Summaries

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Economic Impact of Drip Irrigation Technology on Cotton Growers of Saurashtra Region

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This paper examines differential impact of drip irrigation technology on cotton growers of Saurashtra region. To get better perspectives of the problems and prospects of drip irrigation system, 88 drip adopters and 89 non-adopters for cotton cultivation were collected through survey method for the agricultural year 1995-96. Various farm management concepts were used to meet the objectives of the study.

It was observed that the Jalbindu and Jain Irrigation Companies captured more than 60 per cent of the market share in selling drip sets due to their better quality of equipments, timely services and technical guidance to the farmers. Drip company and other farmers were found to be the major sources of drip system. This suggests that the extension workers can play a pivotal role in creating awareness of drip technology amongst farmers by way of conducting farmers' visits to the nearby farmers having drip irrigation system. The cost-B and cost-C per hectare of cotton cultivation were relatively higher in the case of drip system when compared to surface method of irrigation. However, the magnitude of irrigation cost was comparatively higher in the case of farmers using surface irrigation. Higher yield, lucrative profit, increase in labour productivity and reduction in unit cost of production were the major advantages of drip system over conventional method of irrigation. Other advantages of drip irrigation included saving in water, reduction in weeding and labour cost, successful in irrigating unlevelled and cloddy soils, reduction in tillage, maintenance of soil structure, taking of more than one crop in a year, decrease in diseases/pests, increase in fertiliser efficiency, improvement in quality of product, etc.

Despite innumerable advantages, some constraints have also been encountered in the adoption and operation of drip irrigation system. High initial investment, maintenance of proper pressure in the whole system of drip, lack of technical knowledge, inadequacy and uncertainty in power supply, lengthy procedure of banks for availing the loans, irregular services from the drip companies, damage to pipelines by rodents and squirrels, frequent cleaning of whole system, uneven distribution of water, difficulty in interculturing, clogging of drippers, etc., were the major constraints faced by most of the farmers.

Research and development efforts need to be made on improving the technology and make it more cost effective. The research organisations should also concentrate in evolving best layouts, improving efficiency and tackling the problem of dripper clogging. Since the critical issue is saving of water and augmentation of productivity, timely and uninterrupted power supply may be ensured to popularise drip system on an extensive scale. The manufacturing companies should commit themselves for the supply of standard materials and equipments conforming to prescribed standard norms. Prompt customer services for ensuring proper maintenance have also to be provided. An active involvement of Krishi Vigyan Kendras of Agricultural University, voluntary organisations and panchayats in

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imparting training to the farmers about acid treatment to drippers, water requirement for various crops, layout selection, total requirement of drippers per hectare, type and placement of drippers, etc., will help in taking up drip irrigation programmes on larger scale.

Environmental Concern and Drip Irrigation Technology: A Study Based on Experimental and Field Level Data

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Majority of the environmental problems in Indian agriculture are in one way or other associated with the present method of irrigation. The conventional method of irrigation which is widely practised in agriculture not only leads to inefficient use of irrigation water due to enormous losses in evaporation and distribution but also allows over-use of water. It brings many negative externalities in Indian agriculture. The newly introduced drip method of irrigation (DMI) is proved to be effective in reducing the over-exploitation of groundwater by reducing the consumption of water. Unlike flood method of irrigation (FMI), water-logging and water losses through evaporation and distribution are negligible in DMI. This method of irrigation can be adopted in all kinds of areas. The experiences of the countries which use drip method of irrigation indicate that this method is economically viable and environmentally acceptable. Although DMI has the power to reduce the water related environmental problems, studies have not attempted to bring out the effectiveness of this technology by using field level data. This present study aims to focus on the aspect of water saving capacity and economic viability of DMI. The study has been divided into two parts. The first part reviews the effectiveness of the technology by using the experimental data of the different research stations compiled from the report of the Indian National Committee on Irrigation and Drainage (1992). The second part analyses the field level data collected from 50 drip adopters and 50 non-drip adopters in two districts of Maharashtra.

The experimental data of different research stations show that water saving under drip technology ranges from 30 to 80 per cent in different crops compared to the same crops cultivated under flood method of irrigation. The productivity increase is also significant in all the crops cultivated under DMI. As in the case of experimental data, the results arrived at field level are also encouraging. Drip technology helps saving water by about 29 per cent in banana and by about 37 per cent in grapes compared to the same crops cultivated under flood method of irrigation. The productivity increase is about 29 and 19 per cent respectively for banana and grapes. The benefit-cost (B-C) ratio and Net Present Worth (NPW) computed by using discounted cash flow (DCF) technique for judging the economic viability of the investment on drip system also show that investment on drip system is economically feasible. Further, the computation of NPW shows that the farmers can realise the whole capital cost

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of drip system from the very first year even without getting subsidy from the government. Therefore, keeping in view the rapid decline of irrigation potential and increasing water related environmental problems, concerted policies should be formulated for promoting drip irrigation. Importantly, the government should enact strict regulations for restricting the cultivation of water intensive crops under flood method of irrigation in the areas experienced by groundwater depletion.

Technology for Rehabilitating the Farmers for Sustaining Crop Production in Salt Affected Soils

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In order to meet the growing demand of agricultural production, there is an unabated exploitation of land and water resources with intensive use of complex HYV technology. No doubt there was a remarkable achievement in terms of increasing production, however at the expense of a greater social cost. To achieve long-term agricultural development it is becoming necessary to understand the linkages involved in soil-water management activities. The earlier economic wisdom did not recognise that land and water as an economic good. The outcome of it was that the sustainable and environmentally sound project had not taken off owing to fear of ending up with a low or negative internal rate of return. In the design and development stage of irrigation project the possible damages from the negative side effects, like waterlogging and secondary salinisation, or the additional investments necessary to mitigate the damages, were under-estimated. Due to divergent interests of the parties involved, and weakly defined organisational, social, legal and financial responsibilities stall the necessary actions. The resultant outcome of it is that at the global level about 1.5 million hectares are lost annually as a result of soil salinity and waterlogging. In India although diverse statistics are available on the extent of these soils, it ranges from 5.5 to 13 million hectares.

Due to non-uniformity of land degradation and resource endowments of the farmers, the choice of adoption of technology affects in different locations and calls for alternative technology. To what extent the causes of environmental degradation, particularly land and water, are human-induced and/or to what extent natural and exogenous factors are responsible are not matters of concern of this paper. What matters from an economic point of view is to search the techno-economic options which can prevent waterlogging and soil salinity or enable the reclamation of areas which are already affected by waterlogging and soil salinity in order to sustain or restore the productivity of the agricultural land in the saline environment. Precisely the paper deals with the feasibility of land reclamation technologies and its impact on the farm economy. The results show that the land reclamation technologies are encouraging both for sustaining and restoring the farm productivity in the saline environment.

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Cultural Practices: An Ecofriendly System of Insects/Pests Management

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The dilemma of producing more foodgrains for the expanding population on the one hand and the desire for clear and ecologically sound environment on the other, demands careful planning for managing the obnoxious pests. Sole reliance on insecticides and disregard for deleterious side effects can and should no longer be accepted. To prevent chemical war against insects, the need of the hour is to manage them with other potential weapons like cultural methods.

By cultural practices like sanitation, tillage operations, crop rotation, nutrient management, planting dates, planting geometry, keeping distance from other crops, intercropping/mixed cropping, trap cropping, destruction of alternate hosts, destruction of off types and volunteer plants, selection of proper site, thinning and tapping, pruning and defoliation and water management, the menace of insects and pests can be controlled to a great extent.

