA) was assessed for days to maturity and seed yield thereby indicating the presence of additive gene effect for these traits.

Keywords: *Lens culinaris*; new cultivars; heritability; performance; rainfed farming; agronomic characters; yield components; Pakistan.

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6. Ramzan, A., T. N. Khan, N. N. Nawab, A. Hina, T. Noor and G. Jillani. Estimation of genetic components in F_1 hybrids and their parents in determinate tomato (*Solanum lycopersicum* L.). J. Agric. Res. Vol. 52(1): 65-75 (available online www.jar.com.pk).

Abstract: Genetic analysis of yield and its contributing traits was studied in parents and their F_1 hybrids in determinate tomato. The experiment was laid out in randomized block design with two replications under Vegetable Program at Horticultural Research Institute, NARC, Islamabad, Pakistan in spring 2011. The study was comprised 15 new crosses (determinate), their parental lines along with international hybrids for primary evaluation. Significant differences were observed for the characters viz; number of fruits per plant, number of clusters per plant, number of fruits per cluster, number of flowers per plant, fruit length (cm), fruit width (cm), plant height (cm) and fruit yield (t/ha). Data was analyzed for genotypic variance, phenotypic variance, genetic advance, broad sense heritability (h^2_{bs}), phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV). The highest PCV and GCV magnitude was observed for yield (56.78 and 56.71 t/ha) followed by plant height (44.86, 44.84) and fruits per plant (43.26, 43.23). The heritability (h^2_{bs}) is ranged from 0.93 to 1.00. For all the characters studied the highest heritability was observed in fruit per plant, fruit yield (t/ha) and plant height (1.00). The GA as percentage of mean at 5% and 1% level ranged from 33.96 to 116.68 and 43.53 to 149.53, respectively. The highest estimates of genetic gain were obtained for fruit yield (116.68, 149.53), plant height (92.33%, 118.33%) and number of fruits per plant (89.00, 114.06). The characters with high values of GCV and h^2_{bs} , accompanied by high GA % suggest that improvement of these characters would be effective through phenotypic selection. Four principal components were taken out having Eigen value equal to 1. These added 86% of the variability amongst the genotypes studied. All the four principal components exhibited high commonalities for plant height, fruit length, clusters per plant, fruits per plant, fruit weight (g), fruits per cluster, fruit yield (t/ha), flowers per cluster, clusters per plant. Cluster analysis based on Euclidean distances showed high level of genetic diversity among parents, hybrids and checks.

Keywords: *Solanum lycopersicum*; F_1 hybrids; determinate; heritability; genetic advance; phenotypic coefficient of variation; genotypic coefficient of variation; agronomic characters; Pakistan.

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7. Khan, M. I., M. A. Dasti, Z. Mahmood and M. S. Iqbal. Effects of fiber traits on seed cotton yield of cotton (*Gossypium hirsutum* L.). J. Agric. Res. Vol. 52(2): 159-166 (available online www.jar.com.pk).

Abstract: The study was conducted at the experimental research farm of Central Cotton Research Institute, (CCRI) Multan and Punjab Seed Corporation (PSC) Farm, Khanewal, Pakistan on 48 cotton (*Gossypium hirsutum*) genotypes i.e. 12 parents and their 36 F_1 hybrids at two locations to find out direct and indirect effects of fiber traits on seed cotton yield using path coefficient analysis. Results showed that GOT percentage had positive direct effect (0.734) on seed cotton yield at Khanewal location while negative direct effect (-0.03) at Multan. The indirect positive effects of GOT percentage were found for fiber strength (1.785) and fiber uniformity index (0.187) while negative indirect effects were observed for upper half mean length at both Multan and Khanewal locations. Fiber length exhibited positive direct contribution (3.272) towards seed cotton yield for Khanewal while fiber length had negative direct effect (-0.218) for seed cotton yield at Multan. Fiber strength indicated positive direct effects (0.798) towards seed cotton yield at Multan while negative at Khanewal

location. The negative direct effects (-0.421) were shown by micronaire value towards seed cotton yield at Khanewal while positive (0.265) at Multan. Micronaire value depicted positive indirect effects for fiber strength and fiber uniformity index at Khanewal, while at Multan it is positive for fiber strength and negative for FU index. The upper half means length showed positive direct effects (1.207) on seed cotton yield at Khanewal while negative direct effects (-0.529) at Multan location.

Keywords: *Gossypium hirsutum*; upland cotton; crossbreeding; F₁ hybrids; path coefficient analysis; fibre traits; seed cotton yield; Pakistan.

8. Riaz, M., M. Akhter and R. A. R. Khan. Genetic criterion for selection of highly productive medium grain rice (*Oryza sativa*) lines. *J. Agric. Res. Vol. 52(2): 167-175 (available online www.jar.com.pk).*

Abstract: A study was conducted at Rice Research Institute, Kala Shah Kaku, Pakistan during the year 2010 to find out correlation and level of significance for different rice (*Oryza sativa*) lines for yield and yield components. Six genotypes of medium grain rice (PK 8245-4, PK 8328-4-1-1, PK 3445-3-2, Aerobic 1, RSP-3 and RSP-4) were collected from PARC, Islamabad while KSK-133 and IR-5 were used as check. All the genotypes were planted in RCBD at Rice Research Institute, Kala Shah Kaku, during 2010. At maturity data were recorded for days to 50% flowering, maturity days, plant height, productive tillers per plant and panicle length. Highly significant positive correlation was observed between plant height and grains per panicle. At the same time significant but negative correlation was observed among plant height and productive tillers per plant, days to 50% flowering and 1000 grain weight, plant height and 1000 grain weight, panicle length and paddy yield. These results help us to devise the effective selection criterion for high yielding medium grain rice lines. Among the lines under study, PK 3445-3-2 proved to be having all three characters and thus will be selection of choice for future experiments.

Keywords: *Oryza sativa*; medium grain rice; genotypes; agronomic characters; correlation; Pakistan.

9. Murtaza, N., G. Shabbir, T. Mahmood, M. Ansar and M. I. Tabassum. Criterion for the selection of high yielding maize (*Zea mays*) genotypes. *J. Agric. Res. Vol. 52(2): 177-183 (available online www.jar.com.pk).*

Abstract: The study was conducted at NARC, Islamabad, Pakistan during the year 2009 to estimate heritability and genetic advances regarding yield and yield contributing traits using fourteen maize (*Zea mays*) genotypes (BS-01, Agati 2002, Margalla, EV-1097, EV-1098, Sadaf, EV-6098, EV-5098, EV-7004Q, Soan-3, Islamabad Gold, Islamabad White, Raka Poshi and Sahiwal-2002). The experiment was laid out in RCBD with three replications. Data were recorded for plant height, ear height, ear length, leaf area, number of leaves per plant, 100-grain weight and grain yield per plant. Analysis of variance revealed highly significant mean sum of squares for all the characters studied. The highest heritability estimates were observed for 100-grain weight (97.39%). All the other traits were observed to have heritability estimates ranging from 97.39 (100 grain weight) to 47.06% (number of leaves/plant). Range of genetic advance for different traits ranged from 1.26 (ear length) to 2674.45 (grain yield). The highest genetic advance was recorded for grain yield. Maximum level of phenotypic coefficient of variation was found for grain yield per ha (19.52%) but it was minimum (8.07) for plant height among all the studied traits. Genotypic coefficient of variation for different traits ranged from 6.11 (ear length) to 18.83 (grain yield). All the other traits had their value of genotypic coefficient of variation in this range. Hence, it is recommended that selection may be based on genotypes possessing potential traits like plant height, ear height, leaf area, and grain yield for yield enhancement.

Keywords: *Zea mays*; maize; genotypes heritability; genetic advance; agronomic characters; Pakistan.

10. Hussain, M., J. Anwar, J. Ahmad, G. M. Subhani, M. Saleem, M. Muneer, F. Muhammad and S. B. Khan. Millat-2011-a high yielding, rust resistant wheat variety. *J. Agric. Res. Vol. 52(2): 185-195 (available online www.jar.com.pk).*

Abstract: A new wheat variety (Millat 2011), high yielding and disease resistant was developed by hybridization between two wheat genotypes Chenab-2000 and Inqalab-91 at Wheat Research Institute, Faisalabad, Pakistan. F₂ to F₆ generations of this cross were advanced by modified bulk pedigree method from 1999 to 2005. The plant type of Millat-2011 is semi erect with 100-115 cm height and straw color is yellow. Its flag leaf attitude is semi erect and auricle color is white. This variety has tapering head shape with 10-11 cm length having 16-18 spikelets per spike. The heads of Millat 2011 emerges from flag leaf between 100-110 days and matures within 142-150 days. It has high tillering capacity (490 tillers/m²). The grain is ovate, medium and amber in color. Its grain yield potential is 6358 kg/ha and average yield is 4091-4268 kg/ha in different agro-ecological zones. Millat 2011 generally produced higher yield in late planting than check varieties. The quality parameters are also comparable with the existing varieties. The 1000 kernel weight is 32.00 to 45.69g, seed is in amber colour and contains 12.33 to 15.17% protein and 66.59 to 71.50% flour. It has good chapatti making quality. New wheat variety Millat 2011 is moderately resistant to Ug 99 race of stem rust and also resistant to prevailing races of leaf and yellow rusts. The variety is tolerant to lodging and was approved by Punjab Seed Council for cultivation in Punjab province of Pakistan.

Keywords: *Triticum aestivum*; wheat; genotypes; crossbreeding; new cultivar; Millat-2011; rusts; ug 99; disease resistance; Pakistan.

11. Hajazi, M. Z. U. I., A. Shakeel, J. Farooq, A. Mahmood, A. Saeed, M. F. Saleem and M. T. Azhar. Genetic basis for earliness and yield contributing traits in cotton (*Gossypium hirsutum* L.). *J. Agric. Res. Vol. 52(3): 293-302* (available online www.jar.com.pk).

Abstract: An experiment was conducted to study the inheritance pattern of earliness in cotton at experimental area of Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, Pakistan during 2010-11. For this purpose a 5×5 diallel mating system was employed in F₂ generation of cotton to study the inheritance pattern of earliness and yield related traits. Analysis of variance revealed significant variation (P<0.01) for all the traits studied. The regression coefficient deviated significantly from zero but not from unity for all the traits. The additive component (D) was significant for all the traits but less than the values of dominance components H₁ and H₂ for days to squaring (H₁25.40, H₂22.01), days to flowering (H₁32.64, H₂31.39), days to boll opening (H₁34.88, H₂26.64), maturity of bolls (H₁21.35, H₂20.90), node number for 1st sympodial branch (H₁4.27, H₂4.04) and seed cotton yield (H₁242.32, H₂230.27) showing the preponderance of non-additive genetic effects. Estimates of narrow senses heritability were high for sympodial branches (70%), moderate for days to squaring (50%), node number to 1st sympodial branch (45%) and earliness index (50%). Predominance of additive genetic effects in sympodial and monopodial branches along with seed cotton yield per plant is indicative of early generation selection.

Keywords: *Gossypium hirsutum*; cotton; agronomic characters; additive genetic effects; early generation; earliness; regression coefficient; Pakistan.

