

enhancing their effectiveness in suppressing pest populations. Quantitative approach involves mass-production or, as in a few cases, mass-collection of selected natural enemies and their programmed releases – inoculative inundative – in desired areas, whereas qualitative measures include selection or development of superior strains, provision of supplementary food, manipulated use of alternative host plants or hosts, modification of the habitat, and use of kairomones to influence searching ability of natural enemies. Importance of these is discussed with examples.

Although there is great potential to control forest pests by augmentation, it has not been adequately explored. A few attempts made include the release of *Apanteles melanoscelus* (Hymenoptera: Braconidae) against the gypsy moth larvae, *Lymantria dispar* (Lepidoptera: Lymantridae) in USA, and *Cedria paradoxa* (Hymenoptera: Braconidae) and *Trichogrammatoidea nana* (Hymenoptera: Trichogrammatidae) against the teak defoliators, *Pyrausta mecharalis* (Lepidoptera: Hyblacidae) in India and Myanmar.

Genetic diversity of *Trichogramma*

The occurrence of several instances of diversity between intraspecific populations in Chalcidoidea, notably among trichogrammatids, was reported by H. Nagaraja (Biotech International Limited, New Delhi) emphasizing that this should be considered more seriously before selecting these parasitoids for biological control purposes.

Considerable studies on the genetic diversity of *Trichogrammatoidea* have been carried out in the past 25 years. In *Trichogramma* over 130 species are known to date, many of which are sibling species. Many species have discrete biogeographical populations,

each having developed varying degrees of reproductive isolation and habitat preferences.

Bioenergetics

Bioenergetics and life table studies of parasitoids and predators provide information on the extent of control they can exercise on pest population as well as the rate at which they can build up their population. According to J. Muthukrishnan (Madurai Kamaraj University) such information may find application in designing pest management programmes. His observations were based on the work with predatory wasp, *Delta conoideus* and the endoparasitoids *Apanteles flavipes*, *Microplitis ensirus*, and *Bracon brevicornis*, the latter playing an important role in the control of pests of teak, coffee and tea.

Potential biological control agents

Of the hundred species of reduviids recorded, *Rhinocoris marginatus*, *R. fuscipes*, *R. kumarii* (Harpactorinae), *Acanthaspis pedestris*, *Ectomocoris tibialis*, and *Catamiarus brevipennis*, appear to be potential biological control agents, according to Dunston Ambrose.

These reduviids multiply faster with short life cycles and female biased sex ratio. Among these, harpactorine and reduviine reduviids are multivoltine with higher fecundity and hatchability than piratine reduviids which are univoltine with comparatively lesser fecundity and hatchability.

Speaking of ants as useful predators, G. K. Veeresh (University of Agricultural Sciences, Bangalore) emphasized the fact that they are among the most ubiquitous animal groups in both natural and man-made terrestrial ecosystems. They are particularly dominant

in number and biomass in tropical ecosystems. They exhibit wide range of food preference and occupy all trophic levels. All ponerine ants and most species of Dorylinae are exclusive predators. While doryline ants are generalists, ponerines exhibit varying levels of specialization. *Leptogenys processionalis*, for example, selectively forages on termites and can restrict their potential damage to trees.

The potential of spiders as biocontrol agents was briefed by K. Vijayalakshmi (Centre for Indian Knowledge Systems, Madras) who stated that it has not been fully utilized in India and interestingly enough, they play an essential role in the control of social forest insects. A preliminary survey of the spider population in the social forests and plantation crops has shown that the most common species in these ecosystems belong to the families Salticidae (jumping spiders), Oxyopidae (Lynx spiders), Lycosidae (wolf spiders), Thomisidae (crab spiders), Araneidae (Orb weavers) and Eresidae (social spiders). *Peucetia* belonging to the family Oxyopidae has been observed to be a predator of the semilooper *Tephrina pulinda* and the bagworm *Eumeta cramerii*. Species of *Peucetia* are active hunters, and they do not spin webs, but ambush their prey.

