Certification of organic fodder production at IGFRI

A programme on organic milk production was started at Indian Grassland and Fodder Research Institute, in 1996, wherein 4.5 ha of conventional land was brought under organic fodder production. The organic fodder production programme followed the National Programme for Organic Production standards (considered equivalent to Council Regulation (EEC) no 834/2007 and Swiss Organic Farming Ordinance for Plant products originating in India) under constant supervision of the certification agency, SGS India. Periodic audit as laid down in the certification process was done by SGS India during the last three years. After the latest audit done in 2010, the fodder production programme was certified as organic fodder vide Certificate No is IN10318, under SGS Organic accreditation no NPOP/NAB/009.

The programme was launched to develop protocol for organic milk production under Indian conditions. A multidisciplinary team of scientists from different disciplines like agronomy, soil science, soil microbiology, organic chemistry, animal nutrition, breeding and livestock production management are involved in this project. 4.5 ha of conventional land has been taken under organic fertilization using organic biofertilizer like FYM, Vermicompost and green mulching following NPOP standards. Analysis have been done on soil, water and all other resources for their quality and residue levels. Indigenous milch breed of cattle like Sahiwal, Gir and Tharparkar have been taken in the project. A simultaneous control has also been taken in which conventional fodder production practices as well as animal rearing is being followed to compare the organic and conventional systems.

Crop rotation under organic fodder production
Round the year feed and fodder was ensured to the milch animals by adopting the different crop rotation in different plots: viz. Maize + Cowpea- Maize- Berseem (R1); Sorghum (multicut)- Sorghum- Oat (R2), Guinea grass- Guinea grass+cow pea- Guinea grass+Berseem (R3) and for grain with fodder Jowar- Jowar-Barley (R4) starting from Zaid followed by Kharif and Rabi.

The fodder production from organic fields was higher as compared to inorganic system in all the cropping patterns viz. R1 (234.5 vs 187.3 t/ha); R2 (200.1 vs 143.3 t/ha); R3 (97.5 vs 96.6 t/ha) and R4 (92.5 vs 51.2 t/ha). Total DM yield was also 10-15% higher under organic than inorganic system. Following all the recommended standards, the fodder production programme at IGFRI is now certified as organic fodder in conversion (IC-2) for maize fodder, jowar fodder, oat fodder, berseem fodder, barley straw, barley grain and mustard. Upon certification of fodder produced as organic, efforts are now concentrated towards producing certified organic milk.
Rise in fodder prices pushing up the cost of milk

Forage based feeding system is essential for efficient livestock production because over 60% of the cost of milk production is accounted for by the feed cost. In the recent years there has been a steep rise in milk price across the country. ‘Down To Earth’ magazine has published in June 16-30, 2010 issue, a country wide survey to determine cause of spiralling price of milk. The magazine says that India’s fodder crisis is making milk costlier. There is a huge gap in demand and supply of fodder for livestock. According to IGFRI estimates, by 2020, the country will require 850 million tonnes of green fodder, 520 million tonnes of dry fodder and 90 million tonnes of concentrates. A number of reasons have been attributed to the widening of demand-supply gap which include use of combine harvester, burning of crop residues in the field, switching over from cereal crops that yield fodder to non cereal crops which are more remunerative etc.

IGFRI has been raising the issues at different forum which has held back the livestock sector to realize its potential. The area under fodder production has remained stagnant over the years in spite of increase in number of livestock. The budgetary allocation for fodder production programme is meagre and even that remains unutilized in many states because the administrative infrastructure for fodder development programme is almost nonexistent. In the 11th Five Year Plan, Rs. 4,903 crore were allocated to Animal Husbandry. Of this, only 2.88 percent was allocated for feed and fodder. In the 10th Plan, expenditure on fodder by 22 States ranged from 0.09 percent to 6.63 percent of the total allocation. There is no reliable database on feed and fodder availability and use, to formulate an effective plan for fodder development in the country. Since last few years, IGFRI has been advocating the involvement of NSSO in this process. Another reason which has held back the productivity of forage is the lack of availability of quality fodder seeds. For this IGFRI has been emphasising the need for roping in the National Seed Corporation for production and distribution of seeds of forage crops.