12. Kang, S. A., F. A. Khan and M. A. Javed. Heterosis and combining ability studies for exploitation of hybrid genotypes in *Brassica napus* L. *J. Agric. Res. Vol. 52(3): 303-316* (available online www.jar.com.pk).

Abstract: A study was conducted to estimate the heterosis, general and specific combining ability and potency ratio in *Brassica napus* L. for some seed yield and yield contributing traits. Sixteen genotypes (120-R, B9527-1, MANROO, COMET, S-9, KN (20-35), UAF-1, N-RG, 20E, HYBRIPOL, V-22, STAR, 5-F, GOLARCHI, CRS-5 and PO-9) were crossed among eleven lines and testers in Line×Tester mating design (11×5) during rabi season 2011-12 and their F₁ hybrids were sown in field during rabi 2012-13 in RCBD with three replications. These sixteen genotypes were collected from the Department of Plant Breeding & Genetics, University of Agriculture, Faisalabad, Pakistan for experiment. Data of 55 F₁ hybrids and their parents were recorded for various seed yield and yield contributing traits, i.e. days taken to 50% maturity, plant height, number of secondary branches per plant, number of siliquae per plant, number of seeds per siliqua, 1000-seed weight and seed yield per plant. The data were statistically analyzed for analysis of variance and Line × Tester analysis.

The results of analysis of variance differences were determined among entries for all the traits at significant level ($P \geq 0.01-0.05$). The analysis of variance for combining ability revealed that the mean sum of squares due to lines were significant for all the traits except plant height and for testers the mean sum of squares were non significant for plant height, number of siliquae per plant while other traits showed highly significant results. Highly significant results were found in Line×Tester interaction for all traits except the trait days taken to 50% maturity. The estimation of SCA variance were noticed higher than GCA variance in all traits. The contributions of lines as compared to testers were greater in case of all the traits. Seven hybrid genotypes [CRS-5 × 20E, CRS-5 × KN(20-35), CRS-5 × B9527-1, S-9 × 5-F, MANROO × B9527-1, STAR × 20E, V-22 × KN(20-35)] were revealed highly significant heterosis and SCA effects for yield related traits.

Keywords: *Brassica napus*; canola; genotypes; hybrids; heterosis, combining ability; Pakistan.

13. Subhani, G. M., M. Hussain, J. Anwar, J. Ahmad, M. Tariq and S. B. Khan. A new high yielding, stress tolerant wheat variety Punjab-2011. *J. Agric. Res. Vol. 52(3): 317-328* (available online www.jar.com.pk).

Abstract: Punjab 2011 is a high yielding rust, lodging and heat tolerant wheat variety developed by Wheat Research Institute, Ayub Agricultural Research Institute, Faisalabad, Pakistan. It is a local cross developed through hybridization between two wheat genotypes i.e., AMSEL / ATTILA and INQ.91/PEW'S'. F₂ to F₆ generations of this cross were advanced by modified bulk pedigree method during 2000-05. The variety was tested for multilocation trials under different agro-climatic conditions during 2007-08 and under national uniform trial during two consecutive years, 2008-09 and 2009-10. The variety was finally approved for cultivation in 2011 by Punjab Seed Council. The plant type of Punjab-2011 is semi erect with 110-115 cm height along with yellow coloured straw. Its flag leaf attitude is semi erect and auricle colour is white. This variety has tapering head shape with 10-11 cm length having 19-21 spikelets per spike. The heads of variety emerges from flag leaf between 100-110 days and matures within 144-150 days. This variety has high tillering capacity (480 tillers/m²). The grains of this variety is ovate, medium and amber in colour. Its grain yield potential is 6893 kg per hectare and average yield is 4260 kg per hectare under different agro-ecological zones. This variety moderately resistant to Ug 99 race of stem rust and also proved resistant to prevailing races of leaf and yellow rusts. The release of this variety may reduce the chances of epidemic rusts especially stem rust and high temperature appeared at grain filling stage.

Keywords: *Triticum aestivum*; new variety; Punjab-2011; agronomic characters; ug99; heat tolerant; rusts resistant; Pakistan.

14. Tariq, A. S., Z. Akram, G. Shabbir, K. S. Khan and M. S. Iqbal. Heterosis and combining ability studies for quantitative traits in fodder sorghum (*Sorghum bicolor* L.). *J. Agric. Res. Vol. 52(3): 329-337* (available online www.jar.com.pk).

Abstract: Combining ability and heterosis for some fodder yield and its components were studied among nine sorghum crosses and their six parents (V-1, SV-6, CVS-13, SPV-462, RARI-S-10, TSS-9) at Koont Farm, PMAS, Arid Agriculture University, Rawalpindi, Pakistan during 2009-10. The layout was RCBD with three replications under irrigated conditions. Highly significant differences for genotype, general and specific combining abilities (GCA) were observed for all the components under assessment. However, general combining ability variances were lower than the specific combining ability variances for all the evaluated parameters. All the traits under investigation showed greater dominant variance than the additive variance having degree of dominance greater than unity. The sorghum line V-1 indicated the highest GCA effects in the desired directions for plant height (19.33), TSS-9 for number of tillers per plant (0.17) and CVS-13 for stem thickness (0.19), fresh weight per plant (48.44) and dry weight per plant (12.99). All the nine crosses depicted significant and positive mid parent as well as better parent heterosis for fresh weight per plant and dry weight per plant. The present study indicated that the improvement in fodder yield is feasible due to overall better performance of genotypes having significant better parent heterosis along with good general combiner parents

(V1, CVS-13).

Keywords: *Sorghum bicolor*; genotypes; cross breeding; fodder yield; combining ability; heterosis; partial diallel; Pakistan.

15. Shakeel, A., H. Mehmood, M. M. Sheraz, A. Saeed, M. F. Saleem and G. Nabi. Evaluation of new F_1 hybrids using hybrid vigour analysis in upland cotton for seed cotton yield and fibre quality traits. *J. Agric. Res.* Vol. 52(4): 471-480 (available online www.jar.com.pk).

Abstract: This study was carried out in Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, Pakistan during 2011. Fifteen newly developed F_1 hybrids were evaluated by estimating the magnitude of heterosis, heterobeltiosis and standard heterosis for yield and quality traits of upland cotton. Five cotton genotypes (TH- 41-83, Stoneville-70, Cocker-307, DPL-26 and Allepo-41) were used as female parents while three genotypes (CIM-707, LSS and FH-1000) were taken as male parents. These genotypes were crossed to get fifteen hybrids which were evaluated keeping Bt-121 as a check variety. The analysis of variance indicated significant genotypic differences among parents and their hybrids for all traits studied. The hybrid Stoneville-70 \times LSS showed significant positive heterosis and heterobeltiosis for seed cotton yield (13.3% and 6.13%) and yield contributing components like number of bolls per plant (15.9% and 10.7%), boll weight (32% and 30%) and for fibre quality traits like fibre strength (13.1% and 12.9%). The hybrid DPL-26 \times FH-1000 showed significant positive heterosis and heterobeltiosis for lint (7.8% and 7.5%) and adequate negative but non-significant heterosis, heterobeltiosis and standard heterosis for plant height (-7.4%, -9.4% and -10.7%) and fibre fineness (-14.6%, -19.4% and -9.5%), respectively. The hybrid DPL-26 \times CIM-707 showed significant positive mid-parent heterosis and better-parent heterosis for oil content (15.9 and 10.1) and protein content (30.2% and 29.2%). Only few hybrids showed significant positive heterosis for fibre quality parameters. Stoneville-70 was found as the best female parent performer and LSS as the best male parent performer in the present genotypes. Hence, only, these two genotypes can be very helpful for improvement of different yield and quality traits.

Keywords: *Gossypium hirsutum*; Bt cotton; genotypes; crossbreeding; heterosis; heterobeltiosis; F_1 hybrids; agronomic characters; Pakistan.

16. Ramzan, A., T. Noor, T. N. Khan and A. Hina. Correlation, cluster and regression analysis of seed yield and its contributing traits in pea (*Pisum sativum* L.). *J. Agric. Res.* Vol. 52(4): 481-488 (available online www.jar.com.pk).

Abstract: A field study was conducted in RCBD with 3 replications at Horticultural Research Institute, National Agricultural Research Centre, Islamabad, Pakistan during 2009-10. The research was focused to compute the correlation coefficient, cluster analysis and linear multiple regression on yield and its contributing traits in pea (*Pisum sativum*). Promising genotypes (Fallon, DMR-20, PS-40, 10599, 10674, 10694, 10696, PS-810240, 94610191, 2001-55 FS-21-87, Sheree and DMR-04) were planted in the field alongwith two local checks (Meteor and Climax). The results of correlation between traits showed that number of seeds per pod (0.603**), pods per plant (0.534**) and fresh weight (0.464**) had significant positive correlation with the yield. Cluster analysis based on Euclidean distances showed high level of genetic diversity among different pea genotypes. Dendrogram was formed, comprising four main clusters and six sub clusters. Cluster one showed similarity index (SI) of 28%, second 74% and third cluster 73%. According to Euclidean distance most closely related genotypes were Sheree and DMR-04. The multiple regression variance analysis designated highly significant results among all the characters studied, which suggested that all the characters affected yield components. The R^2 value was 0.782 which shows significance of results. The results from correlation and cluster analysis strongly suggest that number of seeds per plant, pods per plant and seed fresh weight should be considered as indices for developing high yielding pea genotypes.

Keywords: *Pisum sativum*; pea; yield; correlation; cluster analysis; regression analysis; agronomic characters; Pakistan.

Biotechnology / Tissue Culture

1. Siddiqui, M. R. Somatic hybridization via protoplasts fusion in *Lactuca sativa* (Lettuce) and its fused product response to culture media. *J. Agric. Res. Vol. 52(1): 1-9* (available online www.jar.com.pk).

Abstract: The improvement in quality traits of lettuce (*Lactuca sativa*) leaves using somatic hybridization techniques via protoplasts fusion is the main focus of this study. Somatic hybridization between two cultivars of lettuce, Evola and Red Leaf Amboni green and red, respectively, were carried out at Plant Science Laboratory, University of Nottingham, UK during 2006-7 to test the culture of fused protoplasts via polyethylene glycol (PEG) and electro fusion on four types of media i.e. liquid B5 based medium (T₁), embedding of liquid B5 medium over agarose (equal volume ratio) (T₂), embedding of solid B5 medium over agarose (equal volume ratio) (T₃), embedding of liquid B5 medium over MS 0.8 medium supplement with 0.5mg/l NAA and 0.04mg/l BAP (T₄) under five replications. The treatment T₄ in each replication gave significant result for fused protoplasts via chemical and electro- fusion in terms of micro and macro colonies (5 to 73 average micro colonies in petri dishes) culture while other treatments have damaged the protoplast. In all replications under T₄ a large number of micro colonies and macro colonies were observed and tested for viability via Fluorescein diacetate (FDA) test. All macro colonies show 100% viable colonies for regeneration. It has also been observed that electro fusion shows 40.51% protoplast fusion frequency over PEG. Based on the results, it can be concluded that selection of lettuce genotypes on the basis of seed viability using somatic hybridization techniques via protoplast fusion (both methods of fusion) cultured under optimum medium for improvement of lettuce quality could be an important tool in *in vitro* techniques.

Keywords: *Lactuca sativa*; cultivars; somatic hybridization; protoplasts fusion; growing media; Great Britain.