Being closely associated with agronomic practices, no additional financial support, equipment or training is required. Being the simplest and cheapest, these are within the reach of subsistence farmers. If adopted timely, these methods are very effective and accurate without any adverse effect on man, livestock, wildlife, environment and on natural regulatory processes like predators and parasitoids. Thus these methods put minimum strain on nature.

Impact of Integrated Watershed Development Programme in Indore District of Madhya Pradesh

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An attempt has been made in this paper to examine the impact of integrated watershed development programme (WDP) in Indore district of Madhya Pradesh. The specific objectives were to study the cropping pattern, cropping intensity, production, cost and returns and benefit-cost ratio on the farms of different sizes in WDP and non-WDP areas. A multi-stage random sampling technique was used. A sample of three villages each from WDP and non-WDP areas was selected from Indore tehsil of the district. The sample consisting of 60 farmers from each of the categories of WDP and non-WDP areas in the

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WDP was selected randomly making a total of 120 farmers. The farmers were grouped under three size-groups, viz., small (less than 2 ha), medium (2-6 ha) and large (6 ha and above) farms. The data were collected by survey method during the agricultural year 1992-93.

Integrated watershed approach opened up new avenues of development efforts towards improving and stabilising the yields of crops. Watershed management implies rational utilisation of land and water resources for optimum and sustained production.

The study shows that the net returns per hectare in small, medium and large farms were higher in WDP area as compared to non-WDP area. Net returns per hectare from the crops grown in WDP area registered a major increase in the respective size-groups as compared to their counterparts in non-WDP area. Net returns per hectare was also higher in WDP as compared to non-WDP area. The gross and net returns per hectare increased more than proportionately as compared to the increase in production cost. The average benefit-cost ratio was higher at 1:2.51 in WDP as compared to 1:1.83 in non-WDP area. The return on per rupee of investment was also higher in WDP as compared to non-WDP area. The benefit-cost ratios in small, medium and large farms were also higher in WDP compared to their counterparts in non-WDP area. Farmers in WDP area adopted improved technology, thanks to financial assistance provided to them in the form of subsidy and they used higher level of farm inputs like fertilisers, improved seeds and plant protection measures which in turn resulted in higher gross returns and net returns on these farms. The profit was higher for the small, medium and large farms in WDP area, indicating the better impact of WDP on crop productivity. The introduction of higher productivity crops in place of low productivity crops was highly pronounced in WDP area. There had been a positive impact of integrated watershed development programme in raising the level of farm income on watershed area under small, medium and large farms to a greater extent.

The analysis indicated that more importance should be given to encourage the adoption of recommended package of practices, developing suitable varieties of oilseeds and pulses (less water consuming crops) to increase not only the income but also to enrich the soil fertility. There had been a positive impact due to adoption of integrated watershed technology in raising the level of income, employment and productivity of various crops in watershed area under small, medium and large farms. Provision of adequate credit in time, farmers' participation and subsidies of credit in time were important for the success of WDP. WDP would have been more beneficial when all the development works (engineering structures) of the watershed were completed.

The major constraints faced by the farmers in WDP were inadequate staff, lack of infrastructure facilities, small funds for land and water management works, inadequate marketing facilities, and lack of adequate information about the resources and requirement of the farmers of the area for proper planning of WDP. Quite often research and extension recommendations were quite inappropriate and inadequate to meet the site specific requirements. Because of the constraints, the farmers' participation was very low. The results of the study suggested that appropriate steps should be taken by the farmers for rational use of cultivated land, waste land, forests and other common property resources. Soil and water conservation practices adopted by the farmers under integrated watershed development approach should be undertaken. The productivity of crops must be increased by using modern inputs like high-yielding variety seeds, chemical fertilisers and irrigation, etc. The co-ordination of farmers and government functionaries, land development activities were some

of the measures for improving the WDP. Better co-ordination between development agencies and voluntary organisations is also essential for effective implementation of the integrated watershed development programme.

Biomass Management in Micro-Watershed Project: Its Economic Feasibility and Implications

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The present paper attempts to quantify the economic feasibility of biomass management in micro-watershed and its implications on agriculture. Biomass management is a co-ordinated approach that attempts to integrate the benefit of different agro-based resources conservation and maintenance of projects with a special reference to micro-watersheds. The protection of land through watershed development, afforestation programme, construction of biogas, repairing the cattle sheds as well as providing adequate fodder supply from the pasture lands, construction of smokeless oven, etc., were the different components of the biomass management projects. Case study approach was used to analyse the economic feasibility of a biomass management project. The micro-watershed in Karnataka State was selected for the study. In addition to the secondary data on physical and financial performance of the selected project, primary data covering the objectives of the study were collected from randomly selected 80 beneficiaries in the project area. The physical and financial performance of the project has over-achieved the targets. The benefits received through different components in the project such as afforestation, drinking water supply and cattleshed repair, etc., were indirect in nature and hence not included in this analysis.

The estimated benefit in terms of cost reduction of biogas units worked out to Rs. 2,881 per unit. Assuming the average investment cost of biogas unit at Rs. 7,500 and the life of the unit being 10 years, the estimated rate of return would be more than 50 per cent otherwise, the entire investment can be realised within a period of three years. An attempt was made to quantify the benefits of smokeless oven in terms of reduction in fuel expenses, cooking time, etc., and the results showed that the benefits per year worked out to Rs. 462 when compared to the investment cost of Rs. 100 per unit. The incremental income through watershed development activity was Rs. 2,810 for the investment cost of Rs. 1,582. Thus different components of biomass management project were economically viable, besides making an impact on many social and environmental benefits.

The social implications in terms of awareness among the farmers and labourers about the watershed development technology including soil and water conservation, improved

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The views expressed in the paper are those of the author and do not represent the institution to which he belongs.

health conditions and keeping the house and environment clean as a result of using biogas unit and smokeless oven, improved standard of living with adequate drinking water supply in the project area, developing cohesiveness among the farmers through self-help groups were some fo the significant contributions derived by the integrated approach of different components of the micro watershed project.

The empirical findings discussed in this paper buttress the fact that integrated approach of different components of biomass management had ensured the economic viability of micro-watershed project in addition to making the technology more environment-friendly. The findings of the study called for the need to improve the people's participation through formation of self-help groups which would improve the adoption level of technology and also integrate different components of technology more effectively thus making the process environment-friendly. The role of non-governmental organisations (NGOs) in this aspect needs to be recognised and future policy strategies must include the NGOs as one of the effective partners in the project implementation.

Some Ecological Considerations of Punjab Agriculture

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The intensive agriculture system in Punjab has given birth to several ecological problems which are creating hindrances in further increasing the productivity of the principal crops. The immediate fall-out of the existing cropping pattern is the lowering of the watertable. There is problem of soil sodicity particularly in the south-western districts. The ponding of water in rice fields has led to various soil physical problems like compaction and development of hard pan near the surface which creates aeration problems for wheat in medium and fine textured soils. Apart from deficiency of major nutrients, there is widespread deficiency of zinc, manganese and iron. The pollution of groundwater considerably increased over the last two decades. Residues of some pesticides have been detected in excessive amounts in several food commodities particularly milk and milk products. The incidence of many minor insect pests, diseases and weeds has increased. The future research efforts should, therefore, focus on the following priority areas, which would pave the way for sustainable agriculture in the state: Development of sound land use system based on soil capabilities; Water budgeting in relation to planting period, soil type and water availability; Development of management practices for use of marginal and poor quality irrigation water on long-term basis; Integrated management of inorganic and organic nutrients; Micro-nutrient dynamics and availability in different soil types; Long-term impact of rice-wheat system on physical, chemical and biological properties of soil; Monitoring pollution problems resulting from extensive use of agro-chemicals on long-term basis; Integrated pest management systems for minimising pesticide residue problems.

