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Sustainability of Groundwater Utilisation in Thane District

S.P. Deore, J.M. Talathi, S.R. Torane and S.H. Kamble*

An attempt is made in the paper to study the sustainability of groundwater utilisation in Thane district of the Konkan region in Maharashtra. The data collected from 90 farmers from three talukas of Thane district were used to study the impact of groundwater irrigation, structures, investments, input utilisation for crop production and returns on water use efficiency. The sample farmers were categorised into dug-well, borewell and dug-cum-borewell users and were further sub-divided into traditional method of irrigation (TMI) users and modern method of irrigation (MMI) users. The per unit cost of irrigation was significantly influenced by the volume of water used by the farmers in different categories. The per unit cost of irrigation (Rs./HCM of water) on irrigated farms was Rs.427, Rs. 283 and Rs. 361 in traditional method of irrigation and Rs. 661, Rs. 564 and Rs. 641 in modern method of irrigation in dug well (DW), borewell (BW) and dug-cum-borewell (DCBW) respectively. The water use efficiency was more on farms with MMI as compared to farms with TMI. The extent of increase in water use efficiency was to the tune of 102 per cent to 194 per cent across different farms. The per well quantity of water used for irrigation was comparatively higher in TMI compared to MMI across different types of wells. The per hectare net returns were distinctly higher in MMI farms as compared to TMI farms. Even the net returns per HCM of water in TMI group were lower (Rs. 617.12) and in MMI group were higher (Rs.805). The overall analysis thus indicated greater sustainability of groundwater utilisation by the farmers in MMI group. There is need to educate the farmers on the use of modern method of irrigation.

Economic Analysis of Production and Resource Use Efficiency of Potato in Indore District of Madhya Pradesh

A.R. Verma[†]

This paper makes an attempt to analyse the economics of production and resource use efficiency of potato in Indore district of Madhya Pradesh. It examines the cost and returns, the net return, cost of production per quintal of potato, input-output ratio and also to evaluate the resource use efficiency in the production of potato on small, medium and large size-groups of farms. Multi-stage stratified random sampling method was used for the selection of villages and potato producers. Indore block of

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Indore district was selected for the study and nine villages were selected randomly from Indore block. The farmers were stratified into three groups viz., small (<2 hectares), medium (2-4 hectares) and large (4 hectares and above) farms. The primary data were collected from 90 farmers pertaining to the year 2004-2005. To examine resource use efficiency in different farm categories Cobb-Douglas type of production function was used and marginal value product (MVP) to opportunity cost (OC) ratios were computed to estimate the efficiency of resource use.

The explanatory variables used in the production function were land, seed, manures and fertilisers, human labour, bullock labour, machine power, plant protection and irrigation. The coefficients of multiple determination indicated that 94.22, 99.85, 98.97 and 96.09 per cent of the variation in gross returns on small, medium and large and on all farms (pooled) taken together, respectively, was explained by variables included in the function with respect to potato cultivation. The most critical factors like seed, manures and fertilisers, human labour bullock labour and machine power were under-utilised on all farms whereas all the farms were utilising plant protection and irrigation in excess. This implies that there is a lot of scope for augmenting incomes by improving resource use efficiency through use of optimum levels of inputs. The analysis further showed a high degree of resource use inefficiency in all size-groups, warranting a need to adjust the resources on these farms to obtain increased output. Unremunerative prices during the peak season and lack of storage facilities were reported to be the important constraints by potato growers. Besides, high price of seed, fertilisers and pesticides, costly transportation and market charges, inadequate skilled labour, non-availability of funds from institutional source, lack of processing units and lack of information about arrivals and prices in the major consuming markets were the main problems reported by potato producers. The analysis indicated that adequate input facilities and timely supply of cheaper credit by the financing agencies to the producers, processors and traders would help in increasing the productivity as well as efficiency in the marketing of the produce. The Government should establish adequate cold storages and processing units at village level for the purpose of orderly marketing of potato to benefit both the consumers and producers.

