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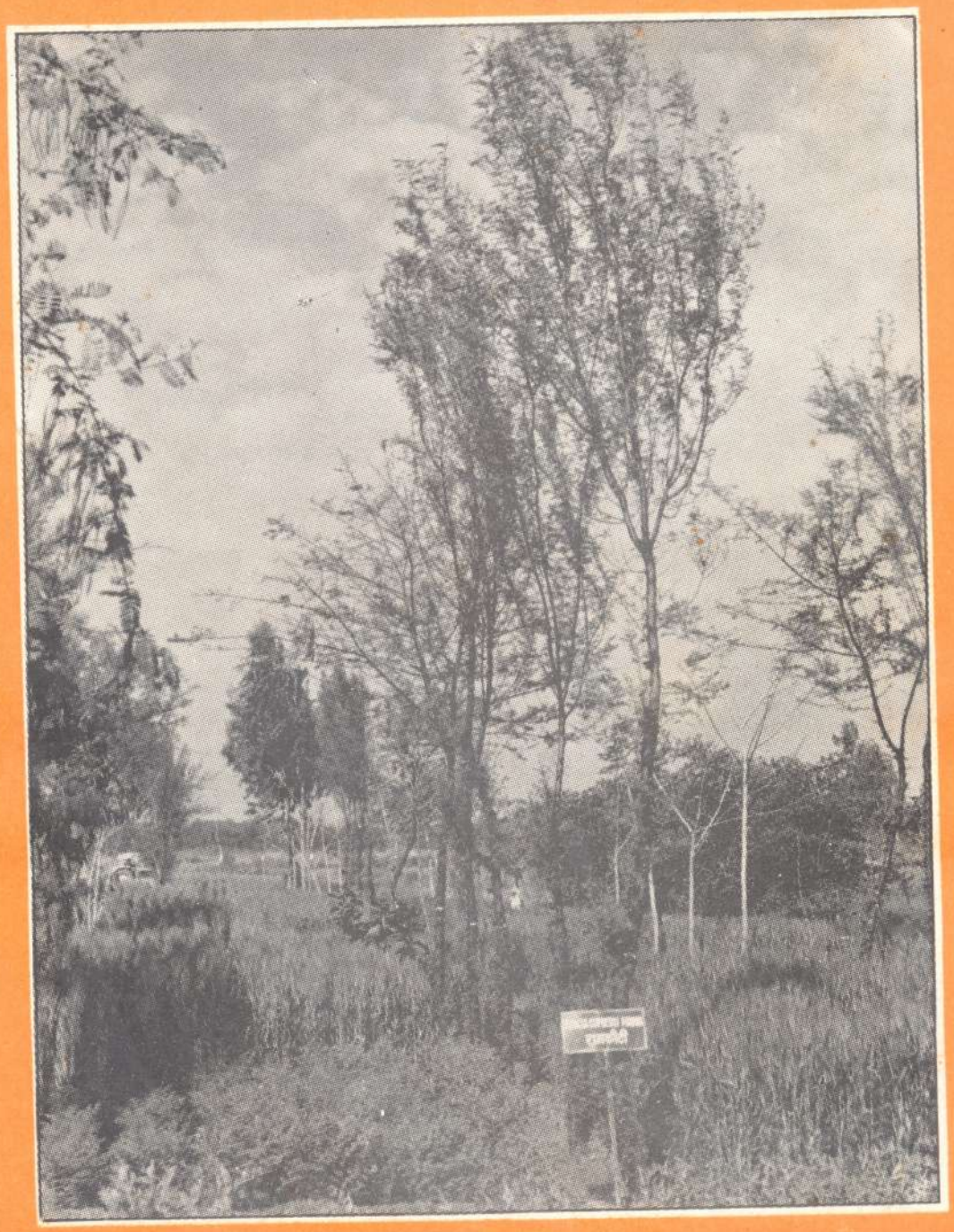

National Research Centre for Agroforestry Jhansi - 284 003 (India)

TREES, AGROFORESTRY AND ENVIRONMENTAL PROTECTION

In order to meet the demand of our ever increasing human and livestock population of 860 and 465 m, respectively India has to produce foodgrain, green and dry matter and fuelwood to the tune of 250, 2085 and 340 m.t. respectively besides 65 m M^3 of timber by 2000 AD as by that time its human and livestock population would be around 1 billion and 600 m, respectively. Green revolution thrust given to meet the food production has resulted in more and more of marginal and submarginal and other wasted land put to arable farming which caused further degradation of these lands resulted in huge loss of precious soil and minerals. Drastic reduction in the forest cover and destruction of woody vegetation from the landscape is causing enormous harm to our environments which is also influencing the agricultural production. Present forest cover in our country is about 1/2 of the national target of 33% geographical area under tree cover.