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An Alternative Approach for Measuring Impact of Technologies on Sustainability: A Case Study of Punjab Aquaculturists

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This paper provides a conceptual framework to measure the impact of different technologies on sustainability. All the aspects of sustainability, i.e., ecological, social and economic are spelt out. It provides an alternative approach to estimate a sustainable technology model (sustainable technology frontier) which defines the input-output relationship of a sustainable production system. The methodology could prove to be a sound alternative as it provides the basis for measurement of loss in efficiency of each individual farm over a period of time for the given technology production system. It decomposes the overall economic efficiency loss into components of technical efficiency and allocative efficiency, because of increasing level of production and input use (intensification), and decline in technical efficiency because of intensification which causes adverse effect on ecological environments. In this situation, a sustainable level of production and input use will be decided by the best combination of both yielding a unique value of economic efficiency. The paper examines the various causes of the failure of intensive aquaculture because of the adverse impact on ecological environment of pond ecosystem. The demonstration of the application of the methodology was carried out by using the data of progressive aquaculturists of the state of Punjab. The extensive and semi-intensive systems were modelled. The estimated coefficients of the sustainable technology frontier are comparatively higher as compared to those estimated in different time periods. A trend of loss in technological efficiency and economic efficiency (both technical and allocative) were noted with the increasing intensification of aquaculture. Moreover, semi-intensive technology does not clearly depict the adverse impact on sustainability of the production system.

Impact of Agricultural Development on Nature and Extent of Resource Degradation in Haryana

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Intensive use of renewable and non-renewable resources with the modern technology has substantially increased the production in Haryana since 1966. However, studies provide evidence that their indiscriminate use has degraded land, polluted groundwater and endangered the health of the people, livestock and animals. It is suspected that existing high

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level of production may severely deplete the natural resources and adversely affect agricultural production in the long run.

In Haryana, during the last three decades the total cropped area increased by 30.22 per cent as compared to an increase of 3.97 per cent in net area sown. With the release of high-yielding and high fertiliser responsive varieties of rice and wheat along with extension of irrigation facilities, there have been major shifts in area from coarse cereals and pulses to rice and wheat. The widespread and repeated use of irrigation water has resulted in rapid rise in watertable in the areas with poor quality groundwater, leading to the problem of waterlogging and salinity. On the other hand, the regions endowed with good quality groundwater are being over-exploited without maintaining the water level at a reasonable depth. Both the situations are undesirable for the sustainability of agriculture. The other problems that originated from unplanned intensive irrigation are infestation of weeds, inception of water-borne diseases, growing income disparities, etc. The changing cropping system of irrigated area in favour of high-yielding crops at the cost of legumes and coarse cereals spoils the crop ecology and recycling of the organic wastes. Over-exploitation of land and water resources in the state has led to deterioration of soil health, created nutritional imbalance and disturbed the natural hydrology. In good water quality regions, the existing mono-cropping system (rice-wheat, cotton-wheat) causes over-exploitation of groundwater in 32 blocks of the state ranging from 87 per cent to 308 per cent. On the other hand, in the central-southern districts where most of the area is irrigated by canals, there is very fast rise in the watertable leading to waterlogging and salinisation. The continuous crop canopy observed for a long period in the state has created the problem of weeds and insect-pests infestation. The severity of infestation of these weeds and insect-pests has reached a stage that without intensive chemical control measures it is very difficult to harvest any yield. The direct ill-effects of farm chemicals have started showing its presence in the form of nitrate concentration in water and pesticides residue in different food items. Therefore, the solution to the controversy of agricultural development vis-a-vis technology and environment lies in the judicious use and proper management of new technology. Side by side to keep future more safe and secured allround efforts need to be made to develop pollution free new technologies capable to meet increasing food demand.

Technology, Environment and Sustainable Development

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Environment protection represents one of the more recent and yet one of the more profound aspects of new public affairs. Environmental issues have aroused too much intellectual and academic interest both in developing and under-developed nations. They include environmental degradation, deforestation, atmospheric pollution and imbalances in ecology resulting from the way natural resources - land, water, minerals etc. are harnessed for fulfilment of human needs. Despite all efforts, India has continued to lose forest cover.

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This may disturb the environmental equilibrium and the life of mankind. The basic aim of our National Forest Policy must be to ensure environmental stability and maintenance of ecological balance including atmospheric equilibrium which are vital for the sustenance of all forms of life - human, animal and plant.

The specific objectives of this paper are to study whether the introduction of technology increases the agricultural production and to examine the effect of technology on environment of agricultural sector. It is observed that the immediate task is to maintain ecological and environmental balance which calls for public awareness about the immediate and grave issues such as global warming, deforestation, pollution, ecological imbalance, effective public relations and publicity and inculcation of consciousness in the minds of the local people to preserve, protect and promote ecology and environment. In this context, technology, which is the major element in the development process, must be carefully chosen to enable the rural poor to acquire knowledge of technologies appropriate to their needs and environment.

Land Degradation in Orissa

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Land degradation is a dynamic process going on over centuries resulting from geomorphic phenomenon and anthropogenic intervention. The major causes of land degradation in Orissa are soil and water erosion, problem soils (saline, alkaline and waterlogged soil) and shifting cultivation (jhum). Orissa has 63.84 lakh hectares of wasteland constituting 41 per cent of total geographical area. Of the total wasteland, the forest degraded land is 32.27 lakh hectares and the rest 31.57 lakh hectares are non-forest degraded land. The present study examines the nature, causes and management of degraded land in Orissa.

The salt affected soils of Orissa are alluvial soils rendered saline due to tidal inundation of brackish sea water. During *kharif* the crop is severely affected due to failure of rains and physiological drought causes due to increased salinity. During off-monsoon period, salt incrustations are developed on the surface due to capillary rise of salt-laden sub-soil water and raising a second crop becomes bleak. The management of this type of soil consists of construction of salt embankments and raising wind breaks to check salt-laden winds, adoption of practices of organic mulching to check capillary rise of sub-soil brackish water, use of amendments, and using salt tolerant crop varieties.

In the deltaic plains of command area, geomorphology is very much conducive to waterlogging upon introduction of canal flow irrigation through gravity. Besides this natural phenomenon, man-made problems like absence of field channels, uncontrolled excess

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irrigation, lack of maintenance of irrigation system, raising of two rice crops in *kharif* and *rabi* have added to the problem. The state has about 75 thousand hectares of waterlogged area. The problem of waterlogging can be tackled by conjunctive use of water in the command areas, provision of drainage facility and crop diversification.

In Orissa, soils become acidic due to leaching of the soil exchangeable bases under heavy rainfalls and high temperature and acidity is attributed to high proportion of aluminium in the effective cation exchange capacity. Acidity creates an unfavourable medium for the soil micro flora responsible for transformation of complex organic matter to availability of nutrient ions like nitrogen, phosphorus, calcium, potash, boron, etc. In this type of soil calcium loving plants like groundnut, ragi, maize can be successfully grown after amendment of soil by application of paper mill sludge. Sand dunes are formed along the coastal strip blown by the strong wind. These are mostly coarse sands, low water retentive, droughty and of very low fertility. This type of land can be put to use for plantations like casurina, cashew, coconut and pineapple.

Faculty and improper method of cultivation of sloppy lands cause soil degradation. In the rainfed upland sloping terrains cereal crops are cultivated in unbunded condition without adequate care for replenishment of plant nutrients and organic matter incorporation for soil rejuvenation. Continuous cultivation of these lands results in loss of soil fertility due to water erosion. In Orissa about 2.65 million hectares forest area has been affected by shifting cultivation. Land based technologies such as labour-intensive agroforestry systems, providing basic needs and employment may be implemented by using surplus labour and wastelands in order to check shifting cultivation.