The development of common property resources for improved productivity by involving local institutions also need to addressed through technological interventions and social fencing. In fact, investing in CPRs is a way to support the landless livestock production system from which a large number of people derive their livelihood. A healthy interaction between forest officials and livestock keepers is also required to avoid conflict and allow sustainable use of forest grasses.

Peri urban livestock production also need quality feed at cheaper rates so that the consumers get milk at affordable price. For them the Complete Feed Block technology developed by IGFRI and other Institutes will be of great help because of ease of transport and providing ration to the animals commensurate with their production levels.

We need to address the issue of spiraling milk price across the country which has badly affected the common man in the recent years. We need to encourage forage based feeding system which decreases the cost of milk production. The bottlenecks that restrict the production and productivity of forage need to be removed by increasing the budgetary support, improving institutional infrastructure and taking up fodder production programme on a large scale.

(KA Singh)
Director
India’s fodder crisis is making costlier

Down To Earth in its recent issue (June 16-30, 2010) has investigated the reasons behind the steep rise in milk price in recent years. It stated that between January 2007 and March 2010 the price of milk rose seven times in Delhi. In the past one year, prices went up from Rs 17 to Rs 22 a litre. On a year-on-year basis, the inflation in milk was 21.12 per cent. There is a gap of 1.8 million tonnes (MT) between demand and the current milk supply according to Shri Sharad Pawar, Union Minister of Agriculture. Ms. Ravleen Kaur, the correspondent says that India’s fodder crisis is making milk costlier. According to NABARD Consultancy Services, there is a 36-57 per cent gap between demand and supply of fodder in the country. The 10th Five Year Plan projected the demand for green fodder in 2010 to be 1,060 MT. A number of reasons have been attributed to the widening of demand-supply gap which include use of combine harvester, burning of crop residues in the field, switching over from cereal crops that yield fodder to non cereal crops which are more remunerative etc. “As the stall-fed dairy owners find it difficult to feed their livestock, pastoral dairy farmers’ battle for survival is becoming increasingly bitter.” According to National Forestry Action Programme of the Ministry of Environment and Forests, around 60 per cent of the livestock (about 270 million heads) graze in forests; this is nine times the carrying capacity of 30 million animals. In Gujarat, the famed grasslands of Banni in Kachchh have been taken over by the weed Prosopis juliflora which has destroyed the natural grasses growing abundantly earlier. The magazine has also quoted Dr. K.A. Singh, Director IGFRI highlighting several measures that need to be taken to augment the forage resource availability in the country. Export of oil cakes have also been implicated in creating a deficit of quality feed for milk producing animals.

Development of Bt transgenic lucerne

Towards development of Bt transgenic lucerne plants for weevil resistance, apical bud along with part of cotyledonary leaves and hypocotyl from in vitro grown seedling was used as explant for Agrobacterium-mediated genetic transformation with synthetic Bt cry6 gene. Co-cultivated explants were cultured on MS medium supplemented with hygromycin (50 mg/l) and BAP (1.0 mg/l) + TDZ (2.0 mg/l) for selection of transformed cells and multiple shoot induction from the surviving explants. Regenerated shoots were rooted on MS medium containing NAA (2.0 mg/l). Plants with well developed shoot and root (Fig. 1A) were hardened and transferred to soil in pots. The putative transgenic lucerne plants (Fig. 1B) were grown under controlled environmental conditions.

Four cry6 gene-specific primers were used for PCR screening of the putative transgenic plants. Agarose gel (1.5%) electrophoresis showed PCR products of expected size in case of putative Bt transgenic plants (T1 & T2) and plasmid (P) control but not in non-transgenic (NT) lucerne plant (Fig. 2). Among 25 putative transgenic plants, 11 were found positive for the cry6 gene. Further molecular characterization by Southern hybridization, Western and ELISA would be required to confirm stable integration and expression of the Bt gene in transgenic lucerne plants.
The division of crop improvement came into existence in the year 1996, when the erstwhile divisions of Plant Improvement, Plant Protection and Plant Physiology & Biochemistry were merged. The parent division of Plant Improvement was established in the year 1967. The division presently has sixteen scientists representing disciplines such as Breeding, Genetics and Cytogenetics, Plant Pathology, Plant Physiology, Plant Biochemistry, Entomology and Nematology.

