Vol XLVIII
No. 3

ISSN 0019-5014

CONFERENCE
NUMBER

JULY-
SEPTEMBER
1993

INDIAN JOURNAL OF AGRICULTURAL ECONOMICS

INDIAN SOCIETY OF
AGRICULTURAL ECONOMICS,
BOMBAY

Summaries

Ind. Jn. of Agri. Econ.
Vol. 48, No. 3, July-Sept. 1993

Fishery Co-operatives Model for Rural Development (An Experience of Reservoir Fisheries in Himachal Pradesh)

S.K. Chauhan and S.K. Sharma*

Himachal Pradesh is blessed with vast aquatic resources comprising major riverine systems, namely, Chenab, Ravi, Beas, Sutlej and Yamuna. The fish production in the state has increased by more than 20 times since 1950-51. The increase in fish production may be due to implementation of various programmes such as Fish Farmers Development Agencies and establishment of co-operative societies in the reservoir fisheries. The paper examines the aims and objectives, organisational structure and growth and functioning of nine fishery co-operatives, assesses the intra- and inter-relations of these co-operatives with the State Department of Fisheries in Himachal Pradesh, growth in fish production and value of fish catch earned by the government in the Pong dam reservoir and assesses the price spread in fish marketing and marketing efficiency. Primary and secondary data pertained to the year 1990-91.

The findings of the study undertaken in Pong dam reservoir of the state reveal that the number of co-operative societies, their membership and fish production increased substantially during the period of fifteen years, 1976-77 to 1990-91. Total revenue earned by the State Department of Fisheries in the form of royalty, licence fee compensation and auction of illegal fish increased by 1,312 per cent. Regarding the fish fauna it was observed that Mahseer has maintained its old composition all along, though it has improved marginally. Harvest of Cat fish comprising Singhara and Malli has shown slight improvement from 25 per cent to 32 per cent. Rohu, which was almost non-existent earlier, now constitutes a major chunk of the reservoir fishery, accounting for 23.54 per cent of fish production. The annual average fish catch per fishery co-operative society was estimated at 703 quintals, of which the share of individual fisherman was 8.58 quintals. The share of fishery in the fisherman's net income varied from 43 per cent in Jawali to 94 per cent in Nagrota Surian Co-operative Society. At the overall level, fishery accounted for 76.16 per cent of the fishermen's net income. All the co-operative societies proved their worth by making profits year after year successfully. The annual profit per fisherman in the co-operatives was Rs. 135. The marketing business shows that the major share (52.43 per cent) of the consumer's rupee goes to the fisherman, followed by the contractor (12 per cent) and retailer (10 per cent), thereby showing efficiency of the marketing system.

On the whole, it can be concluded that the reservoir fishermen's co-operative societies have proved their worth. The factors mainly responsible for the success of fishery co-operatives are (*i*) close linkages between co-operatives and State Department of Fisheries, (*ii*) provision of marketing facilities and remunerative prices for fish, (*iii*) strict implementation of 'close period' for two months in summer and use of recommended mesh size for gillnets, (*iv*) proper spawning in the reservoir and close supervision and guidance to fishermen by qualified and trained persons on the latest technologies regarding fish catch, (*v*) administration of fishing right system and (*vi*) provision of group insurance policy with

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very little premium amount. The policy implications of the study are that such fishery co-operative models should be replicated in other water resources of the state and the country to enhance fish production and finally to improve the conditions of poor fishermen.

Technological Choice for Managing Marine Fish Resources - A Case Study of Coastal Saurashtra

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The paper has made an attempt to study some of the issues involved in the choice of technology for exploiting marine fish resources in coastal Saurashtra. The data covered the period from 1960 to 1987 for three leading fishing districts, namely, Junagadh, Jamnagar and Amreli, of this region. The transformation experience of coastal fisheries of Saurashtra is quite revealing in regard to the choice of technology. The degree of mechanisation in the three fishing districts of Saurashtra is quite dissimilar. Their resource endowments too are non-homogeneous in certain respects. There is high concentration of fish population in shallow water near the coast in the entire region. The use of high tech trawlers against medium technology OBM boats in these three districts and their production and earning per boat are quite suggestive of choice of technology. The high degree of sophisticated mechanisation has led to large catch but its operation efficiency in terms of unit cost has declined. Besides, over a period, the high degree of mechanisation has led to rapid fall in production and revenue per boat. Thus rather than be guided by mere marginal cost and revenue considerations, the concerns of the sustainable development of the resource and communities solely dependent for their livelihood thereupon ought to be given priority while selecting technology for this sector. Therefore, over-fishing needs to be avoided. From the experience in coastal Saurashtra, a medium technology, such as use of OBM boats with certain technical modifications which can equip it for both 'near' and 'off-shore' fishing, is suggested for adoption.

Development of Production Assets for Sustainable Agriculture through Watershed Management Approach - A Case Study of Maheswaram Watershed in Andhra Pradesh

G.V. Jyothi and K.R. Chowdry*

The watershed management proves to be very effective in the management of renewable natural resources and development of production assets for sustainable agriculture at the local level. Maheswaram watershed is one of the watersheds in Andhra Pradesh which is funded by the World Bank. A study was undertaken with a view to assessing the development of production assets for sustainable agriculture through watershed management approach.

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Development of production assets included soil conservation and land development, irrigation development, agro-forestry and pastures. The important components of the soil conservation and land development programme included engineering and mechanical measures, vegetative barriers and agronomic practices, etc. The traditional soil conservation programme consists of contour bunding, gully plugging, check dams, etc. The cost of soil conservation measures worked out to Rs. 793 per acre. The alternative soil conservation programme was the khus grass plantation which acts as a vegetative barrier and is the quickest and cheapest method of soil conservation. The cost of khus grass plantation worked out to Rs. 86 per acre. The opportunity cost of other moisture conservation practices, such as deep ploughing, cultivation across the slope, dead furrow, etc., worked out to Rs. 43 per acre. Land development includes land levelling and land shaping and the costs worked out to Rs. 378 per acre. These programmes were adopted by all the farmers in the watershed area irrespective of the size of holdings. The soil conservation land development programme helped to increase the yield substantially in a sustainable manner. The development of irrigation includes deepening of old wells, digging of new wells, supply of electric motors, etc. It was found that facilities were provided to irrigate 183 acres of land of the selected farmers with a total capital investment of Rs. 26.07 lakhs. The creation of irrigation assets was a major contributory factor to sustainable agricultural development in the watershed area.

A total area of about 72 acres was brought under forest trees, in addition to fruit trees, fodder trees, such as subabul, timber plants, namely, eucalyptus and casurina. Further, fodder was found to be the most important component for livestock development. Pastures and fodders were raised on about 109 acres by the farmers on private lands. The cultivation of fodders gave a fillip to dairying and other livestock activities. Based on the study a number of recommendations have been made which include bringing under watershed management agricultural lands both arable and non-arable in general and dryland areas in particular, according top-most priority to the development of basic resources (land and water) in the watershed management programmes, better utilisation of wastelands through the development of silvi-pastoral system for the development of livestock enterprises, development of khus grass plantations as an effective soil conservation measure and involvement of rural youth in contour surveying through a simple instrument called 'hand leveller' and motivating the farmers to adopt soil conservation measures. As the technologies adopted in the watershed programme appeared to be capital intensive, it is suggested that the agro-biological scientists should focus their attention on evolving alternative suitable and cheaper technologies.

Impact of Integrated Watershed Development Programme in Scarcity Area of Maharashtra

B.J. Hinge, S.N. Tilekar, D.K. Mahandule and S.D. Suryawanshi†

The Integrated Watershed Development Programme broadly aims at soil water conservation, efficient cultivation, afforestation, agro-forestry and land shaping and levelling

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for achieving the desired goal. The programme has been in operation in Maharashtra but its utility and impact are very significant in drought-prone areas. The gestation period on completion of watersheds for 3 to 5 years has been completed in some sites. An investigation was, therefore, made to examine its achievements and to identify the constraints in the working of the programme in the scarcity zone during the year 1992-93. Four watersheds having completed one, two, three and four developmental activities from drought-prone areas of Ahmednagar district were selected. A sample of 40 beneficiaries was selected for the study. In the investigation an attempt was made to assess the situation before and after the watershed development.

The findings revealed that new crops were introduced and so also high value crops were substituted for low value crops. The crop cultivation was improved by the use of modern technology. The area under irrigated crops also increased. There was also increase in the productivity which resulted in increased gross income. The gross income which was Rs. 2,139 per hectare before development increased to Rs. 3,631 after the development of watershed. No substantial change in employment was observed. The benefit-cost ratio for crop production was 2.07.

The major constraints were lack of knowledge in the identification of proper watershed, non-involvement of beneficiaries and total absence of voluntary organisations in the execution of the programme. Similarly, farmers with fragmented holdings were not very much willing to participate. The impact of watershed development programme on land improvement, crop cultivation, productivity and income was observed to be as per expectation. The impact on horticultural plantations and agro-forestry was weak which indicates the need for more concerted efforts in this direction.