Economic Evaluation of Integrated Pest Management Technology in Cotton Farming in Guntur District, Andhra Pradesh

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Attempts are being made to evolve and develop alternative technologies for minimising the use of chemical pesticides, etc. One of the alternative technologies developed is the Integrated Pest Management (IPM) for reducing the use of pesticide and thereby improving the quality of environment. The concept of Integrated Pest Management (IPM) not only emphasises the need for keeping the pest under check but also for the conservation of naturally occurring beneficial fauna. IPM consists of combining a variety of methods like biological control, cultural practices, physical control, and also a limited use of chemical control. IPM is reported to have achieved some success for rice, cotton and sugarcane.

A vigorous campaign on IPM for cotton was taken up in Guntur district of Andhra Pradesh. The IPM technology adopted in Guntur district includes the use of tolerant varieties, farmyard manure, seed treatment, botanical pesticides, microbial insecticides, mechanical methods, synthetic insecticides, growing inter-crops, border crops and marigold, *bhindi*, etc., to attract and trap heliothis. The farmers' method includes the use of pesticides only.

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An attempt is made in this paper to evaluate the economics of IPM technology vs. farmers' method in cotton. The data were collected from the experiments conducted at Regional Agricultural Research Station, Lam and on-farm trials organised by Krishi Vigyan Kendra, Kovuru. The data pertain to the year 1996-97.

The experimental data revealed that the net returns obtained were Rs. 10,771/ha. and the benefit-cost ratio was 2.82 in the IPM Technology as against the farmers' method of net returns of Rs. 6,265/ha. and benefit-cost ratio of 0.67. Under IPM technology soybean was taken as an inter-crop. This gave an additional yield of and 7.5 qtl./ha., which provided additional income of Rs. 8,250/ha. There was a reduction in the use of plant protection chemicals to the extent of Rs. 5,575/ha., that is by 82 per cent.

It is evident from the on-farm trials data that there was a reduction in the expenditure on plant protection of cotton from Rs. 5,900/ha (22.68 per cent of the operational costs) in farmers' method to Rs. 2,950/ha (13.34 per cent of operational costs) in IPM technology. Similarly, a reduction in the expenditure on fertiliser was also noticed from Rs. 4,088/ha (18.48 per cent of the operational costs) in farmers' method to Rs. 1,500/ha (6.78 per cent of the operational costs) in IPM technology. Higher level of farmyard manure was used in IPM technology when compared to the farmers' method. This would improve the health of the soil. The reduction in the use of pesticides and fertilisers would minimise the pollution of soil, water and air and thus would help to improve the quality of environment. It is observed that net returns of Rs. 17.4 thousand/ha were obtained in IPM technology as against that of Rs. 11.2 thousand/ha in farmers' method. The benefit-cost ratio was 0.79 and 0.45 in IPM technology and farmers' method respectively. The IPM technology is found to be economically viable both at the research station and farmers' fields and it helped to reduce the cost of pesticide and fertiliser application. Since the IPM technology is proved to be dependable and superior, a vigorous campaign is suggested to educate the farmers in IPM technology. The government may encourage the production of botanical pesticides and their supply at subsidised price to the farmers in the interest of maintaining the environment quality and farmers' profitability.

Tribal Economy and Agriculture: Policies on Resource Management

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The transformation process of tribal economy from one based on food gathering, hunting and shifting cultivation (free economy) to another based on settled agriculture (market economy), requires a careful empirical examination of various economic and institutional issues involved in technologies to formulate sound technology policy for environmental

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management in agriculture. Keeping this view in mind, a study was conducted in Narayanpur tehsil of Bastar district (tribal district) of Madhya Pradesh. The specific location of the villages in relation to an urban or semi-urban developing area was the guiding parameter to select purposively the villages, namely, Krushnar, Remawund and Madagada in Narayanpur tehsil, a semi-urban area. A total of 49 states of biodiversity erosion were devised to determine loss of plant species and crop varieties. An attempt was also made to study the willingness to pay for biodiversity conservation.

The study concluded that the average size of holding was 2.5 ha with rainfed farming structure. Paddy occupied the major share of total cropped area, followed by horsegram and minor millets. Apart from paddy which included both HYV and traditional varieties, most of the crops grown comprised traditional varieties. The cost-benefit ratio was higher in niger, followed by gram and blackgram. The major source of income and employment was non-timber forest products and agriculture. Crop productivity in the region was absymally low due to subsistence nature of farming. Though the productivity of traditional varieties was quite low, the willingness to pay for the conservation of these varieties was very high due to their inherent potential to resist biotic pressures and being environment-friendly in nature. The study revealed that the introduction of HYV and the proximity to a developing area had adversely affected the diversity of crop varieties. It was also found that there was very low adoption of HYV in the region. This was due to the HYV being input intensive, susceptibility to biotic pressures and inappropriateness in the prevailing farming situation. Rapid deforestation, intensified shifting cultivation, increased settlements, etc., are responsible for fast depleting forest resources in the region. Consequently, increased pressure on land and water resources and lack of institutional arrangements have led to the degradation of natural resources.

Looking into the existing eco-friendly nature of farming, the study suggested that in order to gradually increase the productivity of crops, low input technologies may be developed incorporating the use of improved traditional varieties as well as methods of cultivation through people's participation. The cropping intensity of the region could be increased by the creation of minor irrigation facilities like tanks, wells, tubewells etc., and better rain water management through watershed approach. The study suggested that there is an urgent need to check the conversion of forest land into agricultural land and deforestation. There is a need to institute well defined property rights regimes in order to organise the existing conflicting scenario. Such a measure would go a long way in the improvement and conservation of natural resources.

Groundwater Sustainability: A Case Study of Ludhiana District

Seema Bathla†

Much has been said about the sustainability of groundwater resources and the falling watertable situation in Punjab. But doubts still prevail over the extent and magnitude of the resource depletion and the consequent impact on agricultural development. This paper aims to examine the water regime in one district of Punjab, viz., Ludhiana as well as to provide a methodology for measuring the sustainable development of resource. For the purpose, an

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integrated resource stock-cum-use model of the ecological-economic type has been developed. It is simulation model showing interactions between two sub-modules, viz., groundwater representing ecology, and agriculture representing an economy. The linkages between these are developed through various ecological and economic factors and variables like rainfall, cropping intensity, crop profitability, rural and urban population growth rates. Assuming there are no structural and institutional changes, the existing pattern of resource use is allowed to operate in the future. Comparing the annual water recharge and its demand from different sectors, extrapolation over a period of 20 years (1993-2013) is carried out to determine the sustainability or otherwise of the observed demand patterns. Further, sensitivity analysis is carried out to examine the impact of change in the values of various ecological parameters that vary within a range, on the demand and supply of groundwater resource. The simulated results reveal that as a result of high population growth rate, especially in the urban areas, change in the cropping pattern in favour of water intensive crop sequence, i.e., wheat-paddy and profitability of paddy, there is over-extraction of groundwater resource in the district. Assuming an increase in the cropping intensity as well as profitability of paddy crop in the future too, the over-use of resource will persist. Unless water is extracted within limits, which will negatively affect the crop productivity and hence income, there will be a fall in the watertable by 10-16 cm per year till 2013 A.D. under different scenarios analysed. To bring positive water balance, the situation demands alternative policies like area diversification, change in the structure of electricity pricing, groundwater augmentation technique like artificial recharge, use of drip and sprinkler irrigation and optimum irrigation scheduling.