2. Iqbal, M. Z., A. Mahmood, S. Jamil and S.U. Rehman. Structural, environmental and varietal variation in Bt toxin of three Pakistani cotton (*Gossypium hirsutum* L.) cultivars. *J. Agric. Res. Vol. 52(2): 207-215* (available online www.jar.com.pk).

Abstract: The variation in Bt toxin was measured in three cotton genotypes (MNH-886, FH-142 and FH-Lalazar) at Agricultural Biotechnology Research Institute, AARI, Faisalabad, Cotton Research Station, Sahiwal, Cotton Research Station, Vehari, Pakistan during 2012. The varieties were measured in seed, 20 days old leaf, peduncle of 20 days old leaf, anther, stigma, pedicel, ovary, petals and bracts, immature stem, mature stem, 15 days old boll, 30 days old boll, fully matured boll, main roots, secondary roots and all leaves from top to downwards position. Maximum Bt toxin protein was measured in seed 14.9 (µg/g fresh weight) followed by leaves (5.18 µg/g) irrespective of location and genetic background. All the floral parts including anthers, stigma, pedicel, ovary and petals contained varying magnitude of Bt toxin. No Bt toxin was detected in mature stem, 15 days old boll, 30 days old boll, fully matured boll, main roots and secondary roots. FH-142 had maximum Cry1Ac protein followed by MNH-886 and FH-Lalazar. The expression of Bt toxin was higher at Sahiwal followed by Faisalabad and Vehari. The top most leaf of stem contained maximum amount of Bt toxin in all genotypes at all locations. The Bt toxin gradually decreased in leaves from top to downwards and up to 8th position leaf, it remained 2.28 µg/g on fresh weight basis which is sufficient for the control of lepidopteron insects.

Keywords: *Gossypium hirsutum*; cultivars; Bt cotton, Bt toxin; Cry1Ac; Pakistan.

Agronomy / Crop Physiology

1. Akhtar, N., J. Iqbal, M. Arshad, A. Jahangeer and Z. A. Ahmad. Effect of foliar application of urea on oat forage productivity. *J. Agric. Res. Vol. 52(1): 91-97* (available online www.jar.com.pk).

Abstract: The study was conducted at Agronomy (Forage Production) Section, Ayub Agricultural Research Institute, Faisalabad, Pakistan during 2010-11 and 2011-12. The primary objective was to study effect of foliar application of urea on oat forage productivity and to enhance nitrogen use efficiency. Six foliar applications of urea viz. 0.5%, 1%, 1.5%, 2%, 2.5%, 3% along with $\frac{1}{2}$ recommended dose of N (40 kg/ha) were compared with recommended dose of N (80 kg/ha) under Faisalabad conditions. Recommended dose of N as soil application was treated as control as no foliar application of urea was applied in this treatment. Oat variety CK-1 was sown using 80 kg seed/ha during second week of October 2010 and 2011 in RCBD at research area of the section. The crop was sown in 30 cm apart rows in net plot size of 3x6 meter. Maximum plant height (153.5 cm), number of tillers per plant (26.33) and green fodder yield (56.28 t/ha) was observed in T₇ where recommended N dose as soil application ($\frac{1}{2}$ N at sowing and $\frac{1}{2}$ N 60 DAS) was applied without foliar application of urea. The yield was statistically at par with treatment T₃ (50.85 t/ha) where $\frac{1}{2}$ N was applied at sowing along with 1.5% foliar spray of urea 60 DAS. The results showed that $\frac{1}{2}$ recommend dose of N along with 1.5% foliar application of urea 60 DAS saved almost 1 bag of urea per hectare without affecting green fodder yield of oat.

Keywords: *Avena sativa*; urea; foliar application; forage productivity; Pakistan.

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2. Ehsanullah., R. Qamar, M. Kalim, A. Rehman, Z. Iqbal, A. Ghaffar and G. Mustafa. Growth and economic assessment of mulches in aerobic rice (*Oryza sativa* L.). *J. Agric. Res.* Vol. 52(3): 395-406 (available online www.jar.com.pk).

Abstract: A study was conducted in year 2010 at University of Agriculture, Faisalabad, Pakistan to evaluate effect of mulches in aerobic rice on various agronomic aspects. Transplanted rice (TpR) is water and labour intensive with higher production costs. Keeping in view water crisis, it demands research on new technology to increase water use efficiency and reducing rice cultivation cost. Direct seeded rice (DSR) has low-input demand and may be adopted by farmers if weeds are properly managed. Mulch has the potential to discourage weeds and conserve soil moisture to facilitate direct seeding of rice. Super Basmati was used for direct seeding as a test crop in RCBD to test five mulch materials [maize straw (M_{Maize}), plastic sheet (M_{Plastic}), wheat straw (M_{Wheat}), sunflower straw (M_{Sunflower}) and berseem (M_{Berseem}) @ 5 t/ha] against non-mulched (M₀) control and conventionally transplanted rice. The results indicate TpR significantly lowered total weeds and weeds dry weight compared with DSR (no mulch) while plastic mulch among other mulch treatments had lowered total weeds and weeds dry weight. However, rice yield parameter such as plant height, fertile tillers, panicle length, number of grains per panicle, 1000-grain weight and total grain yield were significantly higher in TpR than DSR (no mulch) while plastic mulch had higher yield attributes than other mulch treatments. Transplanted rice and other mulch materials had significant effect on quality parameters such as opaque kernel, chalky kernel, normal kernel while non-significant effect on abortive kernel and sterile spikelets. Transplanted rice and DSR (sunflower mulch) showed maximum net returns and benefit cost ratio than other treatments.

Keywords: *Oryza sativa*; direct seeding rice; mulches; weeds density; grain yield; cost benefit analysis; Pakistan.

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3. Gillani, S. M. W., A. U. H. Ahmad, F. Khalid, M. S. I. Zamir, M. B. Anwar, W. Ikram and A. Jabbar. Impact of nutrient management on growth, yield and quality of forage maize (*Zea mays* L.) under agro-climatic conditions of Faisalabad. *J. Agric. Res.* Vol. 52(4): 499-510 (available online www.jar.com.pk).

Abstract: An experiment was conducted during 2011 at Agronomic Research Area, University of Agriculture, Faisalabad, Pakistan to check the interactive effect of both macronutrients and micronutrients on the yield and quality of forage maize. The experiment comprised two factors i.e. varieties (Pak Afghoi and Syngenta-6621) and nutrients (NP and micronutrients). The application of NP and micronutrients alone and in combination was carried out with one water spray at 15 days after sowing (DAS), two water sprays at 15 and 30 DAS and three water sprays at 15, 30 and 45 DAS while, recommended dose of NP was used as control. The experiment was laid out in RCBD with factorial arrangement. The application of two foliar sprays of micronutrients at 15 and 30 DAS along with NP applied in soil significantly increased the green forage yield (58.63 t/ha) in Pak Afghoi. The

quality parameters like crude protein (%), crude fiber percentage and ash contents percentage were also significantly affected by the application of micronutrients. Significant differences were also observed among the cultivars regarding plant height, leaf area per plant and stem girth per plant. The variety Pak Afghoi with two foliar sprays of micronutrients applied at 15 and 30 DAS along with NP as soil application produced significantly higher green forage yield (58.63 t/ha) and crude protein (9.55 %). For higher yield and protein content of forage maize, Pak Afghoi variety should be grown with two foliar applications of micronutrients at 15 and 30 DAS along with simultaneous use of NP in soil.

Keywords: *Zea mays*; maize; nutrient management; NP; micronutrients; agronomic characters; forage yield; Faisalabad; Pakistan.

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4. Tanveer, M., Ehsanullah, S. A. Anjum, H. Zahid, A. Rehman and A. Sajjad. Growth and development of maize (*Zea mays* L.) in response to different planting methods. *J. Agric. Res. Vol. 52(4): 511-522* (available online www.jar.com.pk).

Abstract: A field study was conducted in Department of Agronomy, University of Agriculture, Faisalabad, Pakistan during 2011-12 to evaluate growth and development of maize (*Zea mays* L.) in response to various planting methods. Planting methods were bed sowing manually (T₁), ridge sowing manually (T₂) flat sowing with dibbler (T₃), flat sowing with single row hand drill (T₄) and sowing with multiple crop planter (T₅). Results revealed that maximum crop growth rate (CGR) (17.39 g/m²/day) and net assimilation rate (NAR) (6.27 g/m²/day) were noted in T₁, while least values were observed in T₂ and T₃. Similarly, T₁ and T₂ took less days to 50% silking i.e. 74.83 and 75. Leaf area index (LAI) was substantially improved in T₁ (4.69 to 4.94) and T₂ (4.66 to 4.91) followed by T₄ (4.11 to 4.72). However T₃ and T₅ did not improve CGR and LAI. Maximum grain yield was exhibited by manual bed sowing (T₁) (6.24 t/ha), followed by ridge sowing (5.97 t/ha). Least grain yield was obtained by multiple crop planter (T₅) (5.2 t/ha). Therefore, it is concluded that maize sown on beds (T₁) performed better as compared to other sowing methods.

Keywords: *Zea mays*; maize; planting methods; multiple crop planter; crop growth rate; net assimilation rate, Pakistan.

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5. Sanaullah., M. A. Cheema, M. A. Wahid, A. Ghaffar, A. Sattar and S. Abbas. Yield response of autumn planted sunflower hybrids to zinc sulfate application. *J. Agric. Res. Vol. 52(4): 523-533* (available online www.jar.com.pk).

Abstract: A field trial was conducted during 2011 to investigate the impact of zinc sulfate (five levels i.e. 15, 30, 45, 60, 75 kg/ha) on yield and yield parameters of autumn planted sunflower (*Helianthus annuus* L.) hybrids at Agronomic Research area University of Agriculture, Faisalabad, Pakistan. The results revealed that maximum stem diameter (3.04 cm) head diameter (18.35 cm), number of achenes per head (1074), achenes yield (2578 kg/ha) and biological yield (12578 kg/ha) were recorded @ 45 kg ZnSO₄/ha. The maximum values for 1000 achenes weight (64.62 g) and harvest index (21.11%) were achieved in treatment where zinc sulfate was applied @ 60 kg/ha which was at par with 45 kg ZnSO₄. Plant height was non-significant among all the zinc sulfate levels. The sunflower hybrid Hysun-33 produced maximum achene yield (2461 kg/ha) @ 45 kg ZnSO₄/ha. Zinc sulfate applied @ 45 kg/ha produced maximum values for all these traits as compared to minimum in control. As far as interaction between zinc levels and hybrids is concerned maximum head diameter (19.57cm), achenes per head (1093), achenes (2645 kg/ha) and biological yields (13019 kg/ha) were given by Hysun-33 @ 45 kg/ha zinc sulphate. It is concluded that zinc sulphate application promoted yield and yield components of sunflower hybrids.

Keywords: *Helianthus annuus*; sunflower; agronomic characters; zinc sulphate; yield parameters; achene yield; Pakistan.

6. Sajjad, A., H. Munir, Ehsanullah, S. A. Anjum, M. Tanveer and A. Rehman. Growth and development of *Chenopodium quinoa* genotypes at different sowing dates. *J. Agric. Res. Vol. 52(4): 535-546* (available online www.jar.com.pk).