Environment literally means what surrounds us and the surrounding consisting of both organic and inorganic elements which falls in two categories; i) natural environment consisting of physiography, climate, vegetation, soil, water bodies, wild life etc. and ii) human environment comprising of all elements given human touch in the origin including all manifestation of human activities. Environment is now a catch word almost every where and environmental protection today is the concern all over the world. The recent United Nations Conference on Environment and Development held at Rio De Genairo further emphasises needs for protecting our environments and make us all conscious about our degrading environment. In the recent years emphasis is not just survival of life it is the good quality of life which is only possible through a balanced environments. Although the conception is that wealth was major base for good quality life that we borrowed from the west continued to dominate in our social thinking but it is gradually fading away with the awareness about the environment. We are aware that the life saving gas, the oxygen we breath comes from the plants and the carbon dioxide we breath out to the environment is absorbed by the plants and thus the environment is self cleaning system and balance is maintained under normal condition. During the burning of fuel for the last 100 years or so about 240,000 m.t. of oxygen was exhausted and 360,000 m.t. of carbon dioxide is discharged to the atmosphere which has led to high CO_2 content and oxygen deficiency in the air.

The basic reason for ecological crisis is our country's indifference to the nature and our easy adaptability to neglected environments. Although technology advancement if on the one hand has bettered human life it has sharply intensified the pollusion of environment and pose severe threats to our future generation on the other hand. If we consider the examples of big cities of India like Delhi, Calcutta, Bombay, Kanpur etc. we know that lot of advancement has been made in these cities in industrial and other spheres but at the same time the environmental pollusion has been highly intensified not only because of the presence of the resultant pollusion from the industries but also because of large number of people brought in due to industrialisation and other development in the cities. Similarly, over utilisation of natural resources like forest, land and water etc. has resulted further degradation of the environment. It is not only in the industrial sector but even on the agriculture sector also the high yielding varieties with high resource input and emphasis on monoculture without giving sufficient attention on ecological aspect has also led to the environmental crisis. There is hardly any dispute that at this juncture there is an acute need to develop ecological and integrated approach for over all development. It has also been realised that to save our environment from further degradation we have to grow more and more trees and other perennial vegetation. We are also aware that we will have to achieve our national targed of 1/3 area under tree cover but the question arises how we are going to achieve this target . To cover 1/3 area under forest cover is a huge and very difficult task and may be beyond the limit of the government and other few non-government organisations unless every

individual whether rural or urban realise its importance and take responsibility, help in achieving this national target.

Under the circumstances we have hardly any alternative but to introduce suitable MPTS under various Agroforestry systems in the marginal and other wasted land but also in the cultivated area which will help us not only to achieve this national target but can also help us in solving increasing demand of food, fodder, fuel and timber and at the same time protect our environments. If all of us remember that the plants surrounding us provide live saving gas i.e. O_2 and absorb the poisonous gas i.e. CO_2 that we release every time we breath we can easily grow and take care of green plants including trees whether live in urban or rural surrounding and thus help in protecting our environments.

RESEARCH HIGHLIGHTS

Perennial Pigeonpea as a Multipurpose tree species

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Perennial pigeonpea (*Cajanus cajan*) is a truly multipurpose species which provides food, fuelwood and fodder in subsistence agriculture. Recent studies have indicated that perennial pigeonpea behaves like medium duration types in the first year providing minimum competition with other crops like sorghum, groundnut and sunflower giving Land Equivalent Ratio of 1.6 to 1.7. Therefore it could be grown as a component of intercrop eg. 2:1 row arrangement with sorghum: perennial pigeonpea on Vertisol or 4:1 arrangement with groundnut: perennial pigeonpea on Alfisol. Strip or zonal planting of perennial pigeonpea (4 m wide) have also been tried with sorghum and sunflower and they are quite satisfactory compared to block planting. At pod maturity the branches are cut to 0.5 - 1.0 m height as severe pruning could result in high plant mortality. Loses of 5 - 10% due to plant mortality is not serious as neighbouring plants compensate for the loss in production. During the dry season 2 to 3 cuts for fodder is possible in Hyderabad giving fresh weight of 5.5 t/ha on Vertisol and 4.5 t/ha on Alfisol.

