AGROFORESTRY
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NRCAF JHANSI (UP)

AGROFORESTRY AND BIOMASS PRODUCTION

Agroforestry is an integrated self susta -ining land management system which involves deliberate retention / introduction of woody components including trees, shrubs, bamboos, cane etc. with agricultural crops including pasture/livestock simultaneously or sequentially on the same land management unit and at the same time meeting the ecological requirements as well as socio-economic needs of the people.

If you consider agroforestry concept it is similar to forest in which trees of different height, shrubs, grasses and other plants grow naturally as an ecosystem. But whenever we try to grow trees normally we grow under pure plantations as a monocrop system which is far away from the nature and often leads to devastations due to spread of disease and pests etc. on the monoculture species. So through various agroforestry systems we try to go nearer to the natural concept.

Biomass is a comprehensive term comprising of all forms of organic matter derives from the biological activities and present either on the surface of the soil (aerial biomass) or below the soil surface (underground biomass) or may be present at different depth of vast body of water like lakes, streams, river, sea, ocean etc. (aquatic biomass). It may be living or dead including fossil fuel. Green plants with the help of solar energy through photosynthetic activities creating organic carbon that burns with less pollution than fossil fuel. Photosynthesis helps to remove carbon dioxide from the atmosphere and generate the oxygen, the life sustaining gas, and as such it does help to minimise environmental pollution. It is believed that during the last about 100 years or so the concentrations of carbon dioxide in the atmosphere increased significantly due to ever increasing use of fossil fuel. In the last decade or so carbon dioxide increased by 100 ppm which is likely to warm up the upper layer of the ocean and cause rise in the sea level. Since plants use carbon dioxide for their growth so the emphasis of biomass production may help to restore the level of carbon dioxide to the normal. The wider use of biomass for development of our normal ecological imbalance and provide means to recycle nutrients and carbon dioxide from the atmosphere. Although solar energy is readily and freely available but it is utilised to the least extend of about 1% which is about 100×10^2 Kcal. through photosynthesis with a net production of 2×10^{12} t of organic matter with energy content of 3×10^2J. We are very lucky to have a solar radiation available for about 12 hours from $6^{,0}$ clock in the morning to $6^{,0}$ clock in the evening. This important solar energy could be utilised to the maximum extend in our country for increasing biomass production through various agroforestry systems. All the biomass whether it is fuel, grain, crop residue, livestock residue, energy crops, processed waste and their production is a product of either present or past photosynthesis.

In view of our ever increasing population for human and livestock which is likely to reach 1 billion and 600 million respectively by the end of the century it is very important to see how best we can improve the efficiency of utilisation of solar energy for increased biomass production as we have very low per capita land available for cultivation. The only alternative left to us is to expand it vertically instead of horizontally through integrated agroforestry systems. It has been observed that through various agroforestry systems total

biomass production per unit area could be increased significantly in order to meet the ever increasing demands of food, feed and fuel.

RESEARCH HIGHLIGHTS

AGRISILVICULTURAL STUDIES WITH TWELVE MPTS

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Studies were in progress for the fourth year (1991-92) in succession at NRCAF, Jhansi with twelve MPTS spaced in three spacings (4x2, 6x2 and 10x2 M) and raising arable crops in the interspaces. The results of rabi 91-92 are *discussed* (*Kharif* crop failed due to excessive rains in Sept. 1991).

On an average, maximum rabi grain yield (17.12 q/ha) was registered from the interspaces of Mahua (*Madhuca latifolia*) followed by (16.18 q/ha) in Anjan (*Hardwickia binata*) and (15.79 q/ha) in Aonla (*Emblica officinalis*). However in all these trees growth were slow and therefore crop production was fairly good. During March 92, Mahua, Anjan and Aonla gave a plant height of 177 cm, 376 cm and 412 cm, respectively as compared to maximum plant height (998 cm) registered with Safeda (11.14 q/ha grain yield) followed by Babul (745 cm) and Ramkanthi (730 cm) giving a grain yield of 14.51 q/ha and 13.83 q/ha, respectively.

Lowest rabi crop grain yield was registered with *E. tereticornis* (11.14 q/ha) and next in order were Leucaena *l eucocephala* (12.29 q/ha) and *A. cupressiformis* (13.83 q/ha).