Intensity of pest infestations in Social Forestry and plantation crops naturally calls for sustained efforts to utilize natural enemies which abound in large numbers, to achieve increased productivity. With increasing disruption of agroecosystem biological control agents tend to operate below their potential effectiveness, making augmentative release of many of these species increasingly obligatory.

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Forestry for food: Challenges for 2000 AD and beyond

The extent and the growing stock of the world's forest has been subject of continuous interest because of their significance for potential raw material and stabilizing role in the biosphere.

During recent times *forestry for food security* is being emphasized as the world population growth would be up by 3.7 billion in the next forty years and the food production will need to be

doubled (Figure 1). About 19% of the world population (950 million people) in lower income countries are not getting enough food¹. Expansion of cropland projected at 25% and of

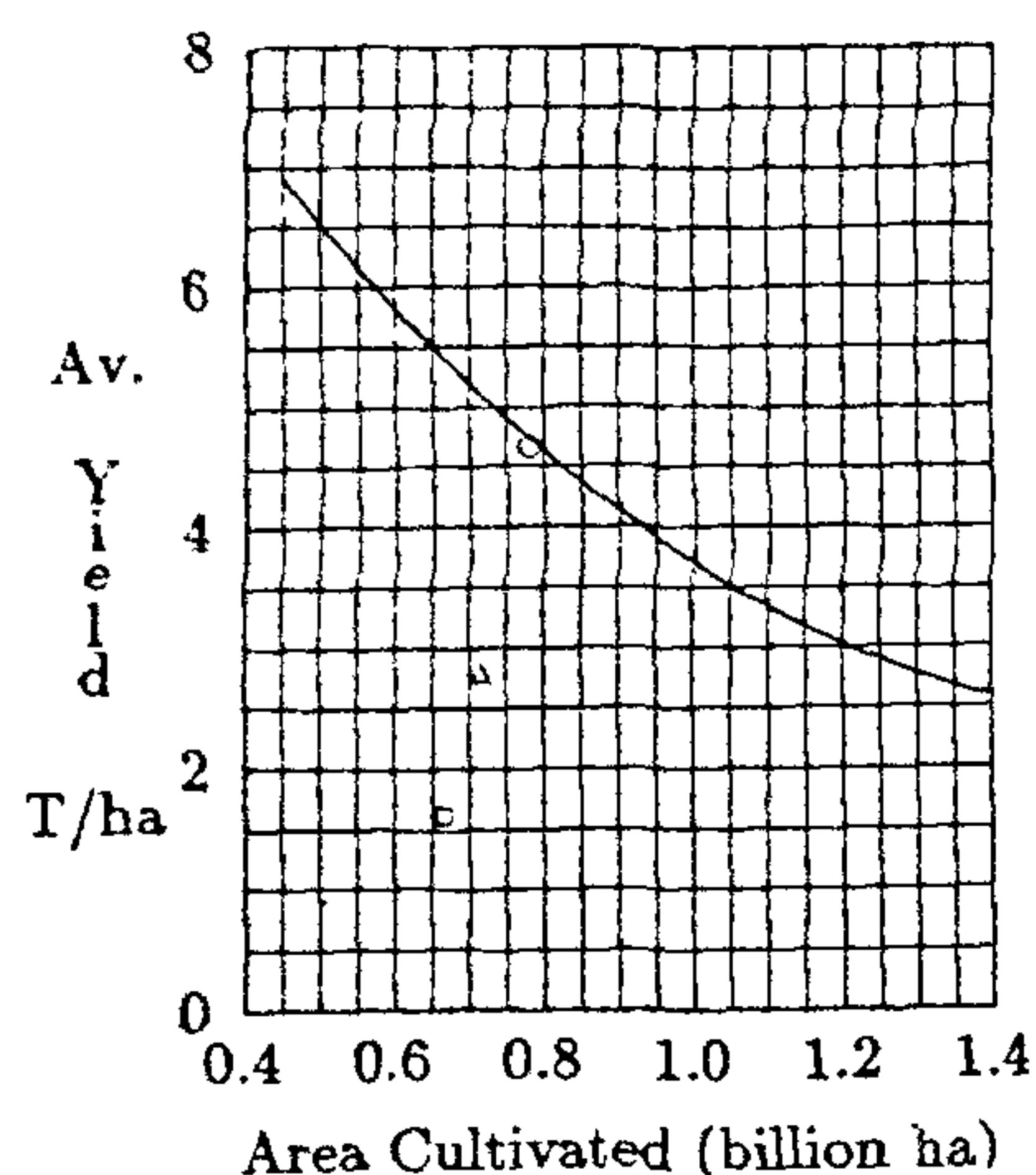


Figure 1. Recent performance and future challenges for world cereal productivity. World population was 3.3 billion in 1965 and 5.3 billion in 1990; it is projected to be 9.0 billion in the year 2030. In 1965 (square), total food production was 1.0 billion tons, in 1.54 billion ha. cultivable area at the rate of 0.65 tons/ha. These values were 1.9, 2.71 and 0.70 for 1990 (triangle); and 3.6, 4.63 and 0.78 for the year 2030 (circle) respectively. Source: *World Development Report*, 1992.

irrigated land by 50% would be at the cost of environment.

India's average annual population growth by the year 2000 AD is projected as 1.7%. This growth rate tantamounts the population to the tune of 1.006 billions. The country has vast geographical area with varying climate and soil with diverse forest types. These forests provide a variety of edible products (Table 1). The forest food plants acts as supplementary emergency and seasonal source of diet².