In the second year the growth of the perennial pigeonpea is more vigorous and competition for light with associated crops is increased. Best crops to use are cereals like sorghum and maize. If competition is too severe during the rainy season the best option is to remove the lower branches which are less productive. Another option is to thin out the plants along each row when competition is unacceptable.

So far we have not grown perennial pigeonpea beyond the third year. Excavation after the second year confirmed that the roots penetrated below a shallow murrum layer to 3 meters, well below that of annual pigeonpea. We are following the consequences on soil changes after a longer period.

Agroforestry studies at MPKVV, Rahuri (MS)

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Studies carried out at MPKVV, Rahuri on agroforestry (tree + crop system) revealed that after six years kharif crops associated with *leucaena* and *eucalyptus* in different alleys were found to be remunerative on medium soils (depth 30-60 cm) as compared to sole *kharif* crops such as pearlmillet, redgram and sunflower in the Scarcity Zone. Alley width of trees should be 10 m and the field crops be cultivated in between. The fuel/small timber wood production from *leucaena* and *eucalyptus* was 47.89 and 46.40 t/ha after 4th and 5th years, respectively.

Mean recovery in grain production after 6th *kharif* season in crops associated with *leucaena* and *eucalyptus* was to the extent of 48 to 55 and 49 to 69 per cent, respectively.

Pearlmillet , redgram and sunflower in association with *leucaena* in the 5th year produce additional annual monetary returns of Rs. 3416, 3091 and 2545/ha over the respective sole crops while the corresponding figures with associated *eucalyptus* were Rs. 4834, 3716 and 5308/ha in the 6th year.

Leucaena and *eucalyptus* in association with arable crops helped in improvement of organic carbon, available N and K over the initial soil nutrient status , whereas P content was reduced to some extent in the 6th year under the *eucalyptus* system.

Dalbergia sissoo : As an Agroforestry Tree.

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D.sissoo Rox..(sisoo,shisham), a native tree of IndoGangetic basin is growing naturally from Bhutan to Pakistan but extending in the east upto Malaysia and in the West upto Afganistan. It has been introduced to many African countries, and as an avenue tree in USA. It is a multipurpose tree which provides timber, fuelwood, fodder and medicine. Its heartwood is golden to brown in colour, very hard strong durable and possessing beautiful natural grains. Its timber is prized for finest cabinet, furniture, veneers, structural work, etc,. The species produce an excellent fuelwood with calorific value ranging from 4900-5200 Kcal/kg. The leaves provide quality fodder during summer containing upto 24.1% crude protein and 26.1% crude fibre on dry weight basis. The oil extracted from roots, and the leaves have medicinal value.

Sissoo stands and scattered trees from the farms are depleting fast in north India because the urban people have become fascinated for its wood used for construction and furniture purpose. Consequently, the region is loosing the requisite tree cover essential for ecological balance and wood needs. The efforts are underway to restore the tree cover through plantations. Planting of sissoo has been ignored by the farmers in comparison to straight and fast growing trees like *poplar* and *eucalyptus*. *Sissoo is moderately fast growing having forks at low height, crooked stem and spreading crown. Due to all these reasons the farmers are hesitant to grow this precious timber s their farms.*

Since the species grow on a wide range of ecological sites, as a result considerable variation exists in growth pattern. The research is underway at Punjab Agricultural University, Ludhiana to select the ideotypes suitable for planting with crops. Some straight trees having clean bole and small and light crown have been selected. The average values for these traits for selected and unselected trees are given below.