Economic Evaluation of Micro Watershed Development in Thane District (Maharashtra)

J.M. Talathi, V.G. Naik and S.G. Borude*

The paper aims at evaluating the comprehensive watershed development programme in Maharashtra with a view to assessing the benefits derived by the cultivators through this scheme. Posheri-3 micro watershed from Thane district of Maharashtra was selected randomly. The data were collected from 36 beneficiary farmers at two points of time, before (1985-86) and after (1991-92) the development of this watershed. In this micro watershed, 20.25 per cent (58.86 hectares) of the command area was covered under different watershed development activities. The cultivated area increased by about 23 per cent from 61.95 ha to 76.14 ha. The idle *varkas* land (land situated on hill slopes, which is of inferior quality) declined to 23.41 ha (32.25 per cent) and the area brought under forest was 9.22 ha. The terracing of land was completed on 7.54 ha (11.44 per cent achievement), horticulture on 2.90 ha (23 per cent achievement) and repairs to bunds of old paddy fields on 39.20 ha (67.64 per cent achievement). In addition to this, two nalla bunding works and afforestation

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on 9.22 ha were completed. Out of the planned expenditure of Rs. 6.34 lakhs, a sum of Rs. 3.69 lakhs was spent on these different activities. The soil and water conservation works were carried out on an average area of 1.21 ha, at a cost of Rs. 7,393 per ha.

The total cropped area increased by 59.5 per cent from 49.46 ha to 78.79 ha. The area under local varieties of rice declined from 88.92 per cent to 35.74 per cent. Consequently, the area under high-yielding varieties of rice increased from 8.25 per cent to 33.34 per cent. The proportion of double cropped area which was just 0.82 per cent under pulses increased to 9.53 per cent covering crops like watermelon, vegetables and pulses. The productivity of the crops also increased after the project work. The yield of rice, gram and *moong* increased by about 31 per cent, 59.60 per cent and 66 per cent respectively. The per head employment to family members increased by 14.36 per cent from 85.18 days to 97.41 days in the command area, while total employment increased by 21 per cent. In the watershed, the water level in the existing wells (drinking water wells) increased on an average by 2.33 ft. in the month of May; four new wells were constructed for irrigation purpose and water was struck at an average depth of 9 ft.

Economic Potential of Watershed Development in Dryland Agriculture: Evidences and Issues

Amita Shah†

Despite the declining trend in agricultural employment, the sector is still considered as the thrust area for generating additional employment in India. While irrigation is recognised as the crucial factor for fostering yield induced growth in farm employment, not much is known about the economic potential especially, in terms of additional employment of dryland agriculture. The present analysis tries to (*a*) provide further evidences on the economic potential of watershed technology and (*b*) suggest alternatives for realising the existing potential. A limited scanning of the experiment results indicated that the improved measures for soil and moisture conservation do provide substantial yield gains which in turn may also enhance on-farm employment on a sustained basis. However, the actual experiences do not confirm significant positive impact particularly under more constrained agro-climatic environment. This was evidenced in the light of the expected impact of the micro watersheds, which emphasises vegetative treatments in a low rainfall region in Gujarat.

It is recognised that under severe moisture stress conditions, yield and cropping intensity cannot be increased substantially. Hence, in the short run, economic benefits may flow mainly through (*i*) reclamation of community wasteland and (*ii*) change in the use pattern (crop-mix) of arable land. The analysis reveals that given the low intensity treatment plans in the micro watersheds, the expected benefits, especially in terms of employment, are quite low. Similarly, availability of fodder per household is also not likely to increase substantially. Compared to this, income from horticulture is expected to be quite high; however, the full realisation of this potential would critically depend on weather conditions for which there is no provision to ensure effective protection in the form of survival irrigation.

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Thus the recently emerging vegetative treatment appears to be environmentally sound and low cost, hence widely replicable but it has low economic potential in the initial stage. Nevertheless, there is scope for enhancing employment and income impact even in the short run. This could be attained by increasing the density as well as quality of plantations with the help of water harvesting structures and plant nutrients. Similarly, land levelling measures could be adopted on selected arable land so as to raise the yield substantially. While these measures are more resource intensive, they are economically more rewarding and also faster. Therefore, instead of diverting resources for wage subsidies to treat the arable land, a better strategy should be to provide credit to the farmers for carrying out required earthworks. Similarly, financial and extension support should be mobilised to develop community wastelands in a more intensive manner. This approach may not only enhance economic potential but may also improve the farmers' capacity as well as willingness to pay for it. In turn, it will make the strategy environmentally as well as economically sustainable.

An Economic Analysis of Degradation of Renewable Natural Resources and Its Implication to Sustainable Agriculture in Arid Zone of Rajasthan

K. Anantha Ram, D.L. Vyas and Rajender Parihar*

The degradation of renewable natural resources like vegetation, soil and groundwater resources in the arid zone of western Rajasthan has been analysed with the help of primary and secondary data. A decline in the area under common property resources (CPRs) by about 27 per cent and an increase in livestock density by 73 per cent between 1956 and 1988 exerted great pressure on grazing resources of the region. Household level data analysis revealed that the total forage supplies at household level declined by 40 per cent in 1988-89 compared to those in 1984-85. The forage supplies from CPRs declined by as much as 70 per cent in the corresponding period, indicating the degradation of grazing land productivity. Besides reduced forage, the fuelwood trees/bushes from CPRs were cut to be used as fuel for cooking. The short supply of fuelwood, owing to the degraded commons, has resulted in diversion of valuable cowdung as cooking fuel worth Rs. 302 (in nutrient) per household per annum. The winds on the denuded CPRs were estimated to cause soil erosion to the tune of 140-280 and 430-970 tonnes/ha on moderately and highly degraded grass lands of the region respectively. The low priced underground water was found to encourage high water duty commercial crops endangering the water source, on the one hand and increased pressure on CPR grazing resources, due to reduced crop residue supplied from cropland.

The gradual disintegration of traditional institutions maintaining the communal resources like grazing lands, water points, etc., with the various land reforms legislation after Independence, virtually threw open the gates for ruthless exploitation of CPRs, leading to degradation of these resources and the attendant problems of soil erosion. With the transition

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from a closed subsistence economy to a market economy with the increased market infrastructure and communication, the exploitation of communal resources has become more profitable. The institutional failure to drive home the value of natural resource stocks and the cost of degradation to the society at large and failure to provide fuelwood substitute like kerosene at reasonable rates and in adequate quantities, accentuated the process of degradation. Besides, Government policies of ad hoc nature like drought relief at the time of distress and charging water not according to cost of extraction, but on flat rate, etc., have encouraged people to be less vigilant and more exploitative in the use of free natural resources. In the above context, sustainable agriculture in arid Rajasthan hinges on the adoption of technologies perfected by Central Arid Zone Research Institute, Jodhpur, for the amelioration of the problems of the region.

Agricultural Development and Shrinkage of Land-Common Property Resources in Himachal Pradesh

Dalbir Singh and Narinder Kumar Sharda†

The study examines the process of shrinkage of land-common property resources (CPRs) and the impact of development of agriculture on the size of land-CPRs in different agro-climatic regions of Himachal Pradesh. The study was conducted in three zones, *viz*, low hills, mid hills and high hills. The cold dry zone was left out because of low concentration of population. From each selected zone, the locations of land-CPRs were selected. These locations were Maokhas from tehsil Bangana of Una district in low hills, Mamlog from tehsil Arki of Solan district in the mid hill and Along from Kotkhai tehsil of Shimla district in the high hills. A cluster of villages which used selected land-CPRs was formed. The list of households in the cluster was prepared and categorised into marginal, small, medium and large size of farmers. All the households (110 in low hills, 354 in mid hills and 104 in high hills) were taken into account to get an idea about the encroachment of land-CPRs. The required data were collected for the year 1989-90. The data relating to encroachment of land-CPRs were obtained from the revenue/forest officials and villagers.

The study revealed that the area under common lands has declined due to its distribution to the landless persons under anti-poverty programmes and other development activities. In addition to this, the land-CPRs also shrunk due to unlawful encroachments. The land-CPRs have declined proportionately more in the mid hill area than in the low and high hill zones. In absolute terms, the shrinkage in the land-CPRs is greater in the high hills than in the mid and low hills. It is inferred that consequent upon the shrinkage of land-CPRs, a variety of problems are being faced by the community in the rural area like social tension and litigation. The study shows that a maximum proportion of households is involved in the encroachment of land-CPRs in the high hill area. Across the different farm sizes, the maximum encroachers are proportionately medium and large farmers in the low and mid hill zones and marginal, small and large farmers in the high hills. The proportion of encroached land to total owned

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land is also the highest in the high hills as compared to that in the low and mid hills. It has been noticed that the land-CPRs adjacent to private owned land are more frequently and easily encroached upon steadily by the individuals. The encroached land is used for agricultural and horticultural production. Thus it can be concluded that with the development of agriculture, particularly cash crops like apple and vegetables, the individuals are motivated to encroach on common lands because the economic gains from a small piece of land are higher than those from grazing animals. This is likely to pose an increasing threat to the sustenance of these resources and ecological imbalances in the region in the times ahead. The government should desist from regularising unauthorised encroachment of land-CPRs merely because these are politically expedient. Special enforcement cells should be set up to identify the unauthorised encroachers and evict them from common lands. This could be done by giving quasi-judicial powers to these cells.