Impact of Prudent Canal Water Use on Land Utilisation Pattern and Productivity in District Ghazipur, Uttar Pradesh

R.K.S. Kushwaha, G.N. Singh, B.K. Gupta, Vinod Kumar and K. Prasad*

The present study is based on intensive enquiry of 50 farmers, selected purposively from a compact area of ten km nesters of canal in length and 150 metres to each side of the canal in breadth in Sadat block of district Ghazipur, Uttar Pradesh at three points of time, i.e., 1984-85, 1990-91 and 1995-96. It was found that with the use of canal water, the watertable has gone up. During 1984-85 there was no waterlogged area but after use of canal water during 1990-91 the waterlogged area increased to 1.81 hectares. With the use of pyrites and gypsum 0.36 hectare of usar land was reclaimed; 1.40 hectares waterlogged and seepaged area was made able for cultivation through drainage system and making small plots between 1990-91 and 1995-96.

The total cropped area has increased by 18.83 per cent between 1990-91 and 1995-96

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due to better use of water. There has been a shift in cropping pattern in favour of paddy (*kharif*), wheat, vegetables, green fodder and *moong* (*rabi* and *zaid*) with the introduction of canal irrigation system. But some important coarse grains and pulse crops could not be grown because of increase in the watertable, waterlogging, seepage and usar land due to canal irrigation. The intensity of cropping was the highest being 190.60 per cent in 1995-96 due to prudent use of canal water. The productivity of paddy (*kharif*), wheat, vegetables, green fodder and *moong* (*rabi* and *zaid*) has gone up but for coarse grains in *kharif* and peas, gram, etc., in *rabi* their productivity has gone down. The total production has increased by 39 per cent between 1990-91 and 1995-96 due to prudent use of canal water.

It may thus be concluded that prudent use of canal water has increased the production and productivity of field crops to a considerable extent. There has been a shift in the cropping pattern in favour of paddy, vegetables (*rabi* and *zaid*), pulses (*zaid*) and green fodder (*rabi* and *zaid*). No doubt the productivity of paddy, wheat, vegetables and green fodder (*rabi* and *zaid*) has gone up, while that of sugarcane, gram, etc., has gone down. Better remedial measures such as better water management, sinking of shallow tubewells, better drainage facilities, efficient soil management through the use of gypsum and organic manure, growing of higher water requirement crop varieties, timely adequate and regular supply of canal water according to the needs of the crops would go a long way in raising the productivity of the crops in the study area.

Easily Managed Environment-Friendly Small Farm Reservoirs - A Key to Socio-Economic Upliftment and Human Resource Development of Villages

R.K. Sahu,† K.K. Sahu,† V.K. Choudhary‡, A.R. Pal† and A.L. Rathore†

In situ conservation and utilisation of precipitation through small farm reservoirs (S.F.R.) conceptualises easily manageable, micro-ecological balance, timeliness, judicious use of harvested stored water, reliability of water supply, crop diversification (including fish and duck rearing in pond), choice of remunerative crop selection with stable foodgrain production, generation of local employment opportunity and minimising migration of people, that lead to overall economic upliftment and simultaneously creating conducive friendly environment free from waterlogging, and raising surrounding watertable and maintaining proper recharge-withdrawal ratio in groundwater exploitation.

Case studies of S.F.R. served area of Chhattisgarh, eastern part of Madhya Pradesh are presented in this paper. Design of S.F.R. using Krimgold's equation revealed that in plain areas one-tenth and in plateau and hilly area one-eighth of the micro catchment area be used for S.F.R. of about 3.0 metres depth, in order to harness 80 to 100 per cent of run-off. The

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cropping intensity increased from 100 to 180 per cent at Raipur (plain areas) and from 70 per cent to 160 per cent at Jagdalpur (plateau area). The net returns increased from Rs. 1,706 to Rs. 13,070 at Raipur and from Rs. 360 to Rs. 9,980 at Jagdalpur. The benefit-cost ratio increased from 1.10 to 1.70 at Jagdalpur and from 1.46 to 2.19 at Raipur. The rise in the watertable was 0.50 to 1.65 metres in monsoon months and from 0.20 to 0.65 metre in non-monsoon months in the surrounding area of S.F.R.. As a result of increased groundwater recharge, conjunctive use of surface and groundwater was attempted at Jagdalpur. Water storage period of 180 to 260 days facilitated fish rearing inside ponds with average net profit of Rs. 3,138 and Rs. 4,875 per ha and benefit-cost ratio of 2.32 and 2.26 in two small farm reservoirs respectively at Jagdalpur.

Remunerative crops like soybean, pigeonpea, vegetables, fruits helped in strengthening the economy of S.F.R. served area. The data on the farmers' fields revealed that a part of the cost of construction of S.F.R. (ranging from 17 to 57 per cent) was recouped during the first year as a result of increased rice production by supplying water during in-season drought. It helped in minimising migration in the watershed area. Intensive cultivation, as a result of S.F.R., increased local employment from 92 man-days to 203 man-days per ha at Jagdalpur and from 98 to 210 man-days per ha at Raipur. Also local employment was generated for construction and maintenance of S.F.R. coupled with drainage system.

Technological Development and Use of Water and Land Resources in Haryana Agriculture

B.S. Tomer and R.K. Khatkar*

Haryana is a state which comprised arid and semi-arid environment. In the arid areas of the state particularly in the south-western regions, the under-groundwater was brackish. Hence, the canal served as the major source of irrigation in these parts of the state. However, in other parts, the major source of irrigation were tubewells. These two sources of irrigation systems in different regions of the state have led to the twin problems of rising ground-watertable in the canal irrigated regions and depletion of watertable in the tubewell irrigated zones. For these reasons, the present study was undertaken to examine the effects of these problems on the pattern, productivity and sustainability of agriculture in the state. The required primary data for 1996-97 were collected from a random sample of 120 farmers taken from the four zones identified on the basis of source of irrigation: having irrigation through canal, tubewell, canal + tubewell both, having brackish under-groundwater and canal + tubewell having suitable under-groundwater.

The findings of the study reveal that in the regions having only canal irrigation, the

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watertable has risen fast because of seepage from canals and no use of groundwater through tubewells. Hence, this brackish and high watertable was degrading the soil through salinity and waterlogging problems. For this reason, the yield and area under the main crops of the region like cotton, bajra and gram were declining alarmingly. While in the regions where only tubewells were the major source of irrigation and there was no recharge of water through seepage from canals, the watertable was depleting fast. The study revealed that although no damage has been done so far to crops in this type of situation, the farmers were finding it hard in installing the tubewells since shallow tubewells were gradually going out of order as the watertable has depleted to more than 20 metres depth.

The study further revealed that in the regions where both canal and tubewell systems of irrigation existed, the problem of rising or depletion of water was not so serious there. While in areas where the under-groundwater was suitable for irrigation, there was no depletion or rising of watertable. The productivity of crops was also found much better than in other zones. However, where the under-groundwater was brackish and both canal and tubewells existed, the watertable was rising to some extent. It was mostly due to the reason that the farmers were not having sufficient canal water to mix it with under-groundwater for its safe use in crops. For this reason, the problem of salinity and waterlogging existed there which was affecting the productivities of crops.

Thus the study suggests that for the better management and use of water and land resources in the state both systems of irrigation, i.e., canal and tubewells should exist simultaneously. In the areas where under-groundwater was brackish and only canal irrigation system existed, the under-groundwater should be lifted through tubewells and added in the canals to boost their capacity. While in the regions, where only tubewells existed for irrigation, the canal system of irrigation be created at least to recharge the under-groundwater through tubewells and added in the canals to boost their capacity. While in the regions where only tubewells existed for irrigation, the canal system of irrigation be created at least to recharge the under-groundwater through seepage from canals.