Trait	Unselected trees	Selected trees
Height (m)	15.6	17.2
First fork height (m)	3.6	7.9
Crown diameter (m)	15.9	9.9
Crown depth (m)	11.9	9.2

The selected trees on an average had 10.3% and 119.4% more height and first fork height , respectively than the unselected ones. Whereas, the crown diameter and crown depth were less by 37.7% and 22.7%, respectively in selected trees. Straight and clean bole of a tree provide better quality timber by producing straight natural grains and by reducing the quantity of reaction wood. The quantity of usable wood recovered from straight and knot free stem is more than that of crooked and forked tree of the same size. Height of the clean bole and size and density of crown are the important factors

affecting the ground vegetation. The seeds of selected trees are being used for progeny testing. Vegetative propagation of these trees through cuttings wood be undertaken to multiply the trees having straight and clean stem, and small and light crown. Such type of trees are expected to be adopted easily by farmers for agroforestry plantations.

Agri-Silvicultural Studies With Twelve MPTS

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Studies continued for the third year (1990-91) in succession with twelve MPTS spaced in three spacings (4 x 2, 6 x 2 and 10 x 2 M) and raising arable crops in the interspaces at theNational Research Centre for Agroforestry, Jhansi. Experimental soil was sandy loan in texture with low in nitrogen and phosphorus and medium in avaiable potash. The rainfall (993.4 mm) in 40 rainy days was above the normal rainfall (870 mm). September month received a heavy rainfall of 493.3 mm which seriously affected the prospects of rainfed *kharif* crops. During rabi the crop under various MPTS gave encouraging results.

Maximum production during rabi was registered with *A. lebbek* (23.3 q/ha) followed by *A.* cupressiformis (22.4 q/ha) and *C. equisetifolia* (22.5 q/ha) and least production with *E. tereticornis* (17.8 q/ha).

Among the tree spacings, on an average maximum yield was recorded with 10 x 2 m spacing (25.0 q/ha) and least with 4 x 2 m (19.3 q/ha). In various crop rotations, wheat (34.1 q/ha) gave maximum yield in pigeonpea-wheat rotation, and chickpea (9.9 q/ha) was equally well in both the rotations (with sorghum and pigeonpea) in association with the tree component.

Wheat production was maximum in pigeonpea-wheat rotation(37.6 q/ha) in association with *A. lebbek*. In case of chickpea it was equally good in sorghum-chickpea and pigeonpea-chickpea rotations in association with *M. latifolia* and *E. officinalis*, respectively recording a grain yield of 12.1 q/ha in each case.

Maximum relative grain yield during the rabi season was registered with *E. H. binata* (81.8%) and least was with *E. tereticornis* (62.8%).

During June 1991, Eeucalyptus recorded maximum plant height (688 cm) in agroforestry situation compared to 489 cm under control. In case of *A. cupressiformis*, there was practically no difference in plant height of 500 cm under agroforestry situation compared to control (490 cm).

On an average, DBH was higher in all the MPTS under agroforestry situation except *A. lebbeck* and *E. officinalis*. Similarly higher collar diameter were also recorded in all the MPTS under agroforestry situation except *M. latifolia, L. leucocephala* and *A. lebbeck* where their performance was poor as compared to control during June.

Agri - Silvi-horticultural Studies Under rainfed Conditions

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For rainfed conditions of Bundelkand region, ber *(Zizyphus mauritiana)* and aonla *(Emblica officinalis)* are most ideally suited fruit crops.

During 1989-90 two sets of experiments were laid out at NRCAF, Jhansi comprising of ber *(Zizyphus mauritiana)* and aonla *(Emblica officinalis)* varieties under rainfed conditions. The experiments were laid out on poor marginal soils of poor fertility status (low in nitrogen and phosphorus and medium in available potash).

For ber treatments consisted of 2 spacings of ber (6m x 6m and 6m x 12m) as assigned to main plots, 4 varieties of ber (Seo, Gola, Banarsi Kark and local) in the

sub-plots and five crop rotations (in the interspaces of the fruit trees) in the sub sub-plots in a split plot design with 3 replications.

For aonla experiment treatments comprised of 2 spacings of the trees (6m x 5m and 6m x 10m) as assigned to main plot, 4 varieties of aonla (Chakaiya, Kanchan, Krishna and NA-7) in the sub-plots and a combination of MPTS (*Leucaena leucocephala*) and no MPTS and crops raised in the interspaces as sub-sub-plot treatments replicated 2 times in a split plot design. During rabi on residual moisture mustard was grown in rotation.