Role of Girijan Co-operative Corporation in the Marketing of Minor Forest Produce in Andhra Pradesh

N. Gopala Rao*

The dense forests of the scheduled areas in Andhra Pradesh are endowed with rich variety of minor forest produce (MFP). The coastal districts are potentially rich and varied items like adda leaf, tamarind, myrobalans, broom grass, soapnuts, nux vomica and R.S. roots are abundantly available. Gum, mohwa flower and seed and kendu leaf and honey are some of the important items available in Telangana and Rayalaseema regions. The tribal people in the state numbering 31.76 lakhs collect these MFP items and sell to different agencies to supplement their meagre income from agriculture.

An attempt is made in the paper to evaluate the role of Girijan Co-operative Corporation in the marketing of MFP in Andhra Pradesh. Traditionally the non-tribal traders are the only channel of marketing of MFP, who used to exploit the innocent tribals by underweighing the produce and paying low prices which are often coupled with petty advances of cash and also barter of items of daily consumption. In order to reduce the influence of the traders, the State Government has established Girijan Co-operative Corporation (GCC) with monopoly rights over procurement of MFP and the private trader was legally prohibited from buying MFP. Though it has succeeded in eliminating the stranglehold of the private trader, it could not completely drive away the trader from the tribal areas because of its inherent operational deficiencies. The main reason for the partial success of GCC is its high overheads, leading to low sale prices and narrow profit margins for the MFP sold by them. The GCC has enforced stricter financial discipline in regard to expenditure so as to see that its impact on the trading business is reduced considerably, besides capturing wholesale markets with greater efficiency to obtain highest selling prices for the MFP to enable the Corporation to pay higher prices to the tribals without incurring losses.

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Analysis of Minor Forest Produce - A Case Study of Shellac Trade in India

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An attempt has been made in the paper to examine some aspects of shellac trade in India. Shellac is one of the important items in the list of minor forest produce (MFP), cultivated by more than five million tribal cultivators in the major forest areas of India. It is the only natural resin of animal origin, contributing significantly to the cash earnings of the cultivators. Shellac trade in India mainly depends on export. The domestic consumption of shellac was only about 15 per cent of the total production. The internal trade was largely carried out through open market channels, mostly by private traders and co-operative marketing societies. Large-sized Adivasi Multipurpose Societies (LAMPS) have been established in the important lac growing areas to carry out marketing of lac. The export trade is promoted by Ministry of Commerce and Shellac Export Promotion Council (SEPC).

The quantum export of lac has declined from 29,300 metric tonnes to 6,200 metric tonnes during the period 1951-52 to 1989-90. This is mainly because of gradual reduction in the production levels, which has resulted in the negative influence on the end users in the traditional consumer countries of Europe and America. However, new markets have been captured in the developing countries of Asia and Africa. Thailand has emerged as the main competitor of India in the international market of shellac.

The study concludes that the mainstay of this commodity lies in the avoidance of synthetic substitutes. In this direction, lac consumption needs to be popularised mainly on ecological and social grounds. Further the non-toxic nature of lac may also help in opening new avenues of consumption in the food industry.

Management of Wastelands through Community Forestry

Vijay Laxmi and V.K. Pandey*

This paper deals with the use and management of wastelands for fodder, fuel and timber production through community forestry. The distribution of these wastelands in different states of the country by their nature and causation shows that salt affected lands are quite high in the western, central and southern regions, while the gullied and ravine lands are largely concentrated in the central region. The waterlogged areas are largely concentrated in the Uttar Pradesh-Bihar tract. The culturable undulating uplands are highly concentrated in Rajasthan, Madhya Pradesh, Orissa, Gujarat, Maharashtra, Andhra Pradesh and Karnataka. Jhum and forest blanks are spread over all the regions, while sandy area is confined largely to Rajasthan State. The unculturable wastelands are more in the northern and central regions. Much of these wastelands can well be used for social forestry through people's

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participation, which is termed as community forestry, in order to meet the deficiency in demand for fuel, fodder and timber in a long run perspective. The community forestry involves afforestation of village common lands with people's participation. The role of government agencies in this programme should be catalytic in nature and should help in transferring the ownership rights of the planted trees to the people.

To test the applicability of the concept that community wastelands could be planned and managed for meeting the local needs of fuel, fodder and timber, a case study of Khulgad micro watershed of Hawalbagh block of Almora district in Uttar Pradesh was undertaken. This case study relates to preparation of an optimum tree combination plan for afforestation of community wastelands through participation of local people for meeting their fuel and fodder demands. The linear programming technique was used to find the optimum tree-mix plan for plantation in 800 hectares of community wastelands in 34 villages of the area. The objective function representing total net social benefits from the planted trees over a perspective period of 100 years was maximised. The constraint set in the usual form related to the total land supply, total annual fuel demand, separate summer and winter season fodder demand and maximum/minimum area constraints for some tree species. The feasible solutions pertaining to optimum tree combination in various alternate plans show that the local requirement of fuel and fodder can be met by the community afforestation programme, in addition to generation of some income from the sale of timber and other products.

The factors which affect the people's participation in the programme were studied through linear regression analysis. It was found that the size of agricultural land holding, level of education, contact with extension worker, scientific orientation, people's overall modernity, plantation of locally desired tree species and distance of present site for fuel and fodder collection all had significant and positive impact on people's involvement in the programme being run by the Central Himalayan Environment Association in the area. On the other hand, the factors of age of respondent, distance of site of plantation and mass-media exposure (via time disposition) were found to have significant but negative impact on people's participation.

Extent of Wastelands and Their Rehabilitation through Proposed Management Skills in Western Himalayas

T.V. Moorti†

The Himalayan land resources are about 16 per cent of the land resources of India. Himachal Pradesh is one of the premier states of the Himalayan region, comprising various climatic regions from sub-tropical to sub-temperate. The increase in human and cattle population and increased requirement of wood for industrial and domestic use, fuelwood and fodder have led to the degradation of land and environment. According to one of the estimates, a land area of 175 million hectares (53 per cent of the total land) is considered to be wasted in India. The corresponding figure for Himachal Pradesh is 2.646 million hectares

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(48 per cent of the total area). Considering the ever increasing human and livestock population and the projected demand for 240 million tonnes of foodgrains, 210 million tonnes of fuelwood and about 2,100 million tonnes of fodder by the turn of the 20th century, it is imperative to look for ways and means by which we could sustain the population pressure in respect of life support components. With this background, a study was conducted mainly to estimate the extent, capabilities and causes of wastelands, besides the present gap in the demand for and supply of fuelwood and fodder, based on analysis of data collected from 1,984 cultivators, selected from 200 villages in the district Kangra of Himachal Pradesh relating to the year 1986-87. The study reveals that, on an average, the area under wastelands was around 80,000 hectares (13.94 per cent of the geographical area) throughout the district. About 48 per cent of such lands belonged to farmers, 39 per cent to State Forest Department and 13 per cent to Village Panchayat and State Revenue Department. A large proportion of wastelands (about 40 per cent) belonged to category IV of land capability classification whereas categories II, III, V, VI, VII and VIII accounted for 2, 21, 13, 20, 4 and 0.4 per cent of such lands respectively. The reasons diagnosed for formation of wastelands were soil erosion emanating from deforestation in forest lands and removal of bushes and vegetation for fuelwood, besides over-grazing, infestation by weeds, state mining and lack of awareness on the part of people to put such lands under useful biomass production. On an average, about 325 man-days of labour were utilised for the collection of fuelwood, of which the contribution of women, men and children was 45, 37 and 18 per cent respectively. The gap between demand for and supply of fuelwood, fodder and timber was met through over-exploitation of their own lands and common lands. All this led to environmental degradation in terms of desertification, disrupted radiation balance, disrupted hydrological cycle, floods during monsoons, draught in summer culminating in shattered life support system in terms of depletion of fuelwood and timber sources. To halt this process, to bring environmental protection and to improve the quality of life of people living around such lands, several management skills have been highlighted, such as adoption of traditional agro-forestry systems, water resource development, financial management and above all, people's participation in wastelands regeneration activity on the concept of equal participation equal benefits.

Evaluation of Soil Conservation Programme in the Watersheds of Kundah Catchment, Tamil Nadu

B. Anuradha*

This paper seeks to evaluate soil conservation measures in Kundah catchment area in Nilgiris district, Tamil Nadu. The data are taken from the study "Evaluation of Soil Conservation Programme in Kundah Catchment - Tamil Nadu and Kerala" conducted by the Agricultural Economics Research Centre, University of Madras. There are seven watersheds where soil conservation measures have been taken up in Kundah catchment area. Out of these, two watersheds, *viz.*, Uppersillahulla and Neeralipallam have been taken up for the

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present study. Eight villages from the two watersheds were chosen and a total sample of 80 farmers, 40 each from the two watersheds, were contacted with a view to examining the yield, income, employment, etc., of the sample farmers during the period 1985-86.