Mandate
- Collection, evaluation, characterization, documentation and conservation of forage genetic resources.
- Development of high yielding nutritive varieties, tolerant to biotic and abiotic stress suitable for different agro-climatic conditions.
- Basic Research relevant to forage crop improvement.

Spectrum of research activities
Presently, eight theme based projects are running in the division. Besides these, a number of externally funded projects by various agencies; ICAR AP Cess scheme, NATP, DBT, DST, NFBSR, National Biodiversity Development Board, Department of Animal Husbandry are running/ completed in the division. The division has also successfully completed two collaborative projects with UK and Australia. Adequate facilities exist in the various laboratories. A mid term storage module for active forage germplasm is in place. More than 15 ha land is available with this division at Central Research farm for conducting research in arable and non arable situations.

Research achievements
Over the past four decades, the division has developed superior varieties in cultivated fodders and range grasses suited to various agro-climatic zones, and identified suitable parents for desirable genes/trait.

Plant genetic Resources
6782 accessions of indigenous and exotic germplasm have been collected, evaluated and conserved for providing base material in the varietal development programme of cultivated and pasture/range species.

Novel genetic stocks registered
* Pennisetum pedicellatum new cytotype - Octoploid (2n=8x=72) INGR 06018; Pennisetum squamulatum new cytotype (2n=56) INGR 06017; Panicum maximum ploidy series comprising of triploid (INGR 09039), tetraploid (INGR 09040), pentaploid (INGR 09041), hexaploid (INGR 09042), Octoploid (INGR 09043), nanoploid (INGR 09044); Pentafoliate mutant in Berseem (INGR 09045); Pennisetum glaucum Tetraploid male sterile line (INGR 09046) and its maintainer (INGR 09047).

Plant Genetic resource – Documentation
Germplasm catalogues have been developed after field evaluation and characterization of Teosinte, Maize, Cowpea, Berseem, Oats, Guinea grass, Stylosanthes, Siratro, Cenchrus and Pennisetum pedicellatum. Forage crop descriptors have also been developed in Dichanthium and Berseem

Plant breeding
The multidisciplinary efforts have resulted into development of superior varieties in important forage species suited for different situations and released after multi-locational trials. A number of such materials are also at different stages of testing prior to their release.

Varieties Developed in cultivated Forages and Range Grasses
Berseem- Wardan, Bundel Berseem 2, Bundel Berseem 3; Lucerne- Chetak; Cowpea-Bundel Lobia 1, Bundel Lobia 2; Guar; Bundel Guar 1, Bundel Guar 2, Bundel Guar 3; Field bean- Bundel Sem 1; Oats- Bundel Jai 822, Bundel Jai 851, Bundel Jai 991, Bundel Jai 992; Cenchrus- Bundel Anjan 1, Bundel Anjan 2; Dinanath grass- Bundel Dinanath 1, Bundel Dinanath 2; N. B. hybrid-Swetika, DHN-6; Bajra- DRSB –2, AVKB-19; Guinea grass- Bundel guine 1, Bundel guinea 2; Sehima- Bundel Sen Ghas 1; Chrysopogon- Bundel Dhawali Ghas-1; Heteropogon- IGHC-03-4.

Cytogenetics
- Tetrhaploid (2n=4x=36), Hexaploid (2n=6x=54) and Aneploid (2n=6x-1 = 53), cytotypes have been identified in Pennisetum pedicellatum. The productivity traits showed an increase with increase of ploidy level. A new perennial race has been found to be an octoploid (2n=8x=72).
- Species relationships have been worked out in Atylosia-Cajanus complex. Trispecific hybrids have been raised.
- Incorporation of desirable traits from wild Avena macroccana and A. sterilis, to cultivated A. sativa has been achieved through amphiploid and backcross breeding.
- Induced tetraploid lines have been established in berseem.
- Basic research on apomixis In Panicum and Pennisetum agamic complex.
- Species relationship based on morphology, cytology, biochemical parameters and Incomptability worked out in Trifolium.