Maximum grain yield (5.22 q/ha) was registered with perennial pigeonpea as compared to a yield of 2.98, 1.95 and 4.26 q/ha registered with til, castor and annual pigeonpea, respectively from the interspaces. Perennial pigeonpea recorded 6.50 q/ha of grain yield in association with desi ber variety. In seo, gola and banarsi the yield ranged between 4.52 to 4.87 q/ha. In crop rotation x tree spacing interactions, maximum production of 5.89 q/ha was registered with pernnial pigeonpea in a spacing of 6m x 6m.

Among spacing x ber varieties, maximum grain yield (4.58 q/ha) was recorded in desi variety spaced at 6m x 6m.

Maximum plant height (206.4 cm) was registered with desi ber during March 91 and similar was in the case of crown diameter (2.78 cm) and plant canopy (124.6 cm).

In aonla experiment, higher grain yields were recorded in tree spacing of 5m x 6m as compared to 10m x 6m spacings. Maximum grain yield (4.25 q/ha) was registered in the interspaces of chakaiya variety followed by krishna (3.83 q/ha) and NA-7 (3.81 q/ha). Interestingly, not much yield differences existed between raising of crops in the interspaces of anola varieties with and without *leucaena* during the *kharif* season. Performance of Urd (Blackgram) was much better in terms of production. It gave a yield of 5.06 q/ha and 5.08 q/ha in association with chakaiya and krishna, respectively without MPTS, whereas higher production of 4.78 q/ha and 4.82 q/ha was registered with kanchan and NA-7 aonla varieties in association with MPTS respectively.

During rabi on residual moisture mustard was raised in the interspaces of aonla varieties. Maximum grain yield

Agri-silvi-horticultural studies - variety kanchan of aonla with urdbean in the interspaces under rainfed condition

Agri-Silvi-horticultural studies at NRCAF Jhansi variety kanchan of aonla with mustard in the interspaces on residual moisture.

(4.11 q/ha) was registered with kanchan followed by chakaiya (3.76 q/ha).

Maximum plant height during March 91 was attained by kanchan (132.0 cm) followed by NA-7 and krishna. Similar case was noticed for collar diameter and canopy. Kanchan recorded highest collar diameter (3.13 cm) and plant canopy (143.4 cm).