The implementation of soil conservation measures in these watersheds include bench terracing, gap filling, contour stone wall, revetment, etc. Bench terracing is the prominent measure in Uppersillahulla, while gap filling and contour stone wall are predominant measures in Neeralipallam. All the 40 sample farms in Uppersillahulla watershed held an average area of 1.66 ha, out of which 57 per cent (0.94 ha) was treated with bench terracing. Potato, cabbage and carrot were the crops grown by these sample farmers. The yields per hectare (*i*) between benefited and pre-implementation area and (*ii*) between benefited and non-benefited area were compared for all the three crops/vegetables. There was at least 10 per cent increase in the yields due to the conservation measures and this increase was also found to be statistically significant.

In Neeralipallam watershed 18 sample farms had an average of 0.93 ha of land treated with gap filling and 22 sample farms with an average of 2.43 ha were treated with contour stone wall construction. The coverage was cent per cent under these two measures. Tea was the only crop grown. Here again the yields showed a rise due to the conservation measures. In these two cases also the increase was found to be statistically significant. The increase in yields of the sample farms has resulted in higher gross and net incomes from cultivation. There was generation of additional employment in the watersheds due to the implementation of soil conservation measures. It has been estimated that 460, 183 and 24 labour days were required to implement the measures of bench terracing, contour stone wall construction and gap filling respectively in one hectare of land. Due to the reluctance of local labour, the works are taken up by the contractors who employ labourers from the neighbouring districts. The implementation of these measures has resulted in the increase of yields and in the adoption of intensive cultivation techniques and hence this calls for additional labour for cultivation which is of a recurring nature. The increase in labour days for cultivation thus created works out to more than 80 for one hectare of land under bench terracing while it is marginal in gap filling and contour stone wall types of measures. Hence, it can be concluded that there has been an increase in yields, income and employment due to the soil conservation measures in the watersheds. But the farmers must be educated about the usefulness and real goals of the scheme. Better knowledge about the importance of soil conservation measures would go a long way in the development of the area served by the project.

Economic Evaluation of Soil Erosion and Soil Conservation Work: A Case Study from the High Range Agricultural Region of Kerala

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Kerala, like other hilly states of India, suffers from the hazards of serious soil erosion problems due to high intensity of rainfall, undulating topography, unscientific and intensive

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agriculture and indiscriminative deforestation. It is more on the high ranges of the state where agricultural development is at the cost of natural forests. The present study tries to make an economic evaluation of soil erosion and soil conservation work in a high range agricultural region (Idukki district) of Kerala State. In order to evaluate the environmental quality of agricultural lands, the study uses both replacement and preventive cost approaches. The replacement cost approach is based on reckoning the cost of replacing productive assets (land) that have been damaged because of pollution (soil erosion) or improper on-site management. These costs, such as additional expenditure related to trenching or digging pits, replacement of eroded soil from these trenches to cultivating plots, construction of temporary bunds, additional money spent on chemical fertilisers or organic matter, etc., are taken as a minimum estimate of the value of measures that will reduce soil erosion or improve on-site management practices and thereby prevent further damages. Preventive expenditure method is based on the premise that cost of environmental damage can be approximated by studying the expenditures that people are willing to incur to prevent environmental hazards permanently (for example, the costs related to the construction of stone bunds, regulating run-off channels, etc.).

The analysis of primary data collected from the pepper gardens located at different altitudes and brought under cultivation at different points of time indicates that the income forgone due to soil erosion is approximately about 4 per cent of every year's yield. To know the economic viability of soil conservation work, the study carried out benefit-cost analyses of pepper cultivation 'with' and 'without' soil conservation. They clearly explain the profitability of undertaking soil conservation work. Yet, the majority of farmers in this study area are not undertaking conservation work. It not only degrades the quality of land but also erodes the economic base of the region by reducing the productivity of the lands if the present rate of soil erosion continues.

Biotic Pressure, Land Use and Sustainable Development in Uttar Pradesh

Ajit Kumar Singh*

The paper highlights the imbalances in land use created by the extreme biotic pressure and suggests a strategy for sustainable development for Uttar Pradesh. The relative scarcity of land resources has been highlighted with the help of different indicators. The density of population in the state has increased from 215 in 1951 to 473 in 1991, while net sown area per person has declined from 0.30 ha to only 0.15 ha during the same period. Though foodgrains output has increased at the rate of 3.5 per cent per annum in the post-green revolution period, food shortages are likely to emerge in future given the continuous rise in population and high income elasticity of demand for foodgrains.

There is an acute shortage of fuelwood in the state. The supply of fuelwood in 1981 is estimated at 18.6 lakh cu.m against the demand of 415 lakh cu.m. Similarly, the reported

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output of timber in the state is only 6.86 lakh cu.m against the current demand of 44.7 lakh cu.m.

Livestock pressure on land is equally high with two livestock units per hectare of net sown area. Consequently, there is an acute shortage of livestock feed and fodder. Thus the supply as a proportion of requirement comes to only 22 per cent in the case of concentrates, 68.2 per cent in the case of dry fodder and 13 per cent in the case of green fodder.

The heavy and increasing pressure of human and livestock population on limited land resources have created serious imbalances in land use in the state. Nearly 60 per cent of the area has been brought under the plough. Very limited area is now available as common property resource. Only one-sixth of the land is officially reported under forests. However, effective forest is much lower around 11.5 per cent of the area, as revealed by landsat imagery. Moreover, the forest cover has been almost completely depleted in the Gangetic Plains of Uttar Pradesh with as many as 32 districts with no forest cover at all. An area of almost 20 lakh hectares is lying fallow and another 20 lakh hectares are classified as wastelands.

The existing pattern of land use is clearly unsustainable over the long run. Urgent steps are, therefore, required to adopt a perspective integrated programme of management and development of the land and water resources of the state for achieving a sustainable pattern of land use and development. Highest priority has to be given to the expansion of area under forests and tree cover and rejuvenating the degraded forest area. A massive programme of wasteland reclamation is needed for afforestation and other productive uses.

Land Degradation in a Sugarcane Growing Tract: An Empirical Analysis

R.R. Doshi†

The paper presents a case study of two tracts from Kolhapur and Sangli districts of Maharashtra State, which were earlier used for cultivation of sugarcane, namely, villages Udgaon and Chinchwad (Shirol tahsil) in Kolhapur district and villages Ashta (Walva tahsil) and Digraj (Miraj tahsil) in Sangli district. The former two villages are located on the right bank and the latter two on the left bank of the river Krishna. The sugarcane cultivation in these tracts increased rapidly during 1960-80 by diverting land from other crops due to establishment of sugar co-operatives. Heavy irrigation of the lands has resulted in the development of saline-alkaline soils, ultimately making the lands unproductive. In Udgaon and Chinchwad villages the salt affected area increased from 120 hectares in 1976 to 146 hectares in 1979. In the periphery of Ashta and Digraj villages the damaged land in 1979 was 284 and 530 hectares respectively. The problem of land salinity came to the forefront about the year 1975 and has continued since then. In 1990-91, 11,376 hectares of land in Sangli district and about 3,000 hectares in Kolhapur district became unproductive due to salinity.

Among the various causes of the malady, heavy irrigation of the soil without regard to

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the soil and topographical conditions of the tract was the prominent one. In these areas the soils are very deep and very heavy in texture and the topography is plane. The constitution of the soil and its topography are not conducive to easy draining of irrigated water. Excess water deposits got accumulated through heavy irrigation or percolation from upper reaches increased the water table and led to accumulation of salt in the root zone and on the land surface. Monoculture is widely practised. Silting of natural drains, waterlogging, diversion of natural courses, heavy doses of predominantly nitrogenous fertilisers for sugarcane crop, etc., are the other factors contributing to the hazard of saline-alkaline soils. Even though the problem became manifest roundabout 1970, neither the cultivators, nor the government agencies nor the co-operative sugar factories took notice of it and acted to revent further deterioration. With rapid escalation of the affected area, since 1975 the land users became a little serious about it.

The reclamation programme recommended by the experts is three pronged: (*a*) improvement of soil by leaching and drainage, (*b*) use of chemical amendments and (*c*) change in agronomic and cultural practices. These programmes involved heavy costs. For providing surface and soil drains, the estimated per hectare cost at 1979 prices was Rs. 7,525 for Ashta-Digraj region and Rs. 1,636 for Udgaon-Chinchwad region. Soil amendment cost by way of application of gypsum, pyrites and/or compost manure was estimated at Rs. 500/ha per annum. Application of pressmud and cultivation of salt tolerant plants like *shevari, dhencha,* sugarbeet, etc. are also advocated. At current prices, the overall financial burden on the cultivator would be about Rs. 26,000 (Ashta-Digraj) and Rs. 6,500 (Udgaon-Chinchwad) per hectare in the initial year, besides the burden of soil amendment in the subsequent years. To enable the cultivators to bear this, 20 to 25 per cent of the cost be given by the State Government as subsidy, co-operative sugar factories should give a matching subsidy and the rest should come from the Land Development Bank as term loan to the beneficiaries. Reclamation work should be undertaken collectively. Efforts should be made to see that in future the hazard is not faced by any sugarcane growing region.