Impact of Irrigation on Land Degradation due to Salinity and Waterlogging on Agricultural Production and Irrigation Issues under Canal Command - A Case Study of Mahi Right Bank Canal Command Area in Gujarat

B.L. Gajja,† M.L. Purohit,† R. Parshad‡ and J.C. Kalla**

In this paper an attempt has been made to find out the effect of salinity and waterlogging on sustainable agricultural production systems and irrigation policy under Mahi Right Bank Canal Command area. The primary data were collected through multi-stage stratified random

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sampling technique from 500 farm families distributed in 50 villages. These villages were classified into land irrigability classes, namely, I to V and the sample farmers were selected based on the degree of soil degradation. The study involved six crops, viz., rice, wheat, bajra (summer as well as *kharif*), groundnut and tobacco as these crops occupied about 80 per cent of the total cultivated command area. The selected farmers were classified according to land irrigability classes and perception of soil degradation levels. The results obtained from this study can be easily be generalised not only for this command area but also for other command areas in Gujarat State. The suggested cropping pattern based on soil-water relationship was often violated and favoured high water requirement crops like rice, etc., irrespective of land irrigability classes. One of the prime reasons for not achieving targetted yield (4-5 t/ha), as fixed by National Commission on Agriculture based on national demonstrations which were undertaken on ideal soil conditions was due to the inclusion of land irrigability classes III, IV and V. These lands have been brought under high water requirement crops like rice and banaña and the cropping intensity was more than recommended. The land irrigability class V which is not suitable for irrigation has also been put under irrigation. The adverse soil condition was noticed in land irrigability classes III, IV and V. The adverse effect has reduced the crop yield significantly. The maximum crop yield under study was found under normal soil of land irrigability class I and minimum under severely degraded soils of land irrigability class IV (V). As the land irrigability class increases, the level of soil degradation also increases. All the crops under study also follow the same path. The results also indicated that land irrigability class and soil degradation levels have negative significant effects on crop productivity. The other variables like fertilisers, hired labour and family labour had positive effect on crop yields, showing that the output of the crops under study can be significantly increased with efficient use of higher levels of fertilisers, hired labour and family labour, etc. The use of hired labour is guided by crop yield level which in turn is guided by many other factors of production including land irrigability class and degree of soil degradation levels. These indicate that as land irrigability class and soil degradation levels increase, the use of fertilisers and hired labour reduced drastically.

The reclamation technology has improved the land productivity in land irrigability class III and IV. The land irrigability class V is not suitable for irrigation and it is very difficult to reclaim such degraded soils. After the reclamation, only the seasonal crop(s) can be grown, otherwise the technology will not yield the desired results. This indicated that only the recommended cropping pattern has to be followed under reclaimed soils. Then why it should not be followed strictly right from the start of releasing irrigation water? By adopting suggested cropping pattern, sustainability can be maintained without creating adverse environments. The construction of tanks and ponds in land irrigability classes III to V would aggravate the problem of salinity and waterlogging. Besides the adverse effects on yield of unsuitable class of lands, the environmental problem is serious and far reaching. The secondary salinisation and waterlogging enshrine a permanently deleterious effect on land.

Impact of Technology on Environment and Sustainability of Haryana Agriculture

R.K. Patel and B.S. Panghal*

The most serious challenge before Indian agriculture in the post-Green Revolution era is how to enhance and sustain the productivity gains already achieved without eroding any further the natural resource-base. The adverse consequences of new technology which led to the over-exploitation of natural resources and intensive and extensive use of chemical fertilisers, pesticides, etc., have led to the present bad situation. In order to arrest and reverse these consequences, an attempt has, therefore, been made in this study to examine the resource use level and their impact on environment and the productivity of agricultural crops in Haryana. Consequently, it calls for policies with a direct focus on resource conservation, and the scientific use of inputs with a view to minimising the pressure on the natural resources. The significant signs of decline in agricultural production are quite visible in Haryana agriculture as is evidenced from the findings of the present study that in order to reverse and arrest the trend of environmental hazards caused by unscientific use of chemical inputs and over-exploitation of land and water resources, the problems of soil salinity, alkalinity and rising/falling of groundwatertable are found to be serious in about 60 per cent of the total area of the state. The areas experiencing a rise in water levels are primarily underlined by brackish and saline groundwater. Needless to say that during the last three decades the watertables in the canal irrigated areas have risen at the rate of 30 to 100 cm annually and in around 400,000 hectares area. The watertable has already come within 3 metres from groundwater surface resulting in degradation of land resources due to water-logging. Moreover, it was observed that in the next three decades the area under critical watertable depth will register a four-fold increase in case no timely and effective curative measures are undertaken. In tubewell irrigated areas, the watertable is going down ranging from 1 to 33 cm annually with more than 50 per cent good quality of water. In view of the above, the need for eco-friendly policies with environment-friendly technologies becomes imperative. Further, minimising the pressure of new intensive technology on the resource-base has assumed importance for sustaining agricultural production and productivity through qualitative, need-based research and extension programmes, better resource-use management along with institutional approaches to resource conservation.

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Prospects of Sustainable Management of Farm Resources in Haryana

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With the increases in crop yields from modern farming techniques reaching a plateau and mounting environmental problems, the need for sustainable and ecological agriculture is increasingly felt. An attempt has been made in the present paper to reschedule the existing resource use and cropping pattern for the state of Haryana in order to attain sustainable management of farm resources at increasing pace. The data for the study primarily related to secondary sources pertaining to the state of Haryana. The optimum sustainable crop combinations at various levels were worked out using linear programming technique. To make gradual switch-over and systematic replacement, the crops, viz., paddy and wheat which required more of water and agro-chemicals were substituted with those requiring less, viz., red gram, green gram, soybean and lentil. The results of the study indicated that through systematic and gradual crop area reduction/substitution, it is possible to attain the ultimate objective of lessening the use of irrigation water and agro-chemicals. The reduced use of crucial farm inputs with or without minimum disturbance to levels of returns can make headway for the sustainable management of crucial farm resources in the short and long run. The optimal plans developed have accommodated economical, ecological and social aspects as well to a possible extent. However, there appears the need for keeping constant vigil on crops and cropping pattern to ensure the sustainable use of farm resources.

Modern Technology vis-a-vis Environmental Degradation - A Case of Rice-Wheat Cropping System

Jai Singh, V.K. Singh and K.K. Kundu*

The paper highlights the environmental consequences of rice-wheat cropping system in Haryana, based on primary and secondary data on rice and wheat production in the state. The results revealed that the widespread adoption of high-yielding variety (HYV) seeds coupled with intensive use of modern inputs, have resulted in an increase in the cropping intensity by about 11 per cent and fertiliser consumption by 181 per cent in 1994-95 over 1980-81. A remarkable increase in area, production and productivity of both the crops has been recorded. About 62 per cent of rice area and 98 per cent of wheat area were covered under the HYVs which under assured input supply increased the production of rice and wheat by about 77 and 209 per cent respectively over a period of 15 years.

But in the last few years doubts regarding the continuity of present system of production are being expressed. Evidences accumulated indicate that the benefits of the modern technology are not so encouraging now. It appeared that the expansion of rice and wheat production has slowed down and historical sources of productivity growth have exhausted most of their potential. Some of the observations made from the present study are as follows. The growth rates of area, production and productivity of rice and wheat have declined in the post-green revolution period (1980-81 to 1994-95) except productivity growth rate of wheat.

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The increasing fertiliser use (around 200 kg nutrients/ha) has led to diminishing marginal grains to nutrient ratio from 14.65 to 9.36 in rice and from 21.5 to 8.67 in wheat between 1970-75 and 1990-94. Due to continuous mono-culture of rice and wheat micro-nutrient deficiency has emerged in major parts of the state. Zinc deficiency has become so widespread that a general recommendation of 25 kg Zn So_4 per hectare has been made. Iron deficiency has also been observed in paddy nurseries. Continuous exploitative agriculture by adopting rice-wheat crop rotation in good quality groundwater region has resulted in lowering of the watertable at the rate of 12 to 33 cm per year. While in brackish groundwater zone there is a fast rise in watertable (18 to 32 cm per year).