Among the tree spacing, maximum grain yield (16.93 q/ha) was registered with 10 x 2 M spacing followed by spacing 6x2 M (14.68 q/ha) and minimum yield of 12.24 q/ha with 4x2 M spacing of MPTS.

Among the grain crops, wheat gave a grain yield of 23.19 q/ha and 22.74 q/ha through sorghum-wheat and pigeonpea-wheat crop rotations, respectively from the interspaces of the MPTS. In case of chickpea it was 6.36 q/ha and 6.15 q/ha from sorghum-chickpea and pigeonpea-chickpea crop rotations, respectively.

AGRI-HORTI-SILVICULTURAL STUDIES

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Studies on crop production in the interspaces of fruit trees and MPTS continued during the third year at NRCAF, Jhansi. During rabi 1990-91 maximum grain yield was registered from the interspaces of Guava (21.7 q/ha) with a relative grain yield of 101% followed by Kinnow (21.5 q/ha) with a relative grain yield of 101%. Minimum grain yield was recorded with Ber (20.0 q/ha) with a relative grain yield of 96 per cent. It is now an well established fact that with the fruit trees as planted during *Kharif* 1988, the interspaces can be effectively used for raising grain crops (*Kharif* crops data is not reported due

to crop failure with excessive rainfall in the month of Sept. 90).

Taking into consideration the rabi crops, wheat gave a grain yield of 32.1 q/ha (relative grain yield 120%) and 32.6 q/ha (relative grain yield 135%) in sorghum-wheat and groundnut-wheat crop rotations, respectively from the interspaces of fruit trees. Chickpea gave a grain yield of 9.9 q/ha (relative grain yield 79%) and 9.8 q/ha (relative grain yield 65%) in sorghum-chickpea and groundnut-chickpea crop rotations, respectively from the interspaces of the fruit trees. Hence from the grain data it is evident that wheat crop was much benefitted, whereas the chickpea crop gave lower grain production from the interspaces of the fruit trees.

In addition to crop production, the MPTS (*Leucaena leucocephala*) growing in between two fruit trees gave a biomass yield (dry matter) of 2.33 t/ha, 1.88 t/ha, 2.29 t/ha and 2.12 t/ha in association with Guava, Ber, Anar and Kinnow, respectively (Biomass yield include fodder from leaves and fuel wood from stem and branches).

Agro-Horticulture System under semi-arid conditions

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Regional Research Station, Pali - 306 401

In order to increase yield potential of per unit area and proper land utilization of orchards during initial stage, an experiment was carried out at Regional Station, Pali. This centre is located in between arid and semi-arid conditions as a transitional zone, and receives 400 mm normal annual rainfall. Soil depth is 30-45 cm. followed by a hard calcarious murram layer. Clusterbean, mungbean and sesame crops were grown under rainfed condition in between two rows of Ber (*Z. Mauritiana*) CV 'Seb' planted at 6 x 6 M spacing.

Intercropping in newly planted fruits orchard had no adverse effect on tree growth upto 4 years. The fruit yield was also increased three folds in Ber during third year after planting when compared with the control (5.1 kg/tree). Good quality of fruits were harvested from trees grown with intercrops. The yield of intercrops were compared with and without fruit trees treatment. The findings revealed that clusterbean produced the highest yield (7.90 q/ha) as compared to the control (1.85 q/ha). However, an average yield recorded in mungbean and sesame were 4.0 and 1.5 q/ha, respectively.

LIGHT TRANSMISSION AND CANOPY TEMPERATURE VARIATIONS OF SOME MPTS

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In average the canopies of 10 years old *A. tortilis* and *H. binata* trees infiltered the maximum amount of PAR (55 to 60%) in all the months whereas the canopy of *L. leucocephala* transmitted lowest amount of

PAR (30%). Under the canopies of all the tree species the highest PAR transmission was recorded during July, August and September which may be due to higher light intensities in these months. The diurnal changes in PAR transmission under the canopies of these tree species in September indicated that *A. tortilis* and *H. binata* allowed maximum light transmission and *L.leucocephala* minimum. However, the canopies of *A.lebbeck* and *A. amara* infiltered almost the same amount of PAR. The lowest canopy temperature with higher canopy-air temperature difference recorded under the canopy of L. leucocephala in all the months except in December. The lowest canopy-air temperature difference was recorded under the canopy of *A. tortilis* and *H. binata*. The higher canopy temperature were observed in the canopies of all tree species during August, September and October, when air temperature was maximum. These findings revealed that *A. tortilis* and *H. binata* transmitted higher percentage of PAR and maintained the canopy temperature very close to the air temperature which are suitable for the optimum growth of grasses under these tree species whereas *L. leucocephala* reduced the thermal load under the canopy and to the surroundings during drier period in semi-arid region.