Abstract: A study was conducted at Department of Agronomy, University of Agriculture, Faisalabad, during 2009-10 to work out the optimum sowing date and screening of most productive *Chenopodium quinoa* genotype at proposed sowing dates. Sowing dates were 15 December, 2009 (PD₁) and 15 January, 2010 (PD₂). Three exotic quinoa accessions (CPI-3, CPI-5 and CPI-7) were tested. Different phenological stages were considered for evaluation. Results indicated that significant effect of sowing dates, accessions and their interaction was observed but varied among different stages. It was noted that Quinoa sown on 15 January, 2010 (PD₂) took more days to true leaf (17.22), four leaves stage (22.83), multiple leaves (26.67) and bud formation (43.78) than genotypes sown at PD₁ (14, 19.44, 25.33 and 36.63, respectively). However, effects of accessions were non-significant at these stages. Contrarily, interaction was non-significant for days to panicle emergence and days to harvesting. Furthermore, effect of sowing dates, interaction of sowing date and accession on days to flowering was highly significant and showed that genotypes sown at PD₁ took less days to flowering (46.56) than sown at PD₂ (55.89). Highest grain and biological yield was obtained at PD₁ (285.93 kg/ha and 6994 kg/ha) than PD₂ (215.18 and 6519.8 kg/ha, respectively). Among sowing dates, it was affirmed that early sowing (PD₁) performed better and exhibited better results than late sowing PD₂. Regarding interaction between accessions and sowing dates CPI-5 gave good performance when sown on 15th December [CPI-5 x PD₁ days to flowering (46), days to harvesting (116.7), biological yield (7673 kg/ha) and economical yield (327.0 kg/ha)].

Keywords: *Chenopodium quinoa*; quinoa; photoperiodism; short day plant; sowing time; agronomic characters; Pakistan.

Soil Sciences & Fertilizers

1. Niaz, A., M. Yaseen, M. Arshad and R. Ahmad. Variable nitrogen rates and timing effect on yield, nitrogen uptake and economic feasibility of maize production. *J. Agric. Res.* Vol. 52(1): 77-89 (available online www.jar.com.pk).

Abstract: An experiment was conducted during 2010-11 at Research Farms (31°N, 73°E and 184.4m above sea level) of University of Agriculture, Faisalabad, Pakistan to assess the effect of variable nitrogen rates and timing schemes on growth, yield, nitrogen uptake and economic feasibility of maize production in RCBD with three replications. Application of entire N at seed bed preparation was found to be least effective. Delaying more than 25% of N late up to the V9 stage proved significantly better with respect to all the parameters but the complete exclusion of basal N could not provide the promising results. Nitrogen application @ 200 kg/ha though brought significantly higher leaf area index (3.67), grain yield (6.85 t/ha) and total N uptake (173.86 kg/ha) but could not significantly affect stover yield over 175 kg/ha. Nitrogen @ 175 kg/ha had higher residual effect on soil N status and also when applied following the timing scheme comprising split application, 25% broadcast-incorporated at seed bed preparation and remaining 75% top dressed at V9 growth stage, 175 kg N/ha provided higher value cost ratio (12.17 Rs. Rs.⁻¹). It is concluded that split application of 175 kg N/ha (25% broadcast-incorporated at planting and 75% top dressed at V9) could be appropriate to attain higher and economical maize production.

Keywords: *Zea mays*; nitrogen fertilizers; timing; top dressing; nitrogen uptake; cost benefit analysis; Pakistan.

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2. Qazi, M. A., M. A. Khattak, M. S. A. Khan, M. N. Chaudhry, K. Mahmood, B. Akhter, N. Iqbal, S. Ilyas and U. A. Ali. Spatial distribution of heavy metals in ground water of Sheikupura District, Punjab, Pakistan. *J. Agric. Res.* Vol. 52(1): 99-110 (available online www.jar.com.pk).

Abstract: Spatial distribution of heavy metals in ground water of industrial area of district Sheikupura, Punjab, Pakistan during 2010 was investigated using Geographic Information System (GIS). To check heavy metals, 235 ground water samples were collected along with the latitude and longitude coordinate values. Samples were analysed for irrigation quality parameters i.e. electrical conductivity (EC), sodium adsorption ratio (SAR) and residual sodium carbonate (RSC). Nineteen samples were selected randomly for five heavy metals (Cd, Co, As, Cu and Mn) and analysed using Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-

OES). An area about 107 square kilometers comprising six villages namely Wandala Nasir, Pindi Das, Purab, Noon, Shamke and Zia Abad was investigated. Prediction maps were developed which illustrate that the extreme eastern and western sides of area of interest have fit ground water including the Zia Abad and Wandala Nasir villages. More than 50% area has unfit ground water on the basis of EC and RSC. Regarding heavy metals, results of prediction maps match with ground realities. Most of the area along Motorway to Muridkey road is dense with varied nature of industries. Cluster analysis showed that 52, 45 and 20% of total area has higher Cadmium, Cobalt and Manganese concentrations, respectively than maximum permissible limits for irrigation purpose. However Arsenic and Copper concentrations were within the safe limits except few patches.

Keywords: Heavy metals; Cd; Co; As; Cu; Mn; geographic information system; GIS Punjab, Pakistan.

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3. Arif, M., M. Tasneem, F. Bashir, G. Yaseen and R. M. Iqbal. *Effect of integrated use of organic manures and inorganic fertilizers on yield and yield components of rice. J. Agric. Res. Vol. 52(2): 197-206 (available online www.jar.com.pk).*

Abstract: The integrated use of organic and inorganic manures on the yield of rice was evaluated in a field experiment at Chakkanwali Reclamation Research Station, District Gujranwala, Pakistan during kharif 2012. The organic sources used were farmyard manure, poultry manure, rice straw, sesbania, compost and mung bean residues alone and in combinations with 50% of recommended dose of fertilizer (RDF). Recommended dose of fertilizer (150-90-60 kg NPK/ha) and control treatments were also included in the experiment. The results showed that organic and inorganic manures in combination increased the plant height, fertile tillers per hill, number of grains per panicle, panicle length, number of panicles per hill, 1000-grain weight, biological yield, grain yield and harvest index. Maximum number of fertile tillers per plant (16.79), number of panicles per hill (8.41), 1000- grain weight (21.12 g), biological yield (10.19 t/ha), grain yield (4.47 t/ha) and harvest index (43.76%) were recorded from the plots receiving poultry manure @ 10 t/ha in combination with 50% of RDF. This was followed by 100% RDF. It is evident that yield of rice can be increase significantly with the combined use of organic manure with chemical fertilizers.

Keywords: *Oryza sativa*; NPK fertilizer; farmyard manure; poultry manure; compost; organic residues; Pakistan.

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4. Hussain, F., A. Khaliq, M. I. Ashraf and I. A. Khan. *Morphological and hydrological responses of soan and khad rivers to impervious land use in Tehsil Murree, Pakistan. J. Agric. Res. Vol. 52(2): 269-282 (available online www.jar.com.pk).*

Abstract: The study was conducted during 2005 to 2009 in District Muree, Pakistan. Rapid degradation of watersheds due to soil erosion, deforestation, urbanization is the critical issue in high hill areas. Housing and infrastructure development, being the top priority of government is also impacting the health of watersheds; resultantly our dams are losing their capacity due to increased sedimentation. The study aimed at assessing the current magnitude and distribution of development in two important watersheds of Punjab. The assessment was carried out by correlating infrastructure development with soil erosion and regime of water in the channels. Impervious land use in Simly watershed is increasing at a pace of 1.91 % per year and presently it is 13.23 % of the total area. It has also been determined that at current pace of development, 16.84 % of the area in Simly will be under impervious land use by 2020. Based on the land use of the area, different channels in Simly stream system were categorized into urbanizing, agriculture and forest and main channel. The study revealed that the soil erosion is more in areas under impervious land use or where the land is disturbed due to developmental activities. The sediment load in different categories of channels was studied. It was found that sediment load in the urbanizing water channel was highest (26.03 g/l) followed by agriculture (8.86 g/l), and forest was the least (1.73 g/l) contributor of sediment in the channels. Water quality of the stream system has also been deteriorated. Turbidity and hardness was more in urbanizing as compared to other land use.

Keywords: Water sheds; hydrological response; impervious land use; Khad miner; Soan river; Murree. Pakistan.

5. Majeed, A., M. A. U. Haq, J. Akhtar and S. M. A. Basra. Screening of maize genotypes against poor quality water in solution culture. *J. Agric. Res. Vol. 52(3): 357-368* (available online www.jar.com.pk).

Abstract: An experiment was conducted in solution culture to understand the response of dissimilar maize (*Zea mays* L.) genotypes against salinity in green house at Saline Agriculture Research Centre, Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad, Pakistan. Maize plants at two leaf phase were transplanted at three different levels of water salinity [(T₁ (Control) T₂ [EC 2.0 dS m⁻¹, SAR 15.0 (mmol L⁻¹)^{1/2} and RSC 2.25 mmol_cL⁻¹] and T₃ [EC 4.0 dS m⁻¹, SAR 25.0 (mmol L⁻¹)^{1/2}, RSC 5.0 mmol_c L⁻¹]. The mixtures of four salts (NaHCO₃, Na₂SO₄, CaCl₂.2H₂O and MgSO₄.7H₂O) were used to formulate saline water levels through quadratic equation. Half strength Hoagland's nutrient solution was applied for nourishment throughout experiment. After 30 days of salinity evolution, maize plants were harvested and data for shoot fresh weight, root fresh weight, shoot dry weight root dry weight, shoot length and root length were recorded. From leaf juice Na⁺ and K⁺ contents were resolute and K⁺: Na⁺ proportion was calculated. All the growing components of maize varieties were significantly abridged owing to salinity effects and genotypic dissimilarity for salt lenience was also noticed between the maize varieties. The genotypes Sahiwal-2002 and Afgoi were classified as salt lenient genotype as these produced the highest shoot biomass (21.6 g and 17.3g) and retained higher K⁺: Na⁺(0.90 and 0.67) ratio, however Sadaf, FH-963 and FH-722 were categorized as salt sensitive genotypes and produced the least shoot weight (8.8 g, 7.7g and 7.9g) and could retain the lowest K⁺: Na⁺(0.34, 0.19 and 0.21) proportions under salinity.

Keywords: *Zea mays*; genotypes; salinity; screening; water solution; Hoagland's nutrient solution; Pakistan.

6. Ezeaku, P. I and F. U. Eze. Effect of land use in relation to slope position on soil properties in a semi-humid Nsukka area, Southeastern Nigeria. *J. Agric. Res. Vol. 52(3): 369-381* (available online www.jar.com.pk).

Abstract: A study was carried out during 2011-12 in Department of Soil Science, University of Nsukka, Nigeria. The study assessed the influence of different land uses and slope positions on variability of some selected soil properties. Correlation between clay, dry bulk density, soil organic carbon (SOC) with slope and land use was highly significant (P<0.001). Clay content decreased downslope, increased in forest soil and with depth but silt-sand increased upslope. Soil bulk density increased with depth, upslope and cropped soil. Soil saturated hydraulic conductivity (K_s) was 48.4% less under footslope, decreased with depth and increased (42.9%) in fallow/grassland soil. Volumetric soil moisture under cultivated and fallow soils was significant (P<0.05). Soil total nitrogen, SOC and cation exchange capacity were significantly different (P<0.05) for different land uses. Soil available phosphorus value was statistically similar. However, all the soil property values were found statistically higher in forest soil than in soil of other land uses. Spatial analysis showed various relations between these soil properties, slope and land uses. No-till practices and ridge-furrow system were recommended to increase SOC for soil and water conservation. The study is useful for knowing the land use effect in relation to slope position on soil properties of Ukpabi- Nsukka located in semi-humid agro-ecology zone of Nigeria.