Adverse Effects of Land Degradation: Some Evidences on Soil Salinity and Waterlogging

P.K. Joshi and B.L. Gajja*

The paper addresses some specific issues related to the dimension and causalities of soil salinity and waterlogging, their consequences and strategies to manage these degraded lands. To measure the adverse effects of these problems, a few major irrigation projects located in different agro-climatic regions were selected. Diverse statistics show that an area of 5.5 to 20 million hectares is either adversely affecting present agriculture or threatening future sources of growth.

Some important adverse consequences of degraded land resources due to salts and waterlogging are measured at farm, regional and national levels. At the farm level, the negative effects are: (*i*) threat to the sustainability of land resources, and (*ii*) decrease in

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farm production by (*a*) abandonment of crop production, (*b*) decline in resource productivity and (*c*) cut-back in resource use. At the regional level, the consequences are: (*i*) displacement of labour from agriculture, (*ii*) widening income disparities and (*iii*) adverse effect on the sustainability of secondary and tertiary sectors. At the national level, the adverse effects may be witnessed in the form of (*i*) decline in agricultural production, (*ii*) effect on gross domestic product, (*iii*) decline in export potential of important crops and (*iv*) increase in the import bill.

Since the problem is of a serious nature posing a threat to intra-generational sustainability of land resources, a few management and policy options are suggested. These include (*i*) developing authentic and reliable data base to plan future course of action, (*ii*) revision of extension agenda in favour of pro-sustainable development, (*iii*) encouraging incentives to community approach, (*iv*) providing incentives to preventive measures, (*v*) developing appropriate irrigation price policy to avoid many land degradation problems and (*vi*) developing suitable organisations and institutions to support many pro-sustainable technologies.

Technological Option to Sustain Agriculture in Saline Environment

K.K. Datta†

Historical evidences showed that mismanagement of canal irrigation in arid and semi-arid regions led to the problem of land degradation in the form of soil salinity and alkalinity. The technology for curing and preventing the saline soils on a sustained basis for crop production consists of providing appropriate land drainage, improved water management practices and selection of a crop-mix with low to moderate water requirement. Among available technologies, agricultural land drainage is gaining in importance as a curative or preventive measure. Similarly, the technological option to cure the salt affected alkali soils on a sustained basis includes (*i*) chemical amelioration for crop production and forestry and (*ii*) biological technology by growing salt tolerant crops. The techno-economic feasibility of agricultural land drainage in different locations in Haryana shows that after the installation of drainage, land utilisation intensified, as a sizeable area of formerly fallow land was brought under cultivation. It resulted in an increase in cropping intensity, changes in the cropping pattern and improvement of crop yields. Benefits are also observed in the form of gainful employment opportunities, external economies and strong inter-sectoral linkages. The benefit-cost ratio and net present worth are estimated at 1.26 and Rs. 4,659/ha respectively. The internal rate of return was 13.3 per cent, which was sufficiently higher than the market rate of interest. The sensitivity analysis by changing the net farm income showed that the drainage for salinity control is financially feasible.

Economic studies of chemical amendment technology for reclamation of salt affected

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alkali soils are also found to be financially feasible in different locations of Punjab, Haryana and Uttar Pradesh. The biological technology (salt resistant paddy-wheat variety like CSR-10 and KLR 1-4) showed remarkable results: the benefit-cost ratio is Rs. 3.48 and the net present worth of Rs. 21,386/ha indicated its financial feasibility. But the process of reclamation was slow. The pay-back period is about 3-4 years.

Finally, the paper deals with the constraints of transferring these technologies. To protect the saline environment for crop production on a sustained basis needs appropriate effective legislation in order to check the mismanagement of natural resources mainly 'land' and 'water'. Proper pricing and accountability are suggested as policy measures and for that people's participation is very much needed.

Sustainable Agricultural Development: A Dynamic Linear Programming Approach

D.V. Subba Rao*

Sustainability of agricultural growth has become an important issue in the context of the widespread concern about the degradation of environment. The increasing pressure of population on natural resources brings into focus the interrelationships which must be investigated in specific quantitative terms. As sustainability issues are dynamic in nature, a sustainable land use model is developed and estimated for a semi-arid region, *viz.*, Ranga Reddy district in Andhra Pradesh. The results indicate that the income can be increased at the expense of soil loss, which is estimated at 3.26 per cent at 12 per cent discount rate. The increase in income is only 0.41 per cent at 5 per cent discount rate. It requires that a minimum of 8.9 per cent of land should be under forests in order to ensure sustainability at 12 per cent discount rate. This percentage is much higher and reaches to 27.1 per cent at 5 per cent discount rate. Sustainable land use over time improves groundwater augmentation which increases income by 4.98 per cent when the supply is raised from 5 per cent to 9 per cent every year.

The land use pattern suggests that dryland horticulture, subabul forestry plantation and pasture development should be taken up on a large scale apart from inter-cropping systems. It is more conspicuous at low discount rate. Therefore, low discount rate conditions need to be created to ensure sustainability. This can be done by extending the long-term credit to sustainable farming systems. In turn, these conditions help to enhance employment potential. These systems further enable to provide sufficient feed and fodder to increase milk production, as the present livestock is under-nourished. Hence, the sustainable land use and livestock systems in an integrated way have enormous potential to improve environmental quality and food security in the years to come.

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Ind. Jn. of Agri. Econ.
Vol. 48, No. 3, July-Sept. 1993

Sustainability of Agriculture on Degraded Irrigated Lands in Haryana

Jai Singh and D.S. Nandal†

Land degradation in the form of soil salinity and waterlogging is assuming alarming proportions in the irrigated areas of Haryana unfavourably affecting the sustainability of agriculture on such lands. The present study is based on the primary data collected from a sample of 248 farmers (114 having normal land and 134 with some degraded land) pertaining to the agricultural year 1989-90. The study examines the adverse effects of degraded land on crop productivity, the magnitude of the problem and its causality and suggests remedial measures to maintain sustainability of agriculture. Although no exact estimates are available about the magnitude of soil salinity and waterlogging problem, yet scattered information shows that 4-5 per cent of the total geographic area of the state is already affected by it. The problem is further increasing with the passage of time with the increase in irrigation facilities due to naturally blocked drainage, native saline groundwater, saline water irrigation, limited rain water recharge, low lying topography, climatic conditions and inefficient water management.

The productivity and return over variable cost from all crops declined on both types of problem soils as compared to normal soils which were partly due to the adverse effect of problem soil and partly due to the squeeze in input use on such lands. Severely affected lands went out of cultivation. The decomposition of change in yield from production function equations shows that both the types of land degradation are mainly responsible for reduction in the yield of paddy and cotton. The dominant downward pull effect is of soil salinity on wheat yield and of waterlogging on sugarcane yield. It was the squeeze in the use of inputs which caused a major decline in the yield of wheat on waterlogged land and in the yield of sugarcane on saline soils. The total loss in the three selected districts due to land degradation was about Rs. 257 million during 1989-90. It is mainly due to degraded land going out of cultivation and partly on account of lower yield obtained from such lands. For maintaining sustainability of agriculture, due emphasis has to be given to provision of land drainage, efficient water management, afforestation and evolution of salt tolerant crop varieties. An appropriate strategy should be evolved for different irrigated regions for management of degraded land and sustainability of agriculture, keeping in view the potential social and economic benefits and costs of alternative remedial measures.

Water Resource Management for Sustainable Agriculture

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Of late, it has been recognised that management of natural resources is very crucial and urgent for sustainable agriculture anywhere and more so in India. Keeping this in view, the

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paper examines the three broad issues of water resource management: (*i*) water use pattern in maize, rice and wheat crops at different locations of an irrigation canal, (*ii*) optimum water utilisation plans for scheduling irrigation to important crops and (*iii*) water recycling to use sewage and industrial waste water for growing of crops, trees, etc. For studying the first two issues, Giri Canal Irrigation Project (GCIP) , Majra in Paonta Valley, Sirmaur district of Himachal Pradesh, was selected purposively, as it is the only canal irrigation system in the state. The command area of this irrigation system is divided into three reaches, *viz.*, head, middle and tail, depending on the distance along the canal. For data collection, two villages were selected randomly from each location; a sample of 40 farmers, representing different size-groups, was drawn at random from each location, thus making a total sample size of 6 villages and 120 farm households. The third issue is mainly based on the studies available on the use of sewage and industrial effluents in different parts of the country.

The study revealed that because of their ignorance, the farmers at head and middle reaches of canal generally over-irrigated their crops, assuming that it would enhance their crop production; but the continued use of excessive irrigation, instead of improving, decreased their crop and water productivity and deteriorated the soil health which adversely affected the sustainability of agriculture and posed environmental hazards, like the problem of waterlogging, wilting, etc. To overcome this problem, the farmers should be educated about the needs and methodology of using irrigation water optimally. Also, the farmers in the head and middle reaches should be advised to avoid over-irrigation and let the surplus water flow for use by the tail-enders of the canal. In areas where irrigation water sources are limited, the potentialities of harvesting and conserving rain water in micro watersheds should be explored and exploited for sustainability of agriculture. The results of research and scattered developmental efforts have shown optimistically that there is a vast scope for utilising sewage and industrial effluents for raising tress, for greening wastelands and preventing their degradation in the country. Therefore, the use of sewage water and industrial effluents/waste water in raising field crops and trees on commercial scale should be assessed and encouraged for its implementation. It would not only help in solving the problem of waste water disposal but also enhance the income and employment avenues for many unemployed and needy persons in the country.