Plant protection
- Status of pests and diseases was identified in cultivated leguminous, cereal forages and range species etc. Extents of quantitative losses due to pests have also been determined.
- Sources of resistance in major forage crops like in cowpea for root rot, leaf hopper, yellow mosaic virus, anthracnose; in Lucerne for downy mildew, rust, aphid and weevil; in Berseem for root and stem rot; Sorghum for leaf diseases and shoot fly; in cluster bean for leaf blight have been identified.
- Evolved pest and disease management strategies in major forage crops with main emphasis on cultural, biological methods, botanicals and chemical seed treatments.
Further, integrated pest management has been worked out for different systems.
- Isolated and identified native strains of biocontrol agents for Fusarium, Rhizoctonia and Macrophomina.
- Impact of weather variables on the development of diseases and pests.

Plant physiology and Biochemistry
- Drought tolerant strains/varieties of oats have been identified.
- Dichanthium annulatum, Stylosanthes scabra, Chloris guyana and Avena strigosa were found tolerant to salinity.
- Molecular markers identified for drought tolerance in Stylosanthes.
- Drought tolerance in receding moisture studied in Sorghum.

Biotechnology
- Regeneration protocol for raising plants from tissue culture has been developed in Cenchrus ciliaris, Dichanthium annulatum, Panicum maximum, Trifolium and Medicago sativa.
- Development of lines tolerant to salinity and identification of associated molecular markers in oats -The resistant and susceptible lines identified. Crosses developed using susceptible and resistant lines. SSR and CISP markers showing polymorphism among parents identified.
- Identification of QTLs for the Genetic Improvement of Stover Quality and Resistance to Foliar Diseases in Dual Purpose Sorghum.
- Development of SSR markers in berseem - 320 SSR sequences and 75 validated.
- Use of molecular markers in improvement of Stylo with special reference to quality and drought -Lines of S. scabra and S. sordida cv seca found drought tolerant. S. seabrana showed better nutritional characteristics like sulphur containing amino acids. Molecular marker like STS utilized in identifying nine new lines of S. seabrana.
- Genetic transformation of Lucerne for weevil resistance - Protocol for regeneration and genetic transformation developed. Bioassay for Bt genes (Cry 3 A, Cry 1a 5, synthetic Cry 6) revealed all three to be effective against weevil. Regeneration of Bt (Cry6) transgenic Lucerne plants done.

Visits Abroad
A number of scientists visited various parts of the world such as USA, UK, Australia, China, Netherlands, Japan, Germany and Egypt under scholarships, training, fellowships, exchange programs or represented Institute in International Symposia and Seminars in the field of Forage Improvement.

Technologies Developed
The division has developed a number of varieties of fodder crops suitable for different agro-climatic situations of the country. The division has also developed the technologies for pests and disease management. Some of them are:
- Aqueous Neem seed kernel extract at 3 per cent and oil suspension at 2 per cent were effective for the management of rangeland grasshoppers.
- Application of Neem cake as soil amelioration @5g/ha reduced the nematodes: Meloidogyne, Tylenchorhynchus and Pratylenchus population from 10 - 40 per cent in sorghum + cowpea, berseem + Japan sarson, maize + cowpea forage production system.
- In a year round fodder production sequence of cowpea + maize- cowpea + sorghum- Berseem, the pests and diseases could effectively be controlled with application of neem cake @ 15g/ha at the beginning followed by seed treatment with carbendazim @0.2% + Thiram @0.25% in all the crops and the need based spray of neem seed kernel extract at 3%.
- In sorghum + Cowpea and maize + Cowpea intercrop, pests and diseases can be managed by seed treatment with T. viride @5 g/kg seed + FYM @ 4 tonnes/ha + spray of 3% NSKE after 30 and 45 DAS.
- Berseem root rot can be managed by seed treatment with NSK powder @ 50 gms/kg seed + foliar spray of 3% NSKE or soil application of T. harzianum @ 2.5 kg + 62.5 kg FYM.