Development of silvipastoral system and evaluation of its forage potentiality

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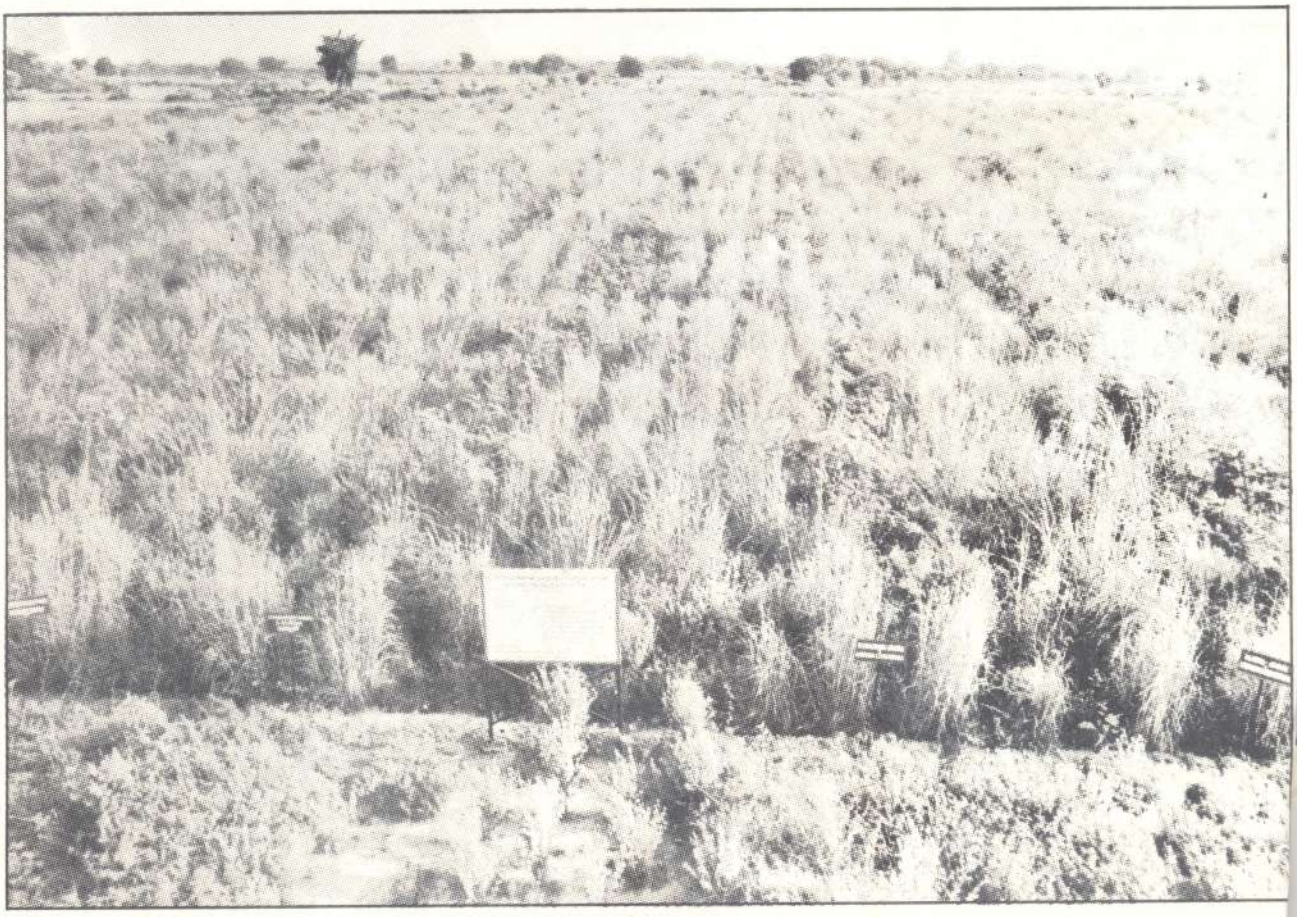
Silvipastoral system was established in sandy soil to know the productivity of silvipasture during early years. Saplings of *Albizia amara* (Kala siris) as a tree and *Dichrostachys cinerea* (Nutan) as a shrub were planted at alternate row at the spacing of 5m x 5m in July 1990. In between two plants of *A. amara* and *D. cinerea* saplings of *Leucaena leucocephala* CV IGFRI 23 (Subabul) were planted. In between two line of tree and shrub rooted slip/seedlings of *Chrysopogon fulvus* (Dhawlu grass) were planted at 100 x 100 cm spacing. In between two rows of grasses a seed mixture of *Stylosanthes hamata* + *S. scabra* were sown at the rate of 4 kg/ha. Basal application of 20 kg N + 20 kg P_2O_5/ha was given at the time of sowing. At the time of planting of trees 20 g BHC + 20 g urea + 50g single super phosphate was given in each pit. With the onset of monsoon 40 kg N + 20 kg P_2O_5/ha was top dressed in



A general view of silvipastoral experiment at NRCAF, Jhansi.

addition to 50 g/plant diammonium phosphate to trees only. During 1990 grass and legumes were harvested for forage in early November, while in trees data on growth parameter and production were taken during December 1990. In 1991 3 cuttings were taken from pasture (grass + legumes) and in trees data on growth and production was recorded ruing December 1991. Pruning of trees were done upto 50% of its height from the ground level.

Forage Production:

Data revealed that during 1990 the dry forage yield was 1.95 t/ha (0.66 + 0.96 + 0.33 t/ha from *C. fulvus, S. hamata* and *S. scabra,* respectively). In 1991 the dry forage yield was 6.99 t/ha (2.86 + 2.78 + 1.35 t/ha from *C. fulvus, S. scabra* and *S. hamata*, respectively). This shows that during second year the forage production was more than 3 times than that of first year.

Establishment, growth and production of Multipurpose trees and shrubs.

Data recorded on establishment revealed that *A. amara* gave maximum establishment of 100 and 97.5% during 1990 and 1991, respectively followed by *D. cinerea* and *L. leucocephala*. During 1990 plant height (126.3 cm) was maximum with *A. amara* and in 1991 highest plant height (282.0 cm) was noted with *L. leucocephala*. The collar diameter was maximum with *L. leucocephala* during 1990 (1.76 cm) and 1991 (3.63 cm). In 1991 DBH was maximum in *L. leucocephala* (2.32 cm). Green leaf fodder recorded with all the trees during 1990 was 80.0 kg/ha, while in 1991 the total production was 992.4 kg/ha. Thus, the total production recorded with pruning of trees during 1991 was more than 3 times than that of 1990.