Keywords: Land uses; soil properties; soil organic carbon; slope position; semi-humid; Nsukka; Nigeria.

7. Nafees, M and A. Amin. Evaluation of heavy metals accumulation in different parts of wheat plant grown on soil amended with sediment collected from kabul river canal. *J. Agric. Res. Vol. 52(3): 383-394* (available online www.jar.com.pk).

Abstract: A study was conducted during 2011-12 at Botanical Garden, Department of Botany, University of Peshawar, Peshawar, Pakistan. The objective was to evaluate heavy metal contents, their uptake and accumulation in different parts of wheat plant. Due to increase in erosion and sedimentation, Kabul River Canal is cleaned every year in the months of January-February. Many people are using the collected sludge as soil conditioner. The sludge with and without soil mixing was analyzed for non-essential heavy metal contents including, cadmium (Cd), chromium (Cr), and nickel (Ni). The average values of Cd, Cr and Ni in soil were 0.17 to 0.2, 0.18 to 0.33 and 0.005 to 0.009 mg/kg, respectively. These concentrations were found within the permissible limits. For further confirmation, the collected sediment was applied to wheat crop grown in pots to assess the accumulation of non-essential heavy metals in different parts of wheat plant. Pots were filled with sediment mixed with soil in the ratio of 25:75 (sediment: soil) and 50:50 (sediment: soil) in triplicate. Different parts of wheat plant were analyzed for selected heavy metals. The concentration sequence was stem > seed > leave > root, for Cd and root > stem > leave > seed for Ni and leaves > root > seed > stem for chromium. It was concluded that the level of these heavy metals was below the standard set for agricultural soil and the accumulation was comparatively low in seed.

Keywords: Trace elements; heavy metals; canal sediments; municipal wastewater; cadmium; chromium; nickel; Kabul river; Peshawar, Pakistan.

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8. Imoro, Z. A., J. A. Boateng and T. K. Aikins. Comparison of soil fertility improvement ability of *Voandzeia subterranea* and *Arachis hypogea*. *J. Agric. Res.* Vol. 52(4): 489-498 (available online www.jar.com.pk).

Abstract: An experiment was conducted in the Department of Range and Wildlife Management, Faculty of Renewable Resources, University of Development Studies, Nyankpala Campus, Tamale, Ghana during 2013 to determine the soil fertility improvement potentials of *Voandzeia subterranea* and *Arachis hypogea*. Three soil samples were taken from two plots grown under *V. subterranea* and *A. hypogea* at flowering stage and after incorporation plant material using grid method. The soil samples were then analyzed for some selected nutrients in the laboratory using standard methods. The results showed that mean values of samples taken after incorporation plant material were significantly higher ($P < 0.05$) than those collected at flowering stage for *A. hypogea* with regards to nitrogen (31.6%), potassium (20.47 mg/kg), organic carbon (8.6%) and pH levels (7.0). However, other nutrients i.e. magnesium (0.57 mg/kg), calcium (1.43 mg/kg) and phosphorus (5.35 mg/kg) were not improved significantly. Also mean values of soil samples recorded after incorporation were significantly higher ($P < 0.05$) than at flowering stage for *V. subterranea* with regards to nitrogen (30.53%), potassium (21.73 mg/kg), organic carbon (9.67%) and pH levels (7.22), but magnesium (0.5 mg/kg), calcium (1.40 mg/kg) and phosphorus (3.07 mg/kg) were not improved significantly. It is recommended that any of these two legumes can be incorporated into the soil to improve soil fertility of rangelands for pasture growth ensuring nutritious and sustainable feed for animals.

Keywords: *Voandzeia subterranea*; *Arachis hypogea*; soil fertility; nutrients; phosphorus; organic matter; calcium, magnesium; Ghana.

Entomology

1. Mahmood, R., A. Rehman and M. Ahmad. Prospects of biological control of citrus insect pests in Pakistan. *J. Agric. Res.* Vol. 52(2): 229-244 (available online www.jar.com.pk).

Abstract: Citrus is attacked by a number of insect pests in Pakistan. The list includes citrus psylla *Diaphorina citri*; leaf miner *Phyllocnistis citrella*; white flies *Aleurocanthus woglumi*, *Aleurocanthus husaini*, *Aleurotuberculatus citrifolii*, *A. jasmine*, *Amurrayae*, *Aleurolobus niloticus*, *Aleurotrachelus* sp, *Dialeurodes citri* and *D. elongata*; scale insects *Aonidiella aurantii*, *A. citrina*, and *A. orientalis*; mealy bugs *Nipaecoccus vastator*, *Ferrisia virgata*, *Planococcus citri*, *Pseudococcus filamenetosus*, *Spilococcus* sp, and *Rastrococcus spinosus*; coccids *Coccus hesperidum* and *Pulvinaria psidii*; margarodids *Drosicha stebbingi* and *Iceryia*

egyptiaca; fruit flies *Bactrocera zonata* and *B. dorsalis* and butter fly *Papiliode moleus*. At present farmers rely on pesticide sprayings in orchards to control pests and diseases. These practices have not only worsened the pest status overtime but also have created the risks of pesticide residues in produce. If present plant protection practices continue, Pakistani growers may have a setback in exporting their produce. Consumers, especially in the developed world, being health conscious force their governments to protect them from ill effects of pesticides. The need of the time therefore is to shift from the present pesticide based plant protection to integrated pest management based on bio-ecological principles to reduce the use of pesticides in crops particularly in horticulture. In the paper, status of key pests of citrus in Pakistan is reviewed and possibilities of their management by non-chemical measures have been discussed.

Keywords: *Citrus sinensis*; insect pests; fruit flies; Psylla, Aleyrodids; leaf miner; mealy bugs; scale insects; biological control; integrated pest management; Pakistan.

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2. Khan, M. M., M. Nawaz, S. A. Cheema and S. S. U. Din. Comparison of new chemistry and conventional insecticides against *Helicoverpa armigera* on sunflower (*Helianthus annuus*). J. Agric. Res. Vol. 52(4): 555-559 (available online www.jar.com.pk).

Abstract: A field experiment was conducted during Kharif 2010 and 2011 at Oilseeds Research Institute, AARI, Faisalabad, Pakistan to find out and compare the efficacy of new chemistry (emamectin benzoate, spinosad) and conventional insecticides (bifenthrin, chlorpyrifos, profenophos) against *Helicoverpa armigera* (Hubner) on sunflower hybrid FH-385. The emamectin benzoate and spinosad proved to be highly effective against *H. armigera*. After 72 hours of treatment emamectin benzoate showed 95.93% and 93.75%, while, spinosad showed 93.02% and 91.04% mortality in 2010 and 2011, respectively. Whereas, the conventional insecticides i.e. bifenthrin and profenophos showed lesser mortality. Moderately effective response was observed for chlorpyrifos. The new chemistry insecticides have proven better in controlling *H. armigera* as compared to the conventional ones.

Keywords: *Helianthus annuus*; sunflower; *Helicoverpa armigera*; head moth; new chemistry insecticides; Emamectin Benzoate; Spinosad; Pakistan.

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3. Karavina, C., R. Mandumbu, E. Zivenge and T. Munetsi. Use of garlic (*Allium sativum*) as a repellent crop to control diamondback moth (*Plutella xylostella*) in cabbages (*Brassica oleraceae* Var. *Capitata*). (Short Communication) J. Agric. Res. Vol. 52(4): 615-621 (available online www.jar.com.pk).

Abstract: An experiment was carried out at Horticultural Research Centre Marondera, Zimbabwe during 2011-12 to determine the effect of *Allium sativum* as a repellent crop to control diamondback moth (DBM) in cabbage. The trial was laid out in RCBD with four treatments. Garlic was intercropped with cabbages in 2:1 and 2:2 ratios. Diamondback moth larval counts were affected by treatments ($P \leq 0.05$). Hence sole cabbages unsprayed with malathion 25WP showed significantly higher counts than the other treatments from week 3 to 8 after transplanting. There were no significant differences ($P \leq 0.05$) in larval populations between intercropped plots and chemically-treated plots. Cabbage quality was poorest in sole cabbages that were not sprayed with malathion 25WP, with a score of 2.85. There were no significant differences between garlic intercropped cabbages (2:2) and those treated with malathion 25WP. Cabbage yield in garlic + cabbage intercropped plots (1:2) was similar to that achieved in plots treated malathion 25WP. The results showed that garlic intercropping can be used to manage DBM effectively. Use of garlic is environment friendly, and farmers can also derive additional benefits from garlic.

Keywords: *Allium sativum*; *Brassica oleraceae*; capitata; cabbage; *Plutella xylostella*; intercrop; repellent; yield; Zimbabwe.

Plant Virology

1. Marwal, A., A. K. Sahu and R. K. Gaur. Association of begomovirus and an alphasatellite with leaf curl

disease of ornamental plant, *Vinca alba* in Punjab, India. *J. Agric. Res.* Vol. 52(3): 339-356 (available online www.jar.com.pk).

Abstract: A study was conducted on *Vinca alba* plant in department of Science, Faculty of Arts, Science and Commerce, Mody Institute of Technology and Science, Sikar, Rajasthan, India during year 2010-11. For this purpose plants of *Vinca alba* were collected from different gardens of Bhatinda city of Punjab province, India. The samples of leaf having the begomovirus symptoms revealed a Polymerase Chain Reaction (PCR) result of ~550 bp of coat protein gene, as anticipated with universal primers. In addition to this, alphasatellite were also found using alphasatellite specific universal primers. Betasatellite was absent in the samples. Apart from PCR, a standard papaya leaf curl virus clone was used in the Dot blot hybridization technique as a probe for DNA-A, with final confirmation of begomovirus. The sequenced begomovirus encodes for coat protein of 134 aminoacids having molecules of 15-62 KD which was 95% identical with papaya leaf crumple virus (HM 140368) and rose leaf curl virus (GQ 478342). The begomovirus and alphasatellite shared nucleotide identity with other isolates reported from Pakistan, China, Taiwan, Viet Nam and India. Thus species of begomovirus with new recombined DNA was evolved. This study highlights the mixing of this isolate with further begomoviruses through recombination, resulting in a new disease composite imparting a severe danger to horticulture, agriculture crops and ornamental plants production.

Keywords: *Vinca alba*; Begomovirus; alphasatellite; ornamental plants; sequence and recombination analysis; leaf curl virus; Punjab, India.

Horticulture

1. Abbas, M. M., S. Ahmad and M. A. Javaid. Effect of naphthalene acetic acid on flower and fruit thinning of summer crop of guava. *J. Agric. Res.* Vol. 52(1): 111-116 (available online www.jar.com.pk).