Traditional Irrigation Systems and Government Assistance: Experience and Lessons from Kuhls in Himachal Pradesh

Ramesh Chand and S.C. Tewari†

Kuhls are the major sources of irrigation in hill areas of the country and in Himachal Pradesh about 90 per cent of the irrigated area is under *kuhl* irrigation. *Kuhls* are small gravity channels constructed along mountain sides leading water from stream and springs to terraced fields. They are mostly farmers' managed irrigation system and persist largely outside government control. These *kuhls* are examples of a common property natural resource which are controlled and operated by a group of local users who have rights in

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them. Since many of these *kuhls* have been operated and managed by beneficiaries themselves, on sustainable basis for a long period, they offer pertinent lessons for participatory or local people's management of common property resources (CPRs). The government has been providing direct and indirect assistance to these traditional systems for improving their efficiency and the impact of government intervention has been debated by the researchers. The present investigation was based on two case studies undertaken to analyse the (*i*) pattern of traditional organisational and institutional arrangements for water distribution, *kuhls* maintenance and conflict resolution among the beneficiaries and (*ii*) the impact of government assistance on operation and maintenance arrangements of community *kuhls* and involvement of beneficiaries in the development work.

Based on the historical connections, three types of traditional systems for *kuhl* management were observed in Himachal Pradesh. The most sophisticated and advanced systems evolved by the local users were prevalent in the areas which were under British Raj and informal or loose organisations of local users having well-defined water rights were in vogue in areas ruled by elite kings of large princely states. The third type of system where there was no order, no organisation of local users, no water rights specified for individual and no set of norms for water distribution was observed in the remote regions which were ruled by petty feudal lords. This study focuses on the second and third type of the system and presents a case study of Kelown-Srinagar *kuhl* in Solan district and Gandhori *kuhl* in Sirmour district of the state. The study brings out that the performance and functioning of the traditional irrigation system was critically dependent on well-defined water rights for each individual in the command area which in turn has been affected by historical connections. The local users were able to maintain and operate the system sustainably where the rights and obligations were clearly defined. There was a strong need for state intervention to define the water rights legally where customary water rights did not hold. The non-existence of water rights resulted in skewed distribution of water in favour of high caste farmers and against lower caste farmers. The development work was not reported to be detrimental to organisational aspects nor did the development agency induce the strengthening of local water user's organisation. Direct assistance by the development agency brought some improvement in the efficiency of the system but the involvement of the local beneficiaries in development work was lacking, which created a feeling of alienation among them.

Factors Influencing Domestic Energy Use: Study of Three Rural Environments in Andhra Pradesh

Jacob George and K. Hanumantha Rao*

Energy is a critical input in development and development itself enhances the demand for energy. The management of demand-supply gap in energy is a challenging task and as a part of the solution set, village and household level energy budgets have to be prepared. The conditions facilitating people to opt for commercial sources or high efficient fuels have to be identified in each environment. The access to forest areas and magnitude of common

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property resources including their access (to the poor) and the socio-economic development play a significant part in the determination of fuel-mix and energy use efficiency and thus the demand for energy for domestic use. Keeping this in view, the paper attempts to estimate the level and pattern of energy use in three different environments characterised by different levels of irrigation (including quality of irrigation) and type of agriculture. It examines the effect of social (family size) and economic (land holding) factors on the demand for energy and also traces the interaction effects of development with the environment as well as the socio-economic conditions of households within an environment. The study was carried out in 1986 in three villages, *viz.*, Chandapur, Kamalapur and Ankapur in Nizamabad district of Andhra Pradesh. Given the low opportunity cost of labour in rainfed areas and access to forest and common property resources, the fuel requirements are met through collection of crop residues, twigs, shrubs (which are less efficient), etc. The expansion of irrigation input resulted in either monocrop culture (paddy) or commercial agriculture led to substitution of less efficient fuels by high efficient ones. The size and the motive behind holding the animal stock facilitated the adoption of the biogas technology. Introduction of liquid petroleum gas and kerosene in prosperous environments helped to increase the efficiency in energy use. Thus the demand for energy increases with development and the environment and economic factors basically determine the fuel-mix in the rural context.

An Appraisal of the Options for Renewable Energy in relation to Domestic Uses

A.S. Solanki, P.M. Sharma and N.S. Rathore†

Presently, there are different conventional as well as non-conventional energy sources which are being used for meeting different energy needs of the population. Several projects on renewable energy are being implemented in Renewable Energy Centre, College of Technology and Agricultural Engineering, Udaipur for research and development works. The sponsoring agencies are mainly the Department of Non-Conventional Energy Sources, Ministry of Energy, Government of India and Indian Council of Agricultural Research, New Delhi. The technical information and data used for this paper are based on the outcome of the research conducted at Renewable Energy Centre, College of Technology and Agricultural Engineering, Udaipur, Rajasthan Agricultural University, Bikaner.

Looking to the magnitude of the share of domestic energy in total energy utilisation (nearly 64 per cent), the focus is on the domestic use of energy, particularly energy meant for cooking and lighting. The alternative sources of cooking energy are biogas, firewood, solar cooker, solar photovoltaics, gasification, wind energy, magneto-hydro dynamics (MHD), geothermal and ocean energy. The options for lighting requirement are biogas, solar thermal, solar photovoltaics, wind energy, MHD, geothermal/ocean energy and wood based power generation system in vogue. The empirical evidences lead to establish the suitability

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of biogas technology both for cooking and lighting energy on the basis of cost effectiveness. Though the per kWh cost is the least in the case of wood based power generation, the initial cost of erection of the plant is very high. Hence, it can be suggested that efforts should continue on experimental basis to make other alternative techniques cost effective. The efforts should also continue to improve the biogas technique in order to overcome the problems faced relating to it so that it may be popularised being suitable in various circumstances. There is also the need to examine and amend suitably the policies to make this best technique for harnessing renewable energy for domestic purpose, more acceptable socially. In fact, location-specific constraint analysis through research endeavour can contribute a lot to make this technique more suitable. The research efforts are not only required on technical front but there is also a great need for socio-economic research in this field.

Energy Needs of Rural People: A Study in Trichur District of Kerala

P. Indira Devi and P.K. Ajithkumar*

Among various sources of energy, fuelwood is the most common one in the rural areas of India. Various studies conducted on this aspect revealed that there is a widening gap between the demand and supply of fuelwood in India. Kerala is no exception to this. Wood as fuel constituted 83 per cent of the total demand for wood in the state. Due to various socio-economic reasons, the supply-demand gap in the state is going to be very severe. In view of this, a study was made to analyse the supply behaviour of firewood in Kerala and the energy use pattern in the rural areas. This will help to develop a suitable policy to manage the situation. The study was based on both primary data and secondary data relating to the period 1960-91. The fuelwood supply in the state showed a declining trend at the rate of 3 per cent per annum for the past 31 years (1960-91). During the sixties, the supply was at a compound growth rate of 3 per cent per annum. Later on, the trend was reversed. During the seventies, the decline in supply was at a very negligible rate of one per cent whereas in the next decade it was at an alarming rate of 14 per cent. If this trend continues the firewood supply from our forest will dwindle in the very future. Even though modern technique can be adopted to increase the productivity of forests, it cannot be achieved by diluting the concepts of sustainability and other ecological considerations. In this context, the best remedy to this problem is agro-forestry. The homesteads of Kerala provide excellent scope for agro-forestry practices. Since this is an age-old practice, the question of social acceptability does not arise. Development of smokeless and fuel efficient chulhas will reduce the burden of rural women also.

The study on energy use pattern in Pananchery Panchayat in Ollukkara development block of Trichur district revealed that 89 per cent of the sample households depended fully on fuelwood/crop residues for cooking. Family income and holding size were found to be the major determinants for selecting the energy source in the rural areas. The homesteads

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could provide all the cooking energy requirements in the case of 47 per cent of the households. Of the remaining, 42 per cent of the respondents supplemented their cooking energy needs with purchased fuelwood and 11 per cent fully depended on outside sources. The average firewood requirement of a family of five members was estimated as 7.5 kg per day when the family used no other source of energy for cooking. The expenditure for this is around 12.5 per cent of the total family income which does not include the associated indirect and social costs. In the case of a typical family which also uses the by-products and crop residues, the average consumption of firewood is 6 kg per day.

At the present level of fuelwood production from our forests, the per capita availability is only 0.327 kg per year. The consumption of fuelwood as estimated at 1.5 kg per capita is several times more than the supply. This gap between supply and demand will be further widened on account of various socio-economic factors. Being the best form of renewable energy and on account of its multiple uses, trees are preferred to meet the problem of rural energy. Fast growing trees which are ecologically and socially acceptable may be introduced in the home gardens. In our motto to develop self-sufficient village, our basic objective should be to solve the problem of energy crisis.