On the basis of two year results, it was observed that such type of wasteland/degraded lands can be developed through silvipasture and quality forage could be obtained.

Occurrence of VAM among certain plants important in agroforestry under semi-arid conditions.

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The symboitic association of vesicular arbuscular mycorrhizae (VAM) with higher plants has been amply demonstrated to confer many benefits to the host. It improves uptake of phosphorus and certain minor elements in plants and increase their resistance/tolerance to diseases and water stress. The climate under Bundelkhand conditions is semi-arid, soils are marginal and limited amount of underground water is available during the summer months and under such condition role of VAM can be beneficial. For various agroforestry systems the important components are MPTS (including fruit trees), grasses and field crops. These components were evaluated at NRCAF for its presence in the roots. Specimen were collected from nursery/field, cleared in 10% KOH, stained in 0.5% trypan blue in lactophenol (after acidification) and mycorrhizal colonization was assessed microscopically. Sixteen species of forestry trees viz., *Acacia cupressiformis, A.tortilis, Albizia amara, A.lebbek, A.odoratissima, Artocarphus heterophylls, Dalbergia latifolia, D. sissoo, Eucalyptus, Hardwickia binata, Leucaena leucocephala (Var. Silvi-4 and K-8), Morus alba, Prosopis cineraria, Sesbania grandiflora, S.sesban and Tamarindus indica*, four species of horticultural crops viz., *Citrus karana, C. sinensis, Psidium guajava and Zizyphus rotundifolia*, nine field crops namely, *Arachis hypogaea, Cajanus cajan, Cicerarietinum, Phaseolus mungo, P. vigna, Sesamum orientale, Triticum aestivum, Vigna sinensis* and *Zea mays*, and eight grasses/fodder crops viz., *Cenchrus ciliaris, Macroptilum atropurpureum, Melilotus parviflora, Stylosanthes hamata, S. scabra, Themeda* and *Trifolium alaxendrium*, were positively tested for the presence of VAM. The colonization index for various plant species varied from 20.4% to 95.9%. Brassica spp. was found non-mycorrhizal.

AGROFORESTRY CALENDER

INTERNATIONAL

Farm Forestry Programme of Scientists at the Chinese Academy of Forestry, Beijing, P.R. China, 6-26 Sept. 1992.

International Conference on alley farming at IITA, Ibadan, Nigeria (Sept. 14-17, 1992). Contact Dr. B.T. Kang, IITA, Ibadan.

Training Course on experimental design and analysis for agroforestry research at ICRAF, Kenya (23 Nov. - 12 Dec. 1992), Contact the Course Coordinator.

World neem conference, Bangalore India (Feb 24-28, 1993). Contact T.S. Subramaniam, Conference Secretariate, ITC Ltd. 7th floor Amrutha Topaz, Hyderabad : 500 482,. INDIA

An International Seminar on managing red and laterictic soils for sustainable agriculture at Bangalore, India (Sept. 24-28, 1993). Contact Director NBSS & LUP, Nagpur: 440 010, India.

NATIONAL

Global Forum on Environmental and Development Education, New Delhi, India, Sept. 24-28, 1993. Contact Dr. Desh Bandhu, President, Indian Environmental Society, U-112 (3rd floor) Vikas Marg, Delhi - 110 092.

Training Course on Farm Forestry System Management at Indian Institute of Forest Management, Bhopal (12-15 Oct. 1992). Contact Dr. T.H. Babu, Programme Director, Indian Institute of Forest Management, P.O. Box. 357, Nehru Nagar, Bhopal - 462 003 (M.P.)

National Symposium on A Decade of Potassium Research, to be held at Potash Research Institute of India, Gurgaon - 122 001, India (Nov. 18-20, 1993). Contact Dr. Mahatim Singh, Director, PRI, Gurgaon.

Resource Inventory Techniques to support agroforestry activities. Dates not finalised. Contact Dr. Atul, Deptt. of Hort. & Forestry, HPKVV, Palampur - 176 062 (H.P.).


DESHARI
दशहरी