Honours and Awards
- DBT Indian Biotech Overseas Associateship awarded to Dr A K Roy, Dr D R Malaviya, Dr P Kaushal.
- DST BOYSCAST fellowship awarded to Dr P Kaushal.
- NAAS Associateship to Dr P Kaushal.
- INSA Fellowship awarded to Dr Amresh Chandra.
- Guman Devi Verma best woman scientist Award - awarded to Dr Shamila Roy.
- ICAR Team Research Award - for forage improvement programme with emphasis on biotic and abiotic stress was conferred to team of scientists: Dr A K Roy, Dr D R Malaviya, Dr P. Kaushal, Dr A Chandra, Dr R N Choubey.
- Indo - US Knowledge Initiative - Dr Suresh Kumar.
- NAAS Fellow- Dr A K Roy, Dr. A. Chandra.

Publications
Since last twenty five years, the division has to its credit more than 516 research papers (in National & International journals); 367 abstracts in national or international seminars/ symposia; 13 book chapters; 70 popular articles and three bulletins. National Guidelines for DUS testing in forage crops - Lucerne and Berseem and Nucleus and Breeder seed production in Berseem and oats have been developed.
Berseem root-rot—spreading in new regions

Until now, root-rot disease of berseem was reported to be confined to northern and central belt of the country where it is very popular and widely grown during winter season. In these regions since the disease starts appearing during mid of February and reach to its maximum level generally during early April. The optimum thermal requirement for disease development is obviously perceived to be a temperature range of 30-40°C.

Recently, severe incidences of this disease were frequently observed at MPKV, Rahuri and Urulikanckan in Maharashtra state and also in the farmers’ field of adjoining areas. Berseem is being adopted by the farmers in these areas and has performed well. A close examination of the disease revealed similar fungal pathogens Rhizoctonia solani and Fusarium semitectum reported from the north and central region. Analysis of nematode community also revealed the variable degree of occurrence of cohabiting major nematode fauna viz., Tylenchorhynchus, Pratylenchus, Meloidogyne and Helicotylenchus spp. Temperature in this region during winter season remains comparatively high indicating that the disease is well adapted to varying climatic conditions or the pathogens may be of a different physiological strain. The progressive spread of the disease could be due to introduction of berseem cultivars in new agro ecological zones. Since root-rot disease of berseem is a major limiting factor in optimizing the forage production, it requires immediate attention for successful management and to prevent further spread of this economically important disease. Berseem growing farmers are advised to follow the crop rotation for minimizing the establishment of pathogen in the fields.

(R B Bhaskar, N Hasan and K C Pandey)

Flowering behaviour in Guatemala grass (Tripsacum spp.)

The Guatemala grass, is a native of Mexico and Central America which has been introduced in many warm countries including India for use as fodder. It is suitable for grazing, cut and carry system and making hay and silage. The CP content is 5-14% and IVDMD 47-65% and is extremely palatable when fed young. Rooted slips of Guatemala grass was established at IGFRI, RRS, Saidhapur farm (15°27’ N latitude and 75°15’ E longitude) to study flowering behaviour for the possible use in breeding programme. During the growth period, the average maximum temperature was 30°C and minimum temperature was 18°C with a mean RH of 76 %. Observations regarding vegetative growth were recorded. The boot leaf formation was noticed in the 2nd week of October and by 4th week of October, 28-30 cm long inflorescence of emerged. The inflorescence is a subdigitate panicle comprising of 6 racemes, terminal and internodes with axillary inflorescence of 2-3 racemes. The top 2/3rd of the racemes consists of 40-44 unisexual awnless male spikelets and the basal one third of raceme is inserted alternately by 8-10 female (pistillate) spikelets.

The staminate flowers are not open until 2nd week of November and subsequently dried completely. However with the onset of winter in the 3rd week of November few basal spikelets in the raceme started opening up and the anthers came out. The pollen fertility was observed only 10-12%. The chromosome number of the species varied from diploid (2n = 2x = 36) to triploid (2n = 3x = 54), tetraploid, pentaploid and hexaploid. Diploids reproduce sexually and polyploids are facultative apomictic. Tripsacum is closely related to maize and can hybridize with it or the vice versa (de Wet and Harlan, 1974, Leblanc et al. 1995a; Jatmiliansky et al. 2004). The F1 of the direct crosses are generally sterile. The flowering behaviour observed in Tripsacum spp. could be exploited under breeding programmes for improvement in fodder maize.