Increased incidence of pests and diseases has been observed in rice and wheat crops. Grassy weeds like *Phalaris minor* in wheat and Echinochloa in rice have become problem weeds causing heavy losses to crop production. Net returns from rice and wheat system have declined after the mid-seventies. The study emphasises the need for improving input use efficiency and judicious planning of cropping pattern to maintain ecological balance in the region.

Nature and Extent of Groundwater Resource Scenario due to Technological Change in Uttar Pradesh

Laxmi Tewari and A.K. Singh†

In Uttar Pradesh, there are two major sources of water for irrigation, i.e., surface and groundwater resources. Out of 80 million hectares of the country's groundwater resources the state accounts for 18 million hectares or for 23 per cent, though the developed irrigation infrastructure has saved the state's economy from vagaries of weather over time. But in several areas of the state, serious decline in the watertable is taking place because of over-exploitation due to technological change in the irrigation structure and cropping pattern which requires more water. Keeping in view the above facts, the study intends to look at the issue of growth in irrigation structure particularly groundwater use structure and the gap that existed between annual normative demand of water for irrigation with groundwater and net draft water in various regions of the state.

The study is based on secondary data furnished by the Water Commission for the years 1982-83 to 1993-94, pertaining to the western, central, Bundelkhand and eastern regions of Uttar Pradesh. The annual normative demand of groundwater has been estimated with the help of evapo-transpiration coefficients for the major crops.

The findings reveal that due to the technological change, the groundwater use structures (private and government tubewells) in all the four regions have tremendously (32 to 162 per cent) increased and the effective number of wells has declined from about 42 per cent to 78 per cent in all the regions over the period. Thus as a result of this increase, the net draft of groundwater has also increased from 8 per cent to 41 per cent in all the regions excepting in Bundelkhand region. The reason may be the steep fall in the watertable from 7.47 metres in 1988-89 to 9.27 metres in 1992-93. The net recharge of groundwater remained to some extent constant during the study period except in the Bundelkhand region. The reason may be due to topography of the land in the region. The water balance has declined in all the regions and consequently the watertable has gone down (roughly 60 to 80 per cent)

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in all the regions during the period. The existing groundwater supply (net draft of groundwater) is not sufficient to meet out the annual normative demand of groundwater for the crop production. Therefore, the gap between the actual requirement and use of groundwater is widening over the period. The other factor which affects the annual normative demand is the cropping pattern. The study also shows that due to increase in the irrigated area with groundwater under major crops, the annual normative demand has increased in all the regions. Thus the water balance estimates in all the regions are negative and have declining trend over the period. Hence, lesser water would be available over time for crop growth in the future. If the present trend continues the situation will become still worse.

Crisis Management of Cotton Production and Implications to Overcome in Prakasam District of Andhra Pradesh

K. Anand Singh and Y. Eswara Prasad*

Andhra Pradesh has made remarkable progress in recent years in the production of cotton in India. Prakasam district in Andhra Pradesh is one where farmers made huge profits by raising cotton as mono-crop. With the continuous failure of the crop many disappointed small and marginal farmers committed suicide. The study revealed that the small and marginal farmers suffered to a greater extent. Many constraints perceived by the farmers were identified and categorised. An attempt was also made to know from various developmental systems the contributions made by them in managing the crisis. Further, an in-depth analysis was done to find out the reasons for the farmers' suicide. In the course of investigation, the farmers suggested solutions to all systems for improving the conditions. And lastly implications to overcome crisis in cotton production focused at different systems are discussed in the paper.

Farm Technology and Environment - Contingent Approach to Resource Management

Amalesh Banerjee†

Application of seed-fertiliser technology has ushered in the prosperity of agriculture in the green revolution area. The output growth, having reached the peak level, has declined later. But the capital intensive technology has resulted in chemicalisation of cultivation which has serious negative effect. Due to regional variation in geo-physical condition, this strategy could not be adopted extensively in different regions of the country. Land reform has augmented agricultural output in some states. Extensive cultivation of forest area has

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also contributed to larger production. Of these three types of mode of production strategy agriculture now being pursued in our country, the seed-fertiliser mechanised technique and extension cultivation in the hill regions have shown a number of negative effects; chemicalisation, deforestation, salinity, construction of dam reservoir damaging the environment are some of the fundamental negative effects. These limitations raised serious questions of evolving a suitable method of resource management in agriculture consistent with social welfare and optimal gain. The resource management strategy in agriculture must strike a balance between the productivity gain of the application of new technology and sustainable environment.

The new resource management should be through the participation of people and panchayat or co-operatives. They should first ensure proper valuation of non-marketable resources like air, environment, etc., through contingent valuation method and then suggest measures for developing endogenous technology and other inputs for utilisation of resources for sustainable development. Contingent valuation of social welfare of non-marketable resources and the market valuation of marginal gain or loss from the use of technology are only complementary techniques. The contingent valuation is a device of putting some number for estimating the use value of those resources, where there is no market and no number. Contingent valuation of common property resources and management of these by collective bodies like panchayat or co-operatives are the basic structure of resource management in agriculture. Only that way we counter the irreversibilities of environments and work for sustainable agriculture development.

Role of People's Participation in Adopting Environment-Friendly Techniques in Farming: A Case Study of Mini-Watersheds of Wadigera, Kalamandargi and Limbu-Mono Tanda of Gulbarga University, Gulbarga

M.S. Kallur*

The study is aimed at critically reviewing and analysing Karnataka's experience in eliciting people's participation in adopting environment friendly techniques in farming in a few selected mini-watersheds, that too with the help of a non-governmental organisation (NGO). Mainly based on primary data, the paper deals with the concept of people's participation and makes a case for it by explaining its crucial role in making the Watershed Development Programme (WDP) a real success. It also, incidentally, comments on the theoretical framework of the concept. The study gives details about the methodology followed and information about promotion or otherwise of people's participation in adopting environment-friendly techniques in farming in the study area. People's participation connotes different things to different people. In this paper, we use the term to mean the 'act of taking part of farmers' as to the (i) adoption and practice of the new dryland crop production technology, (ii) sharing in their responsibility of maintaining soil and water conservation structures and (iii) looking after common property resources created by the State Government, in a good condition that too on a sustained basis. It is needless to say all these

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promote both directly and indirectly the environment-friendly techniques of farming.

The case study method which is also a holistic method is followed by the researcher in order to do full justice to the study of the problem, i.e., people's participation in watersheds. Here, we have applied this method to study institutions which are called 'Sanghas' as to whether they have promoted people's participation or not in three mini-watersheds, namely,: (i) Wadigera, (ii) Limbu-Mono Tanda and (iii) Kalamandargi of Gulbarga district. This is the main objective of the study. Further, it is sub-divided into three specific sub-goals namely, (i) making farmers adopt the new dryland crop production technology, which provides a relatively high income, (ii) maintenance of soil and water conservation structures and (iii) looking after common property resources of the project.

For realising the objectives, we have employed a mix of research tools and techniques including direct observations, canvassing the interview schedules among the selected farmers and group of farmers, use of published and unpublished material, etc. Direct observations were made and farmers of these three mini-watersheds were interviewed in January 1997 and more than ten per cent of the farmers of these mini-watersheds were randomly interviewed. While interviewing them weightage was given to marginal and small farmers also.

The main findings of the study are: Notwithstanding the fact that farmers are being cajoled by Sanghas to adopt the improved agricultural practices, they have succeeded in their attempt only partially. People's participation in the maintenance of soil and water conservation structures is rather discouraging. Sanghas are not at all successful in convincing the farmers to maintain common property resources. It is, therefore, concluded that people's participation in adopting environment-friendly techniques in farming with reference to three mini-watersheds is more or less a failure.