Inadequate attention has been given to forestry-derived food. Addressing an environmental issue, such as *forestry for food*, faced by mankind will ensure better progress in reducing poverty and raising productivity. It is imperative that the current movement of opportunity be seized to bring about an acceleration in human and economic development that is sustained and equitable. So far our attention has been restricted to the fuel and fodder producing crops. Unfortunately, food forestry sector seems to have been overlooked. The *Commonwealth Forestry Conference* in 1987 had

Table 1. Statewise collection of edible forest produce

State (year)	Edible forest produce	Collection (metric tonnes)
Andhra Pradesh (1978-79)	Chironji	208
	Mahua seeds	201
	Mahua flower	12
	Marking nuts	4
Bihar (1980-81)	Mahua seed	1647
	Kusum seed	98
	Sal seed	11425
	Karanj seed	87
	Palas seed	71
Gujarat (1980-81)	Mahua flower	6010
	Mahua seed	668
	Bahera	215
	Aonla	1
	Honey	6
Himachal Pradesh (1980-81)	Dioscorea	492
	Gucchi	10
	Chilgoza	150
Madhya Pradesh (1980-81)	Sal seed	69700
	Gum	900
	Harra	17000
Maharashtra (1980-81)	Gum	2334
	Harra	1756
Orissa (1980-81)	Honey	1
	Mahua flowers	55237
	Gum	512
	Tamarind	3477
Rajasthan (1980-81)	Gum	289
	Chirongi	4
	Honey and wax	17
	Bahera	97
	Aonla	17
	Mahua flower	371
Tamil Nadu (1980-81)	Tamarind	738
	Harra	971
	Cashew nut	6
	Curry leaves	420
	Honey	3
Uttar Pradesh (1980-81)	Gum	163
	Honey and wax	59
	Sal seeds	N.A.
West Bengal (1980-81)	Sal seeds	5380
	Honey	52

Source: Tiwari, D. N., *Forestry in National Development*; Jugal Kishore and Co., Dehra Dun, 1986.

as its theme *forests for multiple use*, in which items of food from the forests were highlighted. Food forestry sector becomes more significant as forest species make significant contribution to the food security and cast income.

To this end, the Indian Institute of Forest Management (IIFM), Bhopal,

organized a national seminar on *Forestry for Food Challenges for 2000 AD and beyond* on March 2-3, 1994, coordinated by J. B. Lal and Uma Malkania. The purpose was to (i) bring together information on contribution that forest species make to national food supplies; (ii) identify the problems and

gaps in sustainable utilization and management of food from forest species, and, (iii) highlight areas for further research and policy analysis in regard to food from forest. To cover the above subjects the seminar was divided into three professional sessions viz, forest food: current status; nutritional aspects, and socio-economic and environmental aspects.