(S Karthigeyan, K Sridhar, Vinod Kumar, Nagaratna Biradar and U P Singh)
Isolation, purification and characterization of Gloecercospora sorghi on culture media

Zonate leaf spot is one of the most important diseases of sorghum. The disease is caused by Gloecercospora sorghi Bain and Edgerton belongs to family Tuberculariaceae of order Moniliales. The pathogen is very difficult to isolate and purify on culture medium and hence colony characters was not characterized properly. Due to lack of culturing techniques, the artificial inoculation techniques have not been developed so far. Several attempts were made to isolate and purify G. sorghi in different synthetic and semi-synthetic culture medium with manipulations in temperature and light but failed. The standard host extract medium prepared from sorghum grain extract agar, sorghum grain meal agar, sorghum leaf extract agar, oat meal agar and potato dextrose agar were also tested but failed to isolate the pathogen. Finally the pathogen was isolated by reducing the agar content from 2% to 0.8% on sorghum grain meal agar and sorghum grain extract agar medium. The pathogen hyphae moved from tissue to medium slowly and sparingly on this semi solid medium. The hyphae was carefully transferred and purified by hyphal tip method on oatmeal agar, where it grew easily sporulating at 28-30°C under day light conditions. The pathogen was not able to grow on potato dextrose agar medium. Initially, the colony was white but later on became dull white. The colony was regular, smooth, slightly fluffy, with circular zonations and rhythmic growth with numerous salmon coloured sporodochia which later on become dark. The full plate growth was observed after ten to twelve days of incubation. Gradually mycelium become scanty and colony converted into pink to salmon pink colored slimy matrix of sporodochial mass. Sporidochia is some time pleurogenously and formed on outer peripheral zone of colony. Sporodochia formed uniformly in circular zone (Fig.1) which consisted of hyaline, simple, aggregated dense, short conidiophores (Fig.2). Conidia developed on swollen apices of conidiophores as long, filiform, sepiate, mostly curved and tapering on apex (Fig.3). A great variation was observed in size and number of septa in conidia of G. sorghi. The number of septa varied from 3 to 20. The pathogenicity was confirmed by detached leaf inoculation technique and culture was re-isolated from the inoculated host.

(K K Pandey, P Saxena, R B Bhasker, D Bahukhandi and P K Tyagi)

April–June 2010
On the occasion of ‘World Environment Day’, one day bio-safety training entitled, “Environmental Safety for Safe & Sustainable Research” was organized by Human Resource Development and Institute Bio-safety Committee on 5th June, 2010. The inaugural session was chaired by the Director, IGFRI. The training was attended by 26 participants including research fellows, research scholars, technical officers and scientists from IGFRI and NRCAF. The emphasis of the training was to save the environment for safe and sustainable research. Trainees participated in pre-disposal treatment of materials containing Ethidium Bromide (EtBr). A substitute of EtBr (i.e. SafeView™; Nucleic Acid Stain) was introduced to them. The trainees were provided with ‘Biological Safety Manual’ compiled by Dr. Suresh Kumar. The year 2010, being celebrated as International Year of Biodiversity, the training also emphasized on the need for environmental and biological safety for conserving biodiversity.

**Visits**

A visit was conducted on June, 18, 2010 for 30 farmers sponsored by Department of Agri, Mahoba, UP.

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**Vivran Heta Utram Apani Bijj**

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<td>Date: 0510-2730666 Fax: 0510-2730833 E-mail: <a href="mailto:igfri@igfr.ernet.in">igfri@igfr.ernet.in</a>;<a href="mailto:igfri_jhansi@yahoo.co.in">igfri_jhansi@yahoo.co.in</a> Website: <a href="http://igfri.ernet.in">http://igfri.ernet.in</a>; <a href="http://www.igfri.org">http://www.igfri.org</a>; Laser typeset by Xpedite Computer Systems, D-20, 2nd Floor Ranjith Nagar Commercial Complex, New Delhi 110 008 and printed at M/s Print Process, 225 DSIDC Complex, Okhla Industrial Area, Phase I, New Delhi 110 020</td>
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