Rural Landlessness, Literacy Rate and Degradation of Forests: An Analysis of Inter-State Variations

T.P. Sinha†

The degradation of forests continues to be a major environmental problem in India. It has been found that it is associated with certain subsidiary activities like livestock rearing, logging, fuelwood gathering, etc., which are natural resource intensive. These activities are outcome of rural poverty and unemployment which are primarily rooted in unequal distribution of agricultural land. In addition to this, factors external to the rural sector such as growth of forest-based industries and management of forests by the government, play an important role in explaining degradation of forests.

With this perspective in view, the paper tries to find which of these factors are statistically significant in explaining degradation of forests across states in an analytical framework of

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a multiple regression equation. In this context, the study makes a maiden attempt to determine the role of literacy in conserving natural resources.

The empirical findings of the study, based on ordinary least squares estimation of multiple regression equation, are that rural landlessness, growth of forest-based industries and supply of fuelwood by Forest Departments increase degradation of forests. Contrary to these factors, it is found that increase in literacy rate among people reduces degradation of forests. Spread of education not only creates an awareness of environment among people but it also makes them less inclined on natural resource intensive activities for livelihood. With education people in rural areas exploit opportunities of employment in non-rural sectors thereby easing the pressure on natural resources. Based on these findings, the paper suggests certain measures like land reforms and promotion of literacy to tackle the problem of degradation of forests.

Effects of Major Irrigation Projects in Creating Waterlogging Problems in Coastal Districts of Orissa

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The problem of waterlogging as a result of major irrigation projects has substantially increased in Orissa. In all major river valley projects the problem is very much acute and a substantial portion of command area has alarmingly become highly waterlogged due to flow or gravity in the coastal districts of the state. Moreover, in the absence of field channels and growing of rice both during *kharif* and *rabi*, the situation has been aggravated very badly. Therefore, an attempt has been made in the paper to study the problem of waterlogging in the coastal districts and in the district of Sambalpur which are under major irrigation projects and to examine direct and indirect socio-economic losses due to waterlogging.

Among all the districts Balasore is worst affected by waterlogging even if the percentage of area under irrigation is only about 17. In the coastal delta of Cuttack, Puri, Balasore for every 100 hectares that are under irrigation, 8 hectares have gone out of cultivation due to waterlogging. The problem is directly affecting production and productivity in the area. A survey in Puri district shows that the loss due to waterlogging varied from 35 to 38 per cent in paddy and jute crops. As a result, the farmers are compelled to keep the land fallow in the *kharif* season, causing serious repercussions on the agricultural economy of the region.

The resource use in the problem area is seriously affected. The estimated functions for two crops, viz., HYV paddy and local paddy reveal that there is a negative relationship between resource use and extent of waterlogging. The use of fertiliser declined by about 45 per cent in HYV paddy and 31 per cent in local paddy. The corresponding figures for labour utilisation are -7.46 and -5.24 per cent for HYV and local paddy respectively. This suggests that the waterlogging condition decreases resource use and results in decline in productivity. The problem is very acute due to flat topography and typical land forms. Some of the land areas have become totally waterlogged and almost become unfit for cultivation. Where water recedes in winter and summer seasons, farmers grow some crops, for which the resource use is inefficient and productivity is very low. The policy measures suggested to tackle the

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problem include conjunctive use of water in command area, drainage and alternative closure and supply of rotational irrigation water, changing the cropping pattern and introduction of more light duty crops.

Optimal Management of Land, Water and Nutrient Resources in Rainfed Agriculture: Some Technological Options

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The paper explores the issues of sustainable development in terms of interdependencies of resources and technologies in a linear programming framework. The model is formulated with two alternative objective functions - one in terms of income and another in terms of energy with a set of constraints that stand for economic and ecological requirements. The reference period for our analysis is the agricultural year 1985-86. Variables in the model are both energy producing as well as energy consuming. The energy producing activities in the model are all land based. The activities include raising of annual crops such as cereals, pulses, vegetables, etc., besides horticulture plantations in arable lands. The non-arable land activities include pastures and cultivated fodders, and forestry plantations. The results of the model for Rangareddy district in Andhra Pradesh suggest that it is optimal to grow crops such as inter-cropping, dryland horticulture, berseem fodder and subabul forestry plantations. The opportunity cost of soil per ton is worked out to Rs. 1,169 and that of water at Rs. 40,408 per hectare-metre implies the urgency for conservation of soil and water. From the society's point of view, it is, therefore, quite logical that investments must be made on watershed development programmes on a large scale. The two major conclusions emerging from the study are that (a) soil conservation can be achieved with smaller area under forests and (b) a larger livestock population can be maintained. The policy implication that emerges from this conclusion is that there is a need to encourage investments in biogas technologies to improve the efficiency of dung as nutrient and to discourage the use of dung directly as fuel. Conserving soil through the adoption of sustainable farming systems has implications for investment in watershed development programmes, which in turn have implications for employment generation in the rural areas. The average investment requirement in watershed development is around Rs. 850/ha while the annual benefits by conserving soil is around Rs. 1,200/tonne. Assuming 2.5 tonnes of soil loss in the region, the annual benefits works out to Rs. 30,000/ha. As the benefits from soil conservation programmes are enormous to the society, greater priority needs to be given in this area.

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Role of Biogas Plant in Environmental Management in Agriculture

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Environmental management is nothing but the proper resource use and resource management. According to Khoshoo, "Environmental management is an inter-disciplinary approach to resource conservation and recycling and it acts as a regulatory force on human wantonness in resource exploitation and resource wasting. The central theme of environmental management is thus the reduction or minimisation of the impact of human activities on the physical and ecological environment. It is an endeavour to avoid the overuse, or misuse and abuse of the resources in the environment." Environmental management attracts much attention especially in the developing countries like India. One among the reasons is the presence of the problem, namely, scarcity of resources. Something must be done to make use of the available resources in an efficient manner for the betterment of the society.

It is a well known fact that fertiliser is applied to increase the yield of crops. The consumption of chemical fertilisers in India has increased over the years. For instance, the consumption of nitrogen has increased from 0.2 million tonnes in 1960-61 to 9.8 million tonnes in 1995-96. The ideal NPK ratio aggregated for the country as a whole is 4:2:1, but the current all-India ratios are far removed from this norm, i.e., 8.5:2.5:1 in 1995-96. Again consumption is biased in favour of nitrogenous fertiliser whose predominant use is a consequence of the price policy adopted for different fertilisers. Only urea (nitrogenous) continues to operate under a price control system and involves heavy subsidy for keeping consumer (farm gate) price low.

There is a way out to solve the problem of giving subsidy and fixing the price of nitrogenous fertiliser at low level, etc. One among the different ways is to encourage the installation of biogas plants by the households, so that the slurry coming out of the biogas plant can be used as manure for agricultural purpose, which is rich in nitrogen content. The extent to which the amount of slurry is replacing the use of chemical fertiliser (nitrogen), to that extent the burden of subsidy will be removed. Again the slurry coming out of the biogas plant is more nutritive than the raw dung and so the use of raw dung as manure can be stopped. The raw dung can be used in a better manner in the form of raw material and the nitrogen rich slurry can be used for crops. This will help to increase not only the productivity of crops but also the gap between the demand for and supply of chemical fertilisers can be removed. So what is needed is the encouragement of installation of biogas plants to harness and use the indigenous raw material in an efficient manner to increase the production and to solve the problem of scarcity of chemical fertilisers and to reduce the import of chemical fertilisers and thereby save the foreign exchange.

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