Non-Commercial Fuel Consumption Pattern in Rural Households of Hisar District and Strategies for Energy Conservation

Sudesh Gandhi, Binoo Sehgal, D.N. Sharma, Rajendra Singh and Indiravati†

The energy required for domestic cooking is very crucial for human survival as the energy needs of the domestic sector are location-specific and depend upon living standards and working conditions. A study was conducted to assess the pattern of utilisation of non-commercial fuels and energy for domestic cooking in Hisar district of Haryana State. The study reveals that in the district the per family monthly consumption of agro-waste, a commercial fuel, was the highest among large families (234.15 kg), followed by the landless (174 kg). Dung cakes occupied the second position but the consumption of firewood was the minimum (5.41 to 13.67 kg). The highest quantity of non-commercial energy per month was consumed by the large farm families (4,040 MJ), followed by the landless (3,648 MJ), medium (3,336 MJ) and small (3,156 MJ) farm families. There was no significant effect of occupation on per capita energy consumption from non-commercial fuels. The average per capita energy consumption of domestic cooking was 15.50 MJ/day in the district.

The performance study of three different types of cooking stoves, namely, traditional, Priyagini and Nada chulha using vessels of different metals, *i.e.*, aluminium, steel and brass vessels with common fuelwood indicates that the thermal efficiencies depended upon the design of chulha and varying fuelwood characteristics along with the material of the vessel. The highest thermal efficiency was observed in aluminium vessel (20.18 per cent), followed

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by steel (19.81 per cent) and brass vessel (19.64 per cent) in Priyagini stove irrespective of type of fuel used. Similar trends were observed in Nada chulha and traditional mud stoves also. Based on the above studies, strategies for conservation of domestic energies (non-commercial fuels) have been proposed. The fuel requirements can be very effectively reduced to one-half to one-third through the use of improved smokeless stoves, biogas plants and improved fuel saving technologies/alternate sources (solar cookers, heaters, driers, pressure cookers, etc.).

Cooking Energy Use Pattern and the Role of Gobar Gas Plants in Mehsana District of Gujarat

D.A. Patel and P.K. Singh*

In India about 95 per cent of the cooking fuel requirement of rural population is met from the non-commercial sources such as firewood, dung cakes and agricultural wastes. The practice of burning dung as fuel deprives the soil of important and costly nutrients. Gobar gas technology is being advocated as an option. The study analyses the pattern of cooking energy use by the rural households of Mehsana district of Gujarat State and compares the benefits from the family type gobar gas plants of four different capacities, *viz.*, 70 cubic feet (cft), 105 cft, 140 cft and 210 cft. For the investigation, 15 gobar gas plant owners from each capacity group were selected at random from the rural areas of Mehsana district. A random sample of 15 households, not owning the plants, was also selected for the purpose of comparison. The data pertained to the year 1988-89.

The results indicated that the households not owning the plants used more cooking energy than those owning the plants. The pattern of energy use among the plant owners revealed that the use increased with the size of gobar gas plant. During certain periods of the year, the production of gobar gas was inadequate to meet the demand for fuel. Therefore, non-gas fuels were also used by the plant owners to supplement the gas supply. But the use of non-gas fuels was observed to be inversely related with the size of plants. The analysis showed that the gobar gas technology helped in reducing the expenditure on cooking fuels, and the plant owners were able to avoid the wasteful practice of burning dung. Rather the technology would help the plant owner farmers in producing enriched manure which would reduce their fertiliser bills. At the overall level, a plant owner realised the benefits of about Rs. 2,241 per year of which 73.84 per cent was in the form of savings in fuel cost and the rest was due to the additional value of manure obtained from the slurry. The study has shown that the gobar gas plants seem to be effective instruments as alternative sources of cooking energy in the rural areas as the gobar gas is cheap, convenient to use and environment-friendly. There is need to popularise the use of this technology by tackling the constraints associated with it through research, development and extension efforts.

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Renewable Energy Resource Assessment and Management of Village Ecosystems of Singod in Kymore Plateau and Satpura Hills of Madhya Pradesh

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A study was carried out during 1990-92 under the purview of the All India Coordinated Research Project on energy requirements in the agricultural sector to assess the energy needs of rural households for the production of different crops in different ecosystems and for various household activities. The village Singod in block Panagar of Jabalpur district was selected, representing the Kymore Plateau and Satpura Hills Region (rice-wheat zone) in Madhya Pradesh. The study gives the details of renewable energy natural resource assessment and management of ecosystems in the village: The total human population of the village is 1,148 and the number of households is 150. The average family size of the village was 7.7. The available unit gross power in the village was 0.8 kw/ha and power available for mobile operations was 0.6 kw/ha. The average milk production was 502 litres/day and dung production 3,350 kg/day. Babul trees are the main source of cooking fuel for most of the households. Planting of fuel trees is urgently required, otherwise the crisis of cooking fuel is unavoidable in the next decade.

As regards the components of renewable energy, soybean, gram, paddy and onion are renewable energy intensive crops requiring 69.2, 58.9, 57.5 and 55.8 per cent of the total renewable energy respectively. Wheat and pea crops used the least amount of renewable energy, 44.0 and 38.8 per cent respectively. Human labour (renewable resources) is the costliest source in the agricultural sector, accounting for about 40 per cent of the total cost of cultivation (Rs. 5,025/ha). This could be drastically reduced if some of the operations such as weeding, harvesting and threshing are mechanised. The average cropping intensity in the village was 133 per cent. It can be further increased if irrigation facilities are made available. The need is suggested to popularise gobar gas plants in the village by providing them on subsidised basis as only one gobar gas plant is available in the village.

The total annual energy input in the village was 12,509 GJ (10^9), of which 69 per cent was used in household activities and crop production required only 31 per cent. Output energy obtained from the village was 22,776 GJ (10^9), of which 67 per cent was obtained from crop production, 29 per cent from dung and 4 per cent from milk. Energy ratio for crop production was 3.92 with a benefit-cost ratio of 1.72. Energy ratio for the entire village was 1.82. The village is self-sufficient in respect of milk, rice, wheat, gram, vegetables, fuel for cooking and grass fodder for grazing livestock. Pulses, sugar and commercial energy sources are availed of from the nearby towns/cities.

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Use of Common Property Resources and Forest Degraded Lands for Energy Plantations and Their Distribution by Village Societies

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The paper deals with the use of common property resources and degraded forest lands for energy plantations and their distribution by village societies in India and the role of Forest Department and non-governmental organisations in the promotion and development of social forestry. It is observed that energy plantations in the past have not been raised in right earnest or after proper planning. Fuelwood-cum-farm forestry programmes covering about 3.5 million hectares were raised during the period of 30 years from 1950 to 1980. Energy plantation projects have already been started in several states. Many of these plantations are inadequately stocked and they only touch the fringe of demand. Thus there is need to draw up and implement definite programmes of energy plantations.

The expected demand of firewood is now estimated at about 150 million tonnes (133 million tonnes in 1982). The recorded production from known sources is only 50 million tonnes (39 million tonnes in 1982). Thus there is a gap of about 100 million tonnes (94 million tonnes in 1982). This is expected to be produced from these plantations on degraded lands and common property resources. Social forestry is forestry 'of the people' and 'by the people' and not merely 'for the people'. The role of Forest Department should be one of promoter and facilitator. Local farmers should be organised into effective receiving system. For the acceptance of the programme there is need to involve non-governmental organisations, Panchayats, mahila mandals, etc., at every stage of planning and implementation.

Sustainable Agricultural Development in the Western Himalayan Region: Present Scenario and Future Strategies

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The Western Himalayan Region of India is constituted by the States of Jammu and Kashmir, Himachal Pradesh and eight hill districts of Uttar Pradesh. This region has a unique ecosystem due to various mountain specificities. The total reported geographical area of the region was about 12.98 million hectares in 1986-87. According to the 1991 Census, its population was 18.76 million with a density of 93 persons per sq.km. The growth rate of population was 2.1 per cent per annum during 1981-91. The economy of the region is primarily agrarian. More than 80 per cent of its population is rural and agriculture including animal husbandry and horticulture is the main occupation of the rural people. About 72 per cent of the workforce is directly or indirectly engaged in agriculture. Women play an

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important role in the hill agriculture. Employment opportunities outside agriculture are almost nil due to very low industrialisation in this region. Population pressure on arable land is very high. The net sown area was about 15.4 per cent of the total reported area (in 1987). The average holding size is just about one hectare and it is further going down due to division of families. Farming is being done on steep slopes. The fields are very small and highly fragmented. Agriculture is mostly dependent on rains as only 25 per cent of the net sown area is irrigated. The productivity of crops is very low due to lack of area-specific varieties, low fertiliser consumption per unit of land (28 kg/ha of net area) and traditional farming practices. More than 90 per cent of the rural people keep livestock mainly for milk, draught power and manure. An attempt has been made in this study to identify the factors responsible for unsustainability of agriculture and resource scarcity and to suggest strategies for sustainable development of this sector. According to 1982 livestock census, there were 14.47 million livestock heads in the region.