Abstract: The study was conducted at University of Agriculture, Faisalabad, Pakistan during 2009-10. The project was undertaken to find out some useful methods to investigate the most economical and suitable concentrations of Naphthalene Acetic Acid (NAA) to thin the flowers of summer crop of guava (*Psidium guajava*) to get bumper winter crop. The results showed that maximum flower drop (69.45%) was observed in the guava plants sprayed twice with NAA with the concentration of 500 ppm during last week of April and first week of May. It was also noticed that as the concentration of the chemical increased the flower drop percentage was also increased. The most suitable concentration of NAA was 400 ppm which produced maximum yield (32.75 kg/plant) during the winter with maximum flower drop percentage (64.92) during the summer. Maximum TSS (7.13%) was recorded in the plants treated with NAA at 200 ppm and the minimum TSS (5.35%) was recorded in the plants treated with NAA @ 500 ppm.

Keywords: *Psidium guajava*; guava; flower thinning; fruit thinning; Agronomic characters; plant growth retardant; naphthalene acetic acid; Pakistan.

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2. Ramzan, A., M. Hanif and S. Tariq. Performance of *Rosa hybrida* L. cultivars under agro-climatic conditions of Islamabad, Pakistan. *J. Agric. Res.* Vol. 52(1): 153-158 (available online www.jar.com.pk).

Abstract: The study was conducted at Department of Floriculture and Land Landscape, NARC, Islamabad, Pakistan during May to July 2011. The objective of the study was to assess the performance of exotic cultivars of hybrid tea roses under agro-climatic conditions of Islamabad. Nineteen hybrid rose cultivars were studied and data was collected on number of branches per plant, plant height (cm), stalk length (cm), number of flowers per plant and flowering percentage per plot. The highest stalk length (24.6, 24cm) was recorded in cultivars Double Delight and Signature. Maximum plant height (100cm) was recorded in Jagua followed by Pink Peace and Honey Perfume (97cm). While minimum plant height (67.33cm) was noted in Abby De Culnry. Maximum number of flowers (52) were produced by cultivar Honey Perfume followed by Pink Peace (50) and Alice Red

(34). Supreme flowering percentage (65%) was observed in cultivar Abby De Culnry followed by Julias Rose (60%) and Cendrila (52%). Results of the study suggest that Double Delight, Signature, Honey Perfume and Pink Peace performed better during hot months of May to July and these are best suited cultivars for further research work.

Keywords: *Rosa hybrida*; hybrid tea roses; cultivars; performance; agronomic characters; Islamabad; Pakistan.

3. Nasir, M. A., M. M. Aziz, T. A. Mohar, J. Iqbal and M. K. Raza. Evaluation of suitable rootstock for enhancement of yield and quality of kinnow (*Citrus reticulata* Blanco) under Sargodha conditions. *J. Agric. Res. Vol. 52(3): 407-414 (available online www.jar.com.pk).*

Abstract: A field experiment was conducted to evaluate the suitable rootstock for yield enhancement of Kinnow (*Citrus reticulata* Blanco) at progeny garden of Citrus Research Institute Sargodha, Pakistan during the year 2002-2011. The seeds of Rough Lemon, Kinnow and Rangpur Lime were sown in nursery during 2002. The seedlings of root stocks were grafted with scion wood of Kinnow mandarin through T-grafting technique during 2004. The grafted plants were transplanted to actual field during September, 2005. Fruit yield was recorded during mid January of three consecutive years (2009, 2010 and 2011). The parameters studied were fruit weight, yield, fruit size, total soluble solids, rind thickness, TSS /acid ratio and juice percentage. The results revealed that rootstocks differ significantly in average fruit weight, fruit size, number of fruits per tree and yield in kg per tree during three successive seasons. Maximum fruit weight (225.12g), diameter (8.02 cm), yield (64.89 kg/plant), rind thickness (0.47 cm), TSS (12.92%), juice (48.11%) and TSS/acid ratio (19.58%) were produced by Rough Lemon rootstock, budded with Kinnow. While these parameters were found minimum in Rangpur Lime rootstocks budded with Kinnow. Results revealed that Rough Lemon rootstock has better effect on the yield and physicochemical characteristic of Kinnow under the prevailing climatic conditions of Sargodha, Pakistan.

Keywords: *Citrus reticulata*; Kinnow; rootstocks; Rough Lemon; Rangpur Lime; physicochemical characteristics; TSS; fruit yield; fruit quality; Sargodha, Pakistan.

4. Hussain, I., S. Ahmad, M. Amjad and R. Ahmed. Effect of modified sun drying techniques on fruit quality characters of dates harvested at rutab stage. *J. Agric. Res. Vol. 52(3): 415-424 (available online www.jar.com.pk).*

Abstract: A study was conducted at University of Agriculture, Faisalabad, Pakistan during 2012 to optimize the best sun drying technique for improving the quality of processed dates (cv. Hillawi). The fruits were collected at rutab/dong stage from 15-25 years old plants and subjected to various sun drying techniques for 6 to 8 days depending upon daily weather conditions. Physicochemical changes related to quality were analyzed and found that the fruits dried under direct sun light during the day time, removed and covered during night showed higher moisture (24.13%), minimum weight loss (18.73%), higher TSS (11.09 °Brix), total sugar (69.39%) and higher reducing sugar (51.47%) with lower acidity (0.130%) in fruits when reached at tamr stage (dried). Higher phytonutrients such as total phenolics (224.28 mg GAE/100 g), total flavonoids (34.31 mg CEQ/100 g) and total antioxidants (72.20% DPPH inhibition) with lower tannins (0.143%) were also found in these fruits. It is concluded that good quality dried dates can be prepared successfully by adopting the modification in conventional sun drying technique that could improve the economic status of farmers.

Keywords: *Phoenix dactylifera*; Sun-drying techniques; Hillawi; dates; fruit quality; rutab stage; physico-chemical characteristics; phytonutriional composition; Pakistan.

5. Hossain, M. F., N. Ara, M. S. Uddin, M. R. Islam and M. O. Kaisar. Effect of sowing dates on flowering, fruit setting and yield of tomato genotypes. *J. Agric. Res. Vol. 52(4): 547-553 (available online www.jar.com.pk).*

Abstract: A study was conducted at Agricultural Research Station, BARI, Thakurgaon, Bangladesh during 2009-10 to observe the sowing date effect on flowering and fruiting of tomato (*Lycopersicon esculentum* Mill.) genotypes. Three sowing dates viz. October 1, 15 and 30 were considered as factor A and tomato varieties viz. BARI Tomato-2, BARI Tomato-3, BARI Tomato-4, BARI Tomato-9 and BARI Hybrid Tomato-4 were considered as factor B. The experiment was laid out in RCBD (factorial) with three replications. Early flowering (52.40 days) as well as early fruit harvesting (119.13 days) was observed in October 1 sowing whereas, sowing on October 30 resulted in delayed flowering (71.73 days) and fruit harvesting (140.67 days). Number of fruits per plant was also maximum (27.40) in October 1 sowing and minimum (13.73) in October 30 sowing. Seed sowing of October 1 was found better in respect of yield (74.75 t/ha) compared to October 15 (58.55 t/ha) and October 30 (24.60 t/ha) sowing. Among the genotypes, BARI Tomato-2 produced the highest (68.12 t/ha) marketable yield followed by BARI Tomato-9 (56.16 t/ha) and BARI Tomato-3 while, BARI Tomato-4 produced lowest (36.91 t/ha). With regards to combined effect of variety and sowing date, BARI Tomato-2 gave highest yield (97.21 t/ha) when sown on October 1st followed by BARI Tomato-9 (89.56 t/ha) on same sowing date.

Keywords: *Lycopersicon esculentum*; tomato; genotypes; sowing date; flowering; fruit setting; yield; Bangladesh.

Food Technology / Post Harvest

1. Zahra, S. M., M. Nadeem, S. Hussain, T. M. Qureshi, A. Din and F. Rashid. Development and evaluation of nutri-bars for internally displaced people in humanitarian emergencies. *J. Agric. Res. Vol. 52(2): 217-226 (available online www.jar.com.pk).*

Abstract: This study was carried out at Institute of Food Science and Nutrition, University of Sargodha, Sargodha, Pakistan during 2012. The objective of study was to develop an easy to digest, instantly low cost and stable nutri-bars for IDPs (Internally displaced people) of humanitarian emergencies. Nutri-bars were developed from different ingredients in six different ratios. These bars were analyzed for physico-chemical, microbiological and sensory characteristics. Maximum moisture content (16.35%) was observed in T₀ (dried apricot paste 12g, dry milk powder 1g, coconut 0.5g, cinnamon 0.5g, cardamom 0.5g, pepper 0.25g, fennel 0.25g, apricot kernel 0.5g, jaggery 2g and chocolate 2g) and maximum crude protein content (9.45%) in T₂. Addition of barley, dried pumpkin and egg white increased the protein contents of nutri-bars. Similarly, crude fiber ranged from 5.47 to 6.37% in treatments T₂ and T₃ while ash contents ranged from 3.11% to 3.50% for T₁ and T₀, respectively. Nitrogen free extract (64.69%) was significantly affected due to addition of cereals along with apricot in different bars. The maximum gross energy value (339.615 kcal/100g) was recorded in treatment T₂ (dried apricot paste 8g, roasted barley & chickpea powder and puffed rice powder 1.5g each, dried pumpkin powder 0.25g, dried egg white powder 0.25g, dry milk powder 1g, ground cinnamon and cardamom 0.5g each, pepper and fennel 0.25g each, coconut 0.5g, jaggery 2g and chocolate 2g). In sensory evaluation treatment T₂ was ranked best regarding sensory characteristics like color, flavour, taste, mouth feel, texture and overall acceptability. It can be concluded from the results that the nutri-bars are good source of energy and nutrition for IDPs.

Keywords: Disasters; IDPs; emergency food; nutri-bars; Pakistan.

2. Masih, S., Z. Iqbal, A. M. Arif, M. Rafiq, G. Rasool and A. Rashid. Effect of linseed oil substitution on physico-chemical properties of cookies. *J. Agric. Res. Vol. 52(3): 425-437 (available online www.jar.com.pk).*

Abstract: In a study conducted at National Institute of Food Science and Technology, University of Agriculture, Faisalabad, Pakistan during 2012, linseed oil was used to replace shortening in standard cookie formula to check its stability and suitability in baked products. Cookies were prepared with five levels of linseed oil (0, 25, 50, 75 and 100%). Treatments effects were significant while storage effects were found non significant on physical characteristics i.e. width, diameter and spread ratio of cookies. The biscuits prepared from 100 percent linseed oil showed the highest width (279mm) and spread ratio (46.39), while maximum thickness (62.16mm)

was noted in standard shortening. The increasing levels of substitution of linseed oil increased proportionately cookie width (275.00 mm in control to 279mm in 100% linseed oil) and spread factor (44.24 in control to 46.39 in 100% linseed oil). There was a linear decrease in cookies thickness from 62.16mm (control) to 60.14mm (100% linseed oil) with increasing levels of substitution. Different levels of linseed oil substitution for cookies preparation and their storage depicted significant differences for moisture, fat and nitrogen free extract (NFE) contents while non significant differences were recorded for protein, fiber and ash contents. Maximum mean values for protein (7.81%), ash (0.63%) and fibre (0.22%) were recorded in cookies prepared from 50 percent substitution of linseed oil. The cookies prepared with standard shortening depicted maximum moisture (3.06%) whereas, maximum fat contents (25.18%) were recorded for cookies prepared from 25 percent replacement of shortening with linseed oil. However, the highest NFE values (65.57%) were recorded for cookies made from 75 percent substitution of shortening with linseed oil. The data further showed that moisture content increased while protein, ash, fat, fibre and NFE contents decreased with increased storage duration.