In his inaugural address, S. Shyam Sundar (former Principal Chief Conservator of Forests, Karnataka), reported that tropical forests have 90% of the genetic resources of the world and our forests are the home of many edible species. Forty one million tribals live in our forests and a good percentage of the people live around the forest. These people depend heavily on the forests for their livelihood. He elaborated in his address that the success of the forestry sector is never credited to foresters while failure greets them all the time. Massive investment in the forest belt to increase the production and regulation of grazing and forest fires are necessary for the success of the new concept of 'Joint Forest Management'. J. B. Lal, (Director, IIFM) welcoming the delegates, emphasized the pressing need of research in this sector which mistakenly considered as of minor importance. He expressed the hope that the seminar would definitely be able to draw up some priorities and guidelines before launching the programme to meet the challenges for the year 2000 AD and beyond.

R. Dobhal (MPCST) suggested a model national food from forestry programme or a shift in the priority in various afforestation programmes. Empirical research³, and advanced technology programme is essential. He further submitted that failure to recognize renewable environmental resources as economic goods has been inherent. By applying cost-benefit analysis we can estimate resources' shadow prices and feed these into economic modelling for forestry as a whole. P. R. Uniyal (MPCST) presented a statistical (nutritional) analysis among the three categories of food derived from conventional, animal and forest resources. He recommended that the food derived from forest has: highest potential for