With respect to the adaptation feature of these trees in the semi-arid condition *L. leucocephala* adapted by maintaining the lowest canopy temperature (Which may be due to the higher loss of water from the canopy), whereas *A. tortilis* and *H. binata* adapted by maintaining the canopy temperature very close to the air-temperature (due to low canopy transpiration and high stomatal resistance). Thus the tree species having canopy temperature below or near to the air-temperature are suitable for arid environment.

A. tortilis and *H. binata* are suitable tree species for agroforestry system and afforestation programme in the semi-arid conditions. Further tree improvement programme is required on *A. tortilis* and *H. binata* for agroforestry and plantations in the arid and dry conditions.

PERFORMANCE OF SHEEP AND GOATS UNDER SILVIPASTORAL SYSTEM UNDER SEMIARID CONDITIONS

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Silvipasture technology has been proved as the most potential system to generate resources like fuelwood, nutritious fodder from trees and forage from pastures (grasses and legumes) from the wastelands. Studies available on the performance of livestock production under silvipastoral system is meagre. Therefore, an experiment was conducted to know the performance of adult sheep and goats under silvipastoral system after second year of its establishment.

Performance of 6 adult male sheep of Muzzafarnagari breed +6 adult male goats of Barbari breed were studied at the farm of National Research Centre for Agroforestry, Jhansi on one year old silvipastoral system (*Leucaena leucocephala* + *Dichrostachys cinerea* + *Albizia amara* as a tree/bush + *Chrysopogon fulvus* as a grass + *Stylosanthes hamata* + *S. scabra* as pasture legumes). The animals were introduced for grazing in October 1991 and continued upto June 1992. The area for grazing of silvipasture

was one hectare. Results showed that on an average, goats gained in their body weight at the rate of 26.6 g/h/day while sheep gained at the rate of 2.1 g/h/day in a total grazing period of 241 days. Goats grazed on silvipastoral system performed better than sheep. It might be due to lower age of goats (1.5 to 2.0 years) as compared to sheep (2.5 to 3.0 years). However, results indicated that sheep and goats can be easily maintained on such type of silvipastoral system throughout the year without supplementation of concentrates.

Table 1: Performance of sheep and goats grazed on one year old silvipastoral system (average of 6 animals).

Species	Age (yrs.)	Initial weight (kg/head)	Final weight (kg/head)	Difference (kg/head)	Weight gain (g/h/day)
Goat	1.5-2.0	21.6	28.5	6.9	26.6
Sheep	2.5-3.0	43.1	43.6	0.5	2.1

SILVIPASTURE APPROACH FOR REHABILITATION OF BARREN HILLS AND WASTELANDS ON WATERSHED BASIS

C.R. Hazra and D.P. Singh

AICRP on Forage Crops,
IGFRI, Jhansi (U.P.)

In a total area of about 418.8 hectare of highly degraded wastelands of Gaharawa village in Jhansi , district of Uttar Pradesh, an area of 83.75 hectare of barren hills was treated with appropriate soil and water conservation measures and planted with suitable trees, shrubs, pature grasses and legumes during 1989. The plantation was also made in the rest of the wastelands. The area planted with different pasture grasses, legumes and trees were *Cenchrus ciliaris, Pennisetum pedicellatum, Stylosanthes hamata, Leucaena leucocephala, Albizia lebbek, Acacia nilotica,* etc. The total forage productivity from silvipasture on barren hills of 83.75 hectare was to the tune of 6300 quintals with average productivity of 75 quintals per hectare (q/ha) during 1991-92 against initial productivity of 6 q/ha during 1989-90. The soil and water conservation treatment had helped in reducing soil loss from 41 tonnes per hectare (t/ha) to 9.5 t/ha from barren hillocks and from 20.5 t/ha to 5.5 t/ha from wastelands. This has also helped in reducing silt deposition from 0.28-0.40 metre to 0.05-0.10 metre and reduced the run-off from 70% to 30% with a rise in water table from 1-4 metre in the adjoining area in the watershed. This lead to increased crop productivity from 3.6 to 19.9 q/ha and an increase in cropping intensity from bare 81 to 156 percent in the treated watershed area. The cost-benefit ratio of the programme stands at 1:2.89. Average income of landless poor (35 families) in the watershed area also dramatically rose from meagre amount of Rs. 2250/- per annum per family to substantial amount of Rs. 11,250/- per annum per family, an increase by 5 times. The silvipasture system has greatly improved the organic carbon content from 0.25 to 0.48 per cent and increased available nutrients of N, P and K by 71, 7 and 54 kg/ha, respectively, in a period of two years.