Keywords: *Linum usitatissimum*; vegetable oil; shortening; cookies; physicochemical characteristics; Pakistan.

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3. Rashid, F., T. Kausar, T. M. Qureshi, S. Hussain, M. Nadeem, A. Ainee and S. M. Zahra. Physico-chemical and sensory properties of orange marmalade supplemented with *Aloe vera* powder. *J. Agric. Res. Vol. 52(4): 561-568* (available online www.jar.com.pk).

Abstract: A study was conducted at the Institute of Food Science and Nutrition, University of Sargodha, Sargodha, Pakistan, to evaluate the effect of different concentration of *Aloe vera* (*Aloe barbadensis* Mill.) powder on physico-chemical and sensory properties of orange marmalade. All treatments (0, 2, 4, 6, 8 and 10% *Aloe vera* powder) were analyzed for titratable acidity, TSS, pH, moisture, fat, fiber and protein contents. The data indicated gradual increase in titratable acidity (0.08 to 0.18%), moisture (0.23 to 0.48%), protein (0.09 to 0.40%) and fiber (0.12 to 1.03%) among all treatments with increasing concentration of *Aloe vera* powder. However, a decreasing trend in pH (3.81 to 2.74), TSS (68 to 56 °Brix) and fat content (1.1 to 0.08%) was noticed with gradual increase in concentration of *Aloe vera* powder in orange marmalade. Sensory attributes like color, taste, texture, flavor and overall acceptability were found acceptable among all treatments but T₁ (2% *Aloe vera* powder) was liked most and T₅ (10% *Aloe vera* powder) was least appealing to the judges. It is concluded from present study that the addition of different concentrations of *Aloe vera* powder in orange marmalade significantly affected the physico-chemical and sensory properties of marmalade.

Keywords: Orange marmalade; *Aloe vera*; *Aloe barbadensis* Mill; physico-chemical characteristics; organoleptic properties; Pakistan.

Forestry

1. Azhar, M. F., M. T. Siddiqui, M. Ishaque and A. Tanveer. Study of ethnobotany and indigenous use of *Calotropis procera* (ait.) in Cholistan Desert, Punjab, Pakistan. *J. Agric. Res. Vol. 52(1): 117-126* (available online www.jar.com.pk).

Abstract: *Calotropis procera* is one of the most common shrub found in Cholistan desert and considered obnoxious due to its poisonous effects on livestock health. On the other hand, it is one of the most effective herbal medicinal shrub in the world. Present study was designed to assess the traditional use of this shrub by the local dwellers of Cholistan desert, Punjab, Pakistan and carried out during the year 2010 to 2012. A questionnaire was used to collect the ethnobotanical information from the locals (n=320) in sixteen randomly selected villages of Tehsil Yazman (part of Cholistan) in Bahawalpur district. Key informants, i.e., the local medicinal plant experts/ traditional herb healers (n=14) were interviewed. Data revealed that this shrub was used in 29 different ailments like wounds (75.9% by local dwellers & 50.0% by medicinal plant experts), snakebite (73.1% by local dwellers & 57.1% by medicinal plant experts), swellings (21.3% by local dwellers & 28.6% by medicinal plant experts) and veterinary ailments (13.8% by local dwellers & 14.3% by medicinal plant

experts). Study also showed that medicinal plant experts use this plant in curing even more number of diseases. Different plant parts were also sampled from the study site and analysed for different chemicals and medicinal attributes. All parts were rich in crude protein (maximum in flowers i.e., 21.69%), crude fibre (maximum in leaves i.e., 29.65%), carbohydrates as NFE (maximum in roots i.e., 67.88%), nitrogen (maximum in flowers i.e., 3.48%), ether extractable fat (maximum in leaves i.e., 7.61%), soluble phosphates (maximum in roots i.e., 0.06%) and potassium (maximum in flowers i.e., 0.86%). Presence of sufficient amount of secondary metabolite compounds (phenolics, flavonoids and alkaloids) enhanced its effectiveness as medicine.

Keywords: *Calotropis procera*; medicinal properties; metabolite compounds; ethnobotany; multipurpose uses; Cholistan desert; Punjab; Pakistan.

2. Ayyaz, F., K. Anjum, I. Qadir, W. Nouman, S. Afzal and M. Asif. *Best economic rotation of farm trees in tehsil Muzaffargarh. J. Agric. Res. Vol. 52(4): 569-579 (available online www.jar.com.pk).*

Abstract: A study was carried out in the Department of Forestry, University of Agriculture, Faisalabad during 2013 to determine the best economic rotation of three farm trees, *Dalbergia sissoo*, *Acacia nilotica* and *Albizia lebbek* in tehsil Muzaffargarh, Punjab, Pakistan. Five villages from whole tehsil were randomly selected. From each village, five plots each having an area of 5 acres growing with above three species were further chosen randomly. Thus a total of 25 plots with an area of 125 acres were sampled. From total 462 trees of all species, 120 trees of each species were randomly selected becoming a total number of trees 360. Maximum age of trees in case of all species was 6 years. So, 20 trees of each age (from 1 to 6 years) were selected, making a total of 120 for each single species. The data showed that farmers were following no specific rotation, but the age at which they mostly fell the trees was 2 to 5 years. Benefit cost ratio (BCR) and net present worth (NPW) were used as economic tools for calculating the best economic rotation. Three rotation options were tested viz. single rotation of 6 years, two successive rotations of 3 years each with total life span of 6 years and third option was two rotations, first of 4 years and second of 2 years with total span of 6 years. The best economic rotation for *Dalbergia sissoo* (BCR 301.72 and NPW Rs. 1503.64) and *Albizia lebbek* (BCR 295.89 and NPW Rs. 1474.48) was single rotation of 6 years, while for *Acacia nilotica*, two successive rotations of 3 years each performed better.

Keywords: Farm trees; *Dalbergia sissoo*; *Acacia nilotica*; *Albizia lebbek*; economic rotation; benefit cost analysis; Muzaffargarh; Pakistan.

Agricultural Engineering

1. Heydari, M. M., and H. R. Mehrzadegan. *Effect of baffles on the flow and hydrodynamics of settling basins: a review. J. Agric. Res. Vol. 52(1): 137-151 (available online www.jar.com.pk).*

Abstract: Settling basins are one of the most important and popular methods to remove suspended sediments from irrigation and drainage networks, power canals and wastewater treatment plants. In these structures, due to different velocity gradients, short-circuiting enlargement of dead zones and high flow mixing problems are caused by circulation regions (dead zones), which can reduce the optimal sedimentation of particles. A common approach to tackle these problems is to use baffles. This paper reviewed the research work on position and size of the baffles in settling tanks and their effects on the hydrodynamics and flow field. This review is a preliminary attempt to consolidate the information for future workers on settling basins.

Keywords: Settling basins; sedimentation baffles; hydraulic structure; position; hydrodynamics; velocity; turbulent; Iran.

2. Valipour, M., *Future of agricultural water management in Americas. J. Agric. Res. Vol. 52(2): 245-267 (available online www.jar.com.pk).*

Abstract: The study is aimed at estimation of area equipped for irrigation in Americas in 2035 and 2060 using study of agricultural water management during 1962 to 2011. For this purpose, all necessary information was gathered from FAO of United Nations and their values were checked using World Bank Group (WBG) data base. Among all presented data in FAO database, 10 indexes were selected for importance and more availability basis for all the regions in Americas and analyzed for all 5 regions in the study area. These indexes are; permanent crops per cultivated area (%), rural population per total population (%), total economically active population in agriculture per total economically active population (%), human development index (HDI), national rainfall index (NRI) (mm/year), value added to gross domestic product (GDP) by agriculture (%), irrigation water requirement (mm/year), percent of total cultivated area drained, difference between NRI and irrigation water requirement (mm/year), and area equipped for irrigation per cultivated area (%). The amount of area equipped for irrigation per cultivated area (10th index) was estimated for three different scenarios by the other 9 indexes. The results showed that trend of permanent crops per cultivated area (with the exception of Northern America), HDI, irrigation water requirement and percentage of total cultivated area drained is increasing and trend of rural population per total population, total economically active population in agriculture per total economically active population, value added to GDP by agriculture, and difference between NRI and irrigation water requirement is decreasing. The results also showed changes of area equipped for irrigation as 9.1 to 26.3% and 17.6 to 51.3% in 2035 and 2060, respectively.

Keywords: Agricultural water management; FAO; irrigation; macroeconomic policies; sustainable development; WBG data base; Americas.

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3. Chatha, Z. A., M. Arshad, A. Baksh and A. Shakoor. *Design and cost analysis of watercourse lining for sustainable water saving. J. Agric. Res. Vol. 52(4): 581-588 (available online www.jar.com.pk).*

Abstract: A study was conducted in the Directorate of Water Management, University of Agriculture Faisalabad, Pakistan during the year 2011. The objective was to compare the performance and cost of various alternatives for watercourse improvement. For this study three watercourses (5486-R, 114626-R and 116928-R) located at Shahkot distributory in Sheikhpura district were selected under different socio-economic conditions. The detail cost of material, labour, lining and earthen improvement of watercourses were calculated on annual basis. The average net return of water saving of higher cost improvement and lower cost improvement were compared. Average water flow rate at section A (head), B (middle) and C (tail) of water courses was calculated as 25, 22 and 19 lps, 61, 45 and 44 lps and 55, 47 and 38 lps for watercourse 5486-R, 114626-R and 116928-R, respectively. Average loss rate of water was calculated as 1.91, 3.08 and 2.51 lps per 100m length of watercourse. The annualized watercourse lining cost (annual initial cost of improvement + annual maintenance cost) of watercourse was found as Rs. 254, 245 and 216 per meter per year for 114626-R, 116928-R and 5486-R, respectively. The results revealed that lining is the best alternative for sustainable water savings as compared to earthen improvement and cleaning of watercourses.

Keywords: Design; cost analysis; watercourse; lining maintenance; cost benefit analysis; water saving; Pakistan.

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4. Chatha, Z. A., M. Arshad, A. Baksh and A. Shakoor. *Optimum length of lining for watercourse improvement using graphical approach. J. Agric. Res. Vol. 52(4): 589-595 (available online www.jar.com.pk).*

Abstract: The present study was carried out in Directorate of Water Management, University of Agriculture Faisalabad, Pakistan during 2011 to determine the optimum length of watercourse improvement. The research was conducted at three watercourses i.e. No. 116928-R, 114626-R, and 5486-R located at Shahkot distributory in Sheikhpura district. Graphical approach was used to find out the optimum length of watercourses by determining the channel using time along the entire length of watercourse. The optimum length of lining for watercourses depends upon the cost of improvement and net returns, as net return for lining exceeds its cost, the length of lining remains economically feasible. The average losses per 100 meter length in lined portion of watercourse No. 116928-R, 114626-R, and 5486-R were 2.51, 3.08 and 1.91 lps respectively. The optimum lining length was found to be 50, 55 and 49 percent of the entire length of watercourse 116928-R, 114626-R

and 5486-R, respectively. It was concluded that lining of watercourses may be extended more than 50 percent of the entire length. The study is helpful for additional lining of watercourses and choosing of cost effective approach for watercourse improvement.