The development process so far in the region is not environment-friendly. Agriculture, livestock and forests are closely interrelated. Due to poor resource base of the farmers' they do not have enough domestic supply of fuelwood and fodder with them. About 70 per cent of the total demand for these items is met from forests in the region. There is indiscriminate lopping and felling of trees resulting in deforestation and soil erosion. A large number of standing trees are being felled for packing boxes under timber distribution rights. There is imbalance in the value of benefits derived annually from the forests and investment made for their protection and regeneration. The livestock is dependent on grazing, and stall feeding practices are not common in this region. Farmers are encroaching on the marginal lands for cultivation. These lands have steep slopes and due to digging and ploughing of such lands, the soil gets loosened and it is washed with the heavy rains. Farming is being done without any soil and water conservation practices which not only result in loss of nutrients every year but also in escalation of soil erosion. There is great pressure of livestock and human population on land in the region. The sedimentation rates of water reservoirs like Bakhra, Pong and Ram Ganga, etc., are very high.

Keeping in view the above facts, it is suggested that appropriate steps should be taken for rational use of agricultural land, forests and common property resources. Soil and water conservation by watershed development approach should be undertaken. Land use should be rationalised by demarcating land suitable for agriculture/horticulture/pasture/forestry. Cultivation of crops should be restricted to soils with less than 30 per cent slope. Land with steep slopes should be used for horticulture, fodder tree plantation, etc. Social forestry programme should be popularised by enlisting people's participation and management and protection of forests and common lands should be given more emphasis. Cutting of trees for packing boxes and other domestic purposes should be stopped. Mining and quarrying should not be allowed in dense forest areas. The use of liquefied petroleum gas, gobar gas and other energy sources in place of wood should be popularised. The number of livestock can be reduced by step-wise cross breeding of poor quality animals. Stall feeding in place of grazing practices should be encouraged. The productivity of crops must be increased by using modern inputs of high-yielding variety seeds, chemical fertilisers and irrigation. Farming has to diversified by growing high value crops like fruits and vegetables.

Impact of Conventional Farming on Long-Term Sustainability of Agricultural Production in Nainital Tarai of Uttar Pradesh

Lal Singh Gangwar and Chandra Sen*

Conventional farm production technology in India has made progress since the widespread use of high-yielding varieties (HYVs) seeds, petro chemicals as fuel, fertiliser and pesticide particularly in areas endowed with assured irrigation. But during the green revolution period, over-exploitation and misutilisation of the natural resources had deleterious effects on long-term sustainability of agricultural production. This paper examines the changes in cropping pattern and their impact on sustainability of resource use in Tarai environment of Nainital district in Uttar Pradesh, which was purposely selected. The secondary information collected from different sources was used for analysis. The concept of sustainable agricultural development faced its severest test in Tarai environment. The facts revealed drastic increase in the wasteland and barren land area. There had been wide shift in the area from coarse grain, oilseeds and pulses to rice, wheat and sugarcane. Continuous monoculture cropping pattern led to the emergence of soil borne diseases and problems of weed management in paddy and wheat. It increases the use of plant protection chemicals which have adverse impact on the environment, leading to environmental pollution and health hazards. The analysis of long-term fertiliser experiments (1971-89) revealed the loss of organic matter and a steady decline in the productivity of rice, maize and wheat on zinc deficient Hapludolls at Pantnagar. Application of heavy machinery for paddling leads to development of compactness of soil which causes poor drainage. Misuse of canal water and seepage has had an adverse impact on soil health. Analysis of the collected data pertaining to various indicators of agricultural development has helped in identifying the factors responsible for soil degradation. The need and scope for sustainability of the cropping system is discussed in the context of Tarai farmers. It is suggested that Government should ban the use of harmful pesticides. Farmers should adopt the integrated pest management approach. Appropriate strategies should be developed for judicious use of canal water. Incentives should be given to the farmers to enhance the area under oilseeds and pulses.

Factors Affecting Agricultural Sustainability in a Flood-Prone Region of Bihar

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The study seeks to examine the factors determining the agricultural sustainability of North-East Alluvial Plains of Bihar which is highly flood-prone. Three factors, *viz.*, cropping pattern, growth performance of various factors of production and resource use efficiency, determining sustainability of agriculture are examined in detail with the help of time-series data for the period from 1970-90. In order to estimate the efficiency of determinants of agricultural sustainability, log-linear form of factor demand function has been used. The

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five identified factors are area under high-yielding varieties (HYVs), irrigated area, fertiliser consumption, annual rainfall and farm harvest prices (lag one year).

Paddy crop was predominant in the cropping pattern in the zone as compared to other crops. However, a shift was observed with respect to the area under paddy specially after 1970-71 when the area under paddy as a proportion of total cropped area declined from 62.63 per cent in 1970-71 to 61.53 per cent in 1974-75 and to 54.56 per cent in 1984-85. However, the area under paddy slightly increased to about 57 per cent in 1989-90. The change in the area under paddy during the study period was probably due to changes in the priority of resource allocation among the farmers towards different crops for sustenance, depending upon the expected change in weather and parity prices of different crops in the cropping pattern. Wheat remained as a dominant crop in the cropping pattern after paddy in the zone as compared to other crops, accounting for 16.24 per cent in 1989-90. There was also a proportionate increase in the area under maize in 1989-90 (11.24 per cent). A significant change was observed with respect to the area under jute crop which declined from 9.71 per cent in 1970-71 to 9 per cent and 8.83 per cent in 1974-75 and 1989-90 respectively. The area under pulses was only 1.89 per cent in 1970-71 which declined further to 0.94 per cent in 1974-75. But it increased to 3.93 per cent in 1979-80. During the last twenty-year period (1970-90), the acreage under oilseeds has not shown any perceptible change in the overall cropping pattern of the zone under study.

The gross cropped area under major crops showed an increasing trend upto 1989-90 except in 1974-75, a sign of slow but steady agricultural sustainability in the zone under study. As regards the growth of fertiliser consumption in the zone, it showed a steady increase from 1970-71 and reached the highest peak in 1989-90, indicating a growth of roughly 13 times over the base year of 1970-71. A possible reason for poor growth performance of irrigated area was due to the fact that the Kosi command under the study area which created a large irrigation potential during the mid-sixties and the early seventies gradually declined due to the problem of silting and waterlogging. Rainfall showed an increase of 40.48 per cent, 9.42 per cent, 61.3 per cent and 18.80 per cent in 1974-75, 1979-80, 1984-85 and 1989-90 respectively. It indicated that the agricultural production in the zone was largely dependent upon rainfall, *i.e.*, if rainfall distribution is uniform, production is optimum; otherwise it hampers overall growth performance. Farm harvest prices (lag one year) of agricultural produce are governed by the level of production, general price level and inflation rate in the economy. It showed a positive growth rate over the years. During the twenty-year period (1979-90), the determinants of agricultural growth and sustainability in this agro-climatic zone were the seed, fertiliser and irrigation based new technology accompanied by favourable farm harvest prices. Annual rainfall could not contribute to agricultural growth performance.

Sustainability of Agriculture in Punjab: Some Ecological Considerations

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In the Punjab State, a rapid change in the cropping pattern in favour of paddy and wheat has taken place especially after the onset of the green revolution. This has resulted in a

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number of imbalances in natural resources and life hazards. The underground water in the state is the most limited national resource which is being exhausted at a faster rate without an equivalent recharge. The soil fertility is declining especially in terms of micronutrients. The disposal of paddy straw is also a problem. A number of human and animal health hazards such a respiratory and skin diseases, outbreak of malaria, imbalanced diet, etc., are commonly observed as a result of substitution of a number of crops with paddy and wheat. The ecological problems resulting from deforestation, perpetuation of insects-pests, weeds and diseases and high use of pesticides are also of great concern, which need immediate attention. Further, the seasonality in the resource use and market gluts requiring larger market infrastructure have also been observed as a consequence of changed cropping pattern in the state.

Sustainability of Agriculture amidst Existing Farming Practices - A Case Study

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Agriculture being the back-bone of Indian economy has attained a place of pride specially in food production. This has been possible through the application of science and technology in this field. Modern agricultural technology, on the other hand, requires higher doses of external inputs which in turn causes leakage of valuable foreign exchange, nutritional imbalance in the soil, ecological pollution, etc. All these are unfavourable for sustainability of agriculture. The paper examines the existing production pattern and resource use in agriculture, evolves alternative production strategy for sustainability of agriculture and analyses the constraints on agricultural sustainability, based on analysis of data obtained from 80 farmers of Jaunpur district of eastern Uttar Pradesh. Multi-stage random sampling technique was adopted to select the farmers and probability proportional sampling method was used for redistribution of their number in different farm size categories (marginal, small and large). Existing resource use pattern in agriculture and other activities was studied. Low external input use in agriculture is a common practice in the area. Farmers are ignorant of the principles of crop rotation and they take crops only in two seasons, *i.e.*, *kharif* and *rabi*. Some resourceful farmers take crops of *zaid* too but on a very small proportion of their irrigated land. Dairying and poultry farming, like crop farming, are also adopted as a way of life but gradually they emerge as a side business in the area. Thus the existing technology widens the scope of sustainability of agriculture, because of the low use of external inputs in it. An alternative plan, using multi-objective programming approach at existing level of technology, was developed. Both the income and employment have got increased significantly in this plan. Though the use of some of the inputs also has increased, it can be met through green manuring, wise recycling of bio-mass, adoption of legume based crop rotations, etc.

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