AGROFORESTRY CALENDER

NATIONAL

Seminar on Agroforestry in 2000 AD for the Semiarid and Arid Tropics from March 12-13, 1993 at NRCAF, Jhansi (U.P.) 284 003, India. Contact Dr. A.S. Gill, Organising Secretary, NRCAF,Jhansi (U.P.) 284 003, India.

International Seminar on Managing Red and Lateritic Soils for Sustainable Agriculture at Bangalore, India from Sept. 24-28, 1993. Contact Prof. J. Sehgal, President, Indian Society of Soil Survey & Land Use Plannning & Director, National Bureau of Soil Survey & Land Use Planning, Nagpur - 440 010, India.

International Symposium on Environmental Degradation in Arid and Semiarid and Dry Sub-humid Ecosystems from Nov. 22-25, 1993 at Jodhpur (Raj.), India. Contact Dr. J. Venkateswarlu, Director, CAZRI, Jodhpur (Raj.) 342 003, India.

International Symposium on Pulses Research at Directorate of Pulses Research, Kanpur (U.P.) 208 024, India from Dec. 4-8, 1993. Contact Dr. A.N. Asthana, Directorate of Pulses Research, Kanpur - 208 024, India.

Conference on Sustainable Development of Degraded Lands through Agroforestry in Asia and the Pacific, New Delhi, India from Dec. 6-11, 1993. Contact Dr. Panjab Singh, President, RMSI & Director, Indian Grassland and Fodder Research Institute, Jhansi, 284 003, India.

Second National Symposium Allelopathy In Sustainable Agriculture, Forestry and Environment from Sept. 6-8, 1994 at Jodhpur (Raj). Contact Dr. S.S. Narwal, Prof. of Agronomy, Dept. of Agronomy HAU, Hisar.

INTERNATIONAL

Symposium on MPTS for Rural Livelihood, Manila, Philippines from May 3-6, 1993. Contact Dr. V.A. Fernandez, Dean, College of Forestry, Univ. of the philippines, Los Banos (UPLB), College, Laguna 3720, Philippines.

International Workshop on Rosewood (Dalbergia spp.): Multipurpose and High Value Timber, Nitrogen Fixing Tree at Hetauda, Nepal from May 31 to June 4, 1993. Contact Dr. James Roshetku, NFTA, 1010, Holomua Road, Paia, Maui, Hawaii 96779, USA.

Sixth Certificate Course in Community Forestry, Bangkok, Thailand from June 7 - Oct. 8, 1993. Contact Dr.S.Sukwong, Director, RECOFTC C/o Faculty of Forestry, Kasetsart Univ., Bangkok 10900, Thailand.

International Sympoisum on Genetic Conservation & Production of Tropical Forest Tree Seed, Chiang Mai, Thailand, Bangkok from June 15-19, 1993. Contact Symposium Secretariat, ACFTSC, Muak-Lek, Soraburi 18180, Thailand.

Third North American Agroforestry Conference, Ames, Iowa, from August 15-18, 1993 at Ames, Iowa. Contact Dr. Richard C.Schultz, Department of Forestry, 251, Bessey Hall, Iowa State Univ., Ames, Iowa 50011-1021, USA.

14th Commonwealth Forestry Conference from Sept. 13-18, 1993 at Kuala Lumpur, Malaysia. Contact Secretary General CFC-14, Forestry Dept. Headquarters, Peninsular Malaysia, Jalan Sultan, Salahuddin 50660, Kuala Lumpur, Malaysia.


कृषि वानिकी से सम्बन्धित विचार गोष्ठी
सहयोग - आकाशवाणी, छतरपुर (म.प्र.)
एवं
राष्ट्रीय कृषिवानिकी अनुसंधान केन्द्र, झाँसी (उ.प्र.)
विषय - कृषि-वानिकी पद्धति क्यों ?
ग्राम - करारी (झाँसी)
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