Keywords: Watercourses; lining; water saving; cost; Pakistan.

Veterinary / Animal Sciences

1. *Pershotam, K., S. G. B. Hoffmann, M. Dilly and B. Bhutto. Immunohistological detection of androgen receptor in bovine placentomes during early pregnancy. J. Agric. Res. Vol. 52(2): 283-292 (available online www.jar.com.pk).*

Abstract: A study was conducted at Veterinary Clinic for Obstetrics, Gynecology and Andrology, Justus-Liebig-University, Giessen, Germany during the year 2009-10. In this study expression of androgen receptor (AR) in bovine placentomes during early pregnancy was investigated to identify the putative target cells (PTC) of placental androgens. For this purpose placentomes were collected from six healthy cows between 50 to 150 days of gestation at a local slaughter house of Giessen, Germany. These placentomes were assigned to two observational groups i.e. first and second trimester. An indirect immune peroxidase staining method was employed using the streptavidine biotin technique for signal enhancement following standard using a polyclonal primary antibody raised in rabbits against a peptide mapping at the N-terminus of the human AR was applied. Epididymal caput from a postpubertal bull was used as a positive control tissue. In bovine placentomes, irrespective from gestational age distinct to intense nuclear staining was observed in all invasive trophoblast giant cells located in the caruncular epithelium. Significant immune staining was also found throughout gestation in mature trophoblast giant cells (TGC) situated in the chorionic epithelium. This staining pattern suggests that AR expression is up-regulated during TGC differentiation. In bovine trophoblast cells the androgens and AR may be elements of an intracrine mechanism involved in the control of TGC differentiation and AR may be up-regulated by increasing androgen levels in differentiating trophoblast cells.

Keywords: Bovine; placentomes; androgen receptor; estrogen; pregnancy; Germany.

Agricultural Economics

1. *Sher, F., M. Hussain, S. Hassan, K. Bukhsh, M. M. Q. Baig and M. Q. Waqar. Comparison of economic return of approved and unapproved varieties of fine rice. J. Agric. Res. Vol. 52(1): 127-136 (available online www.jar.com.pk).*

Abstract: The study was conducted in Gujranwala and Hafiz Abad districts, Pakistan during 2010. Eighty six farmers were randomly selected from five Tehsils of Gujranwala and Hafizabad districts. Information about farms, farmers and varieties was collected using a well designed and pre-tested questionnaire. The objective of the study was to find reasons regarding growing unapproved varieties by farmers and their economic returns. Average yield for Basmati-515, Super Basmati and Indian variety was 4313, 3784 and 4544 kg/hectare, respectively. Average gross income per hectare for the respective rice varieties was Rs.127950, 114279 and 136345, respectively. The yields of Indian variety and Basmati-515 were comparable to some extent, but it was significantly higher than the Super Basmati. The reasons for higher yield and better income were better crop rotation followed by availability of tractors, availability of more canal and tubwell water, seed treatment and timely transplanting.

Keywords: *Oryza sativa*; cultivars; Basmati-515; Super Basmati; gross income; Gujranwala; Hafizabad; Pakistan.

2. *Yasin, M. A., M. Ashfaq, S. A. Adil and K. Bakhsh. Profit efficiency of organic vs conventional wheat production in rice-wheat zone of Punjab, Pakistan. J. Agric. Res. Vol. 52(3): 439-452 (available online www.jar.com.pk).*

Abstract: The present study was conducted at Institute of Agricultural and Resource Economics, University of Agriculture, Faisalabad, Pakistan during the year 2011-12. In this study profit efficiency of organic and conventional wheat production was compared by collecting primary data of crop year 2011-12 from districts Sheikhupura, Nankana Sahib and Gujranwalla. Profit efficiency of organic and conventional wheat farmers was calculated by stochastic profit function. Maximum Likelihood estimates (MLE) results of Cobb Douglas frontier profit function show that average profit efficiency of organic wheat farmers is 0.915 relatively higher than that of conventional wheat farmers (0.911). It indicated that organic wheat farmers are more profit efficient than conventional farmers. The results revealed that normalized price of other inputs caused significantly to lower the profit in both organic and conventional wheat farming with elasticities -0.238 and -0.327 respectively. The normalized price of irrigation contributes significantly to lower the profit in organic wheat farming with elasticity of -0.176, while, normalized price of labour lower the profit significantly in conventional wheat farming with elasticity of 0.349. The fixed factors play an important role in increasing profit but pest breakouts affect the profit negatively in both organic and conventional wheat farming. The results of inefficiency model indicated that education and experience in wheat farming significantly reduced the profit inefficiency in both organic and conventional wheat farming. The study suggests that profitability of both organic and conventional wheat farming can be enhanced by investing in education and strengthening the role of extension department.

Keywords: *Triticum aestivum*; organic farming; conventional farming; profit efficiency; Punjab, Pakistan.

Agricultural Extension

1. *Ata, S., B. Shahbaz, I. A. Khan and M. Iftikhar. Role of date palm in livelihoods of farmers of marginal areas: a case study of south Punjab, Pakistan. J. Agric. Res. Vol. 52(3): 453-462 (available online www.jar.com.pk).*

Abstract: A study was conducted to explore the role of date palm in improving livelihoods of farmers in Dera Ghazi Khan district of South Punjab at the Institute of Agricultural Extension and Rural Development, University of Agriculture, Faisalabad, Pakistan during the year 2010-11. For this purpose structured interview schedule was prepared to collect quantitative data from randomly selected respondents whereas qualitative data was collected through key informant interviews. The results indicate that most of the trees in study area were in scattered pattern. Moreover, no or little attention was paid by the farmers regarding production technology and marketing potential of date palm. The data showed that date palm was the third major source of income for 62.5 percent of respondents. About 76, 72.5 and 67.5 percent of the respondents prepared bed frames, mates and manual fans, from date palm, respectively for household purpose while 45, 33.3 and 33.3 percent of respondents prepared these items for commercial purpose. The usage of a wide range of both commercial and household date palm products in the study area was found which indicates the considerable role of date palm in sustainable livelihoods of farmers.

Keywords: Date palm; farmers; natural capital; poverty; sustainable livelihoods; South Punjab; Pakistan.

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2. *Asif, M., S. Ali, M. Ahmad, T. Ali, M. Luqman and U. Safdar. Analysis of physical constraints affecting the efficiency of public extension agents in cotton Zone of Punjab. J. Agric. Res. Vol. 52(3): 463-470 (available online www.jar.com.pk).*

Abstract: A study was conducted at Institute of Agricultural Extension and Rural Development, University of Agriculture, Faisalabad, Pakistan, during the year 2011 to analyze the effect of physical constraints on efficiency of public extension agents in cotton zone of Punjab, Pakistan. All Agriculture Officers and Field Assistants working in Bahawalpur and Rahim Yar Khan districts were constituted as populations of the study. Study samples of all 27 Agriculture Officers (AOs) and 120 randomly selected Field Assistants (FAs) were drawn and interviewed through pre-tested interview schedules. The results revealed that physical constraints like lack of vehicles, internet facility, mobile phone and extension audio/video aids affect the efficiency of extension workers from an average to a great extent. The data depicted that lack of vehicle, mobile phone, audio aids, visual aids, computer and internet connections is affecting working efficiency of extension workers

with mean values of 2.64, 2.04, 1.73, 1.81, 2.72 and 2.56 and standard deviation of 0.49, 0.45, 0.53, 0.57, 0.46 and 0.51, respectively. The study revealed that, it is irrational to expect an efficient work from public extension agents without equipping them with modern and requisite physical facilities. It is recommended that government should immediately support extension field staff with provision of physical facilities for efficient extension implementation and execution at grass root level.

Keywords: Extension work; physical constraints; efficiency; extension agents; cotton zone; Punjab, Pakistan.

3. *Safdar, U., B. Shahbaz, T. Ali and S. Ali. Impact of climate change on agriculture in north west Pakistan and adaptation strategies of farming community: a case study of Kaghan valley. J. Agric. Res. Vol. 52(4): 597-606 (available online www.jar.com.pk).*

Abstract: Agricultural production is susceptible to weather and climate. Pakistan is also facing the severe impact of climate change which results into floods and low agricultural production. Hilly and mountainous regions of Northern Khyber Pakhtun Khwa (KPK) province are more vulnerable to climate change. However, little information is available on the impact of climate change on agriculture in the mountainous regions of KPK. This paper illustrates the impact of climate change on agriculture in the Kaghan Valley. A study was conducted in the Institute of Agricultural Extension and Rural Development, University of Agriculture, Faisalabad during the year 2012. Kaghan Valley of district Mansehra of KPK, Pakistan was selected as study area. The respondents were selected through multistage random sampling. The results showed that majority (65.8%) of respondents belonged to middle age (35-50 years). The education level of respondents was low as more than half (55.83%) of them were found illiterate. The results showed that the most significant impact of climate change was high temperature (M=3.85), high rate of precipitation (M=3.75), pattern of rainfall and temperature (M=3.75), deforestation (M=3.61) and floods (M=3.51). A large majority (67.5%) of respondents started cultivating multiple crops as adaptation strategy against climate change. It is recommended that heat and moisture tolerant varieties should be introduced to conserve agriculture against the drastic impact of climate change. There is need of creating awareness among the people for their capacity building to cope with climate changes. Alternate source of fuel must be provided to the people to conserve forest and ultimately to reduce impacts of climate change.

Keywords: Adaptation strategy; agriculture; climate change; Kaghan; Pakistan.

4. *Saghir, A., K. M. Chaudhary, M. Sharif, R. Aftab, I. Ashraf and S. Ali. Gender and information gap in large and small ruminants with special context of neonatal care. J. Agric. Res. Vol. 52(4): 607-614 (available online www.jar.com.pk).*

Abstract: Neonatal care is a neglected area in livestock production sector. Future generation is based on the care of calves/ kids of large and small ruminants. Although, women involvement in livestock activities ranges from 60-90 percent but not well equipped with technical knowledge for calf care and management. A study was conducted in the institute of Agricultural Extension and Rural Development, University of Agriculture Faisalabad, Pakistan during the year 2009-10. The objective was to find out gender and information related gap regarding neonatal care of large and small ruminants in District Okara, Punjab, Pakistan. The results revealed that majority (67.1%) of respondent's maintained 1-4 number of calves and 0-1 number of kids. Small number of respondents were aware of cutting/disinfecting of naval cord and other related practices of calf care. An overwhelming majority (99.4%) fed the calf through mother. About one fourth of respondents claimed about diseases such as HS, Enterotoxaemia and sheep pox. One-third of respondents (31%) utilized TV to get information. Lack of training, less availability of veterinary services and lack of cooperation of Livestock Department were the major factors hindering the neonatal care. It is suggested that female farmers should be trained by government to raise their information level to enhance the production of calves through neonatal care.

Keywords: Gender; information gap; calf neonatal care; large and small ruminants; Pakistan.

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