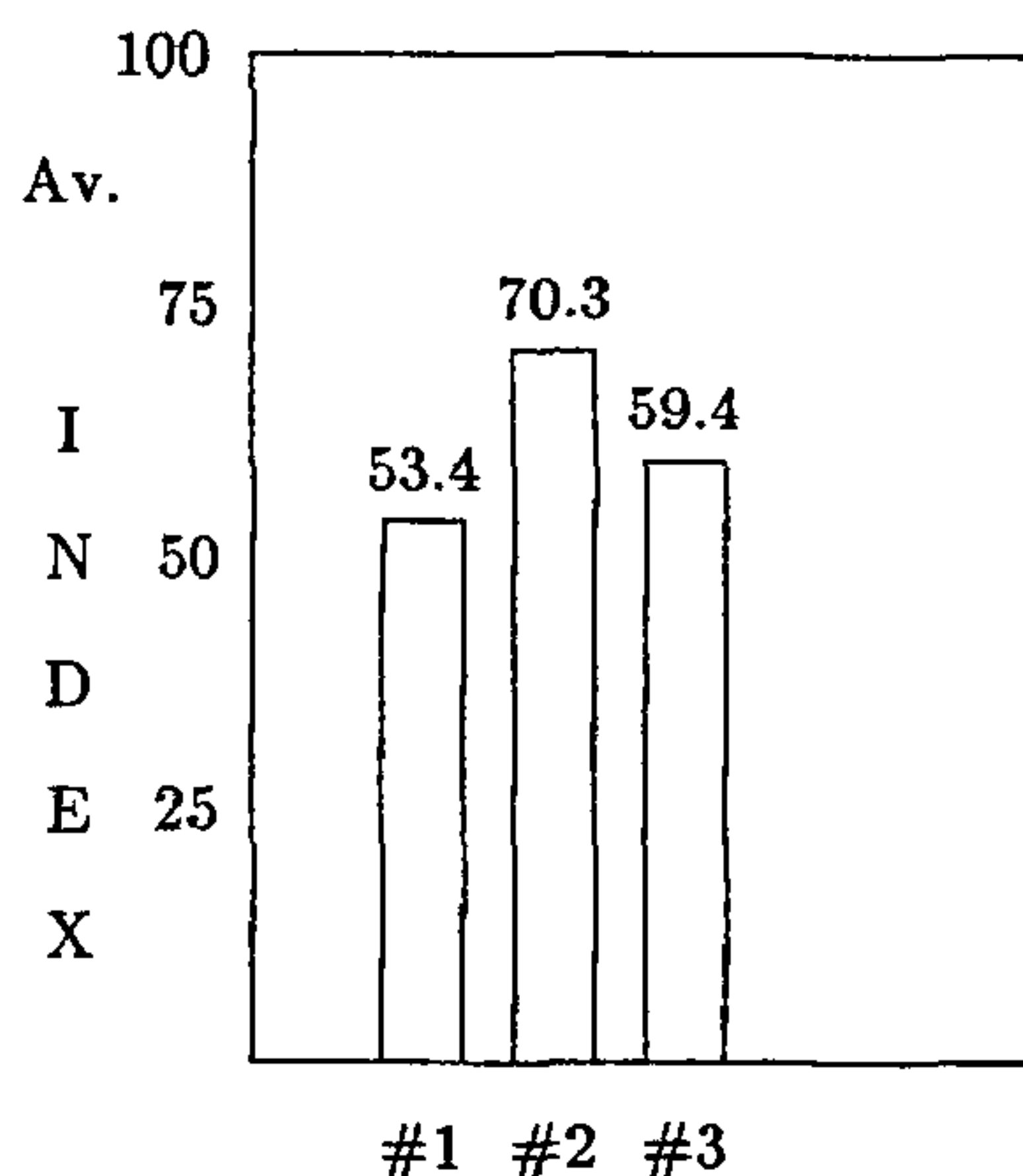


Figure 2. Average index for staple food (#1), animal derived food (#2), and food derived from forests (#3). Index represents a sum of energy, protein, mineral and vitamin values.

energy, carbohydrates, minerals and medicines; even potential for vitamins; higher potential for fibre than that of animal-derived food; least potential for fat, cholesterol and adverse effects; and higher average food index than common vegetarian food (Figure 2). K. Khanna of University of Delhi, emphasized the role of micronutrient vis-a-vis forest food. She identified that forest species contain an appreciable amount of vitamins and minerals, especially carotene and iron that can be very useful dietary component of the tribal and other concerned people. Dhiman of FRI, Dehra Dun, calculated the potential of edible bamboos in India. He discussed the development in edible shoot production and their processing with reference to their potential application. Ismail of A.P. Agricultural University, presented his findings on food-based agroforestry system for semi-arid tropics. The results of 3 years of intercropping studies with *ber* variety 'Gola' and arable crops, viz. sunflower, castor and red gram in the semi-arid tropics, have revealed that the intercropping system yielded more food (fruits + foodgrains) than either sole

farming of crops or sole tree farming. The mean overall gross monetary return was highest with *ber* + castor and sunflower combination (Rs 20,600/ha), followed by *ber* + castor and sole *ber* farming (Rs 19,600/ha each), under rainfed conditions, including the returns from fruits, fuelwood and foodgrains.

Depletion of forests is directly related with the rate of depletion of the forest gathered food resources, observed M. S. Solanki, R. B. Mathur (CMFP, Dehra Dun) reported his Centre's efforts in creating a database for efficient management of non-wood forest produce. S. D. N. Tiwari emphasized the creation of a branch in the forest department for developing plant growth of food-yielding species under forest conditions that can be combined with development of medicinal and aromatic plants. An almost similar theme was expressed by A. Sharma of CIMAP, Lucknow. J. N. Srivastava observed that the crux of the problem was lack of data or rather no basic data for each status survey was deemed necessary. He listed some forest plants of U.P. for the enhancement of productivity of food resource, research in regeneration, and multiplication.

To cope with the challenges of the 21st century for food security, the concept 'joint forest management' was advocated by all. The role of non-governmental organization and intensive cultivation with biological methods was recommended, besides, inventory preparation and nutritional assessment of plants from the forests that derives food.

Prof. Lal, Dr Malkania and IIFM Members deserve to be congratulated for their efforts in focusing the right theme at the right time.

1. *Development and the Environment*, World Development Report, World Bank, Oxford University Press, 1992
2. Lal, J B, Malkania, Uma and Yadav, Vasu, Forest Food Species Status, Value and Future Challenges, Status Paper, IIFM Bhopal, 1994, pp 25
3. Gadgil, M. and Guha, Ram Chandra, *This Fissured Land - An Ecological History of India*, Oxford University Press, 1993

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