Resource Use Efficiency of Paddy in Lower Bhavani Project Command Area in Tamil Nadu

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A study was conducted in Lower Bhavani Project (LBP) command area in Tamil Nadu with a view to assess the productivity, water use efficiency, equity and resource use efficiency in paddy cultivation. The command area was divided into three reaches

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such as Upper, Middle and Lower. From each reach 30 farmers were randomly selected; the reference year as 2000-01. Percentage, average and ratio analyses were used to analyse the data. Functional analysis in the form of Cobb-Douglas production function was used to determine the input-output relationship. The study has shown the existence of variation in productivity of paddy in different locations in the command area. This is due to the availability of water. In upper and lower reaches manure, water and plant protection had significant influence on the income of paddy farmers whereas in the middle reach fertiliser, manure, water and plant protection were the significant variables. Resource use efficiency analysis showed that marginal value productivity for manure, water and plant protection were found to be greater than marginal input cost in all the reaches. This indicated that there is a possibility to increase the yield by increasing the use of these inputs in the command area.

Efficiency of Irrigated Agriculture Across Different Sources of Irrigation - A Case of Arecanut in Southern Transition Zone of Karnataka

K.B. Umesh, V. Padmavathamma and E. Rejeesh[†]

Irrigation is a critical input in agriculture from the point of view of food security in India. The suitability and adoption of any method of irrigation is influenced by the quantity as well as duration of water availability under different water resource regimes. This paper makes an attempt to analyse the comparative economics of arecanut cultivation under different sources of irrigation and the associated productivity of water and other sources of cultivation in arecanut cultivation in Southern transition zone of Karnataka. The study was conducted in Tarikere taluk of Chickmagalore district of the covered zone. The required information were collected from 30 farmers each under canal command, tank command and groundwater area during the months of April-May 2004. The analysis of cropping pattern indicated that paddy and arecanut were the major crops in canal command area. In tank command area, ragi, arecanut and pulses dominated the cropping pattern. In groundwater-irrigated area, arecanut, pulses and ragi were the major crops. The analysis of relative economics revealed that, though the average productivity of arecanut was high using lower quantity of irrigation water: in groundwater irrigated farms the net income and return per rupee of investment was lower because of higher fixed costs incurred towards irrigation wells. The analysis of the resource productivity and allocative efficiency showed that area under arecanut (in canal command), PPC (in canal and tank command), quantity of irrigation water used (in tank and groundwater) and human labour (in groundwater) were the major significant factors influencing the income of the arecanut farmers. Thus it is evident from the study that in water scarce situations like tank and groundwater irrigation, the quantity of water used in arecanut

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cultivation emerged as the major factor and farmers in these areas were found to use this resource less than optimum. The outcome of the study also demonstrates the importance of plant protection chemicals in arecanut production. Therefore there is a need to create appropriate incentive mechanism to encourage all the farmers to adopt modern scientific methods of irrigation along with other inputs and cultivation practices, which not only contribute to increasing their farm income but also helps in sustainable and optimum utilisation of all the resources in the long run.

Resource Use Efficiency in Different Methods of Sugarcane Cultivation in Western Maharashtra

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Sugarcane being a major cash crop grown in Maharashtra on a large scale and the main source of raw material for sugar industry spread over the State, always look for technological innovations in its cultivation packages. Strip (patta) method of sugarcane planting technique has been recently introduced and it is followed by a large number of sugarcane growers. Besides, sugarcane being an expensive crop, the efficient use of resources is equally important. An attempt has been made in this paper to examine the resource use efficiency under both the strip and conventional method of sugarcane cultivation in Western Maharashtra. The investigation was based on the farm level data collected from 60 sugarcane growers adopting strip method and 60 adopting conventional method from the six selected villages of two tehsils from Satara district of Western Maharashtra. The study pertained to the agricultural year 2001-02. Using Cobb Douglas production function marginal value productivities and their use efficiency were estimated. The results of the study indicated that due to adoption of strip method of sugarcane planting there is a saving in the use of important resources like labour, planting material and manure and fertilisers over the conventional method of planting. This saving was maximum in the use of manure of about 16.40 per cent followed by planting material 12.43 per cent and bullock and human labour by 11.46 and 7.25 per cent. There was a reduction in the per hectare total cost of cultivation of sugarcane by 3.37 per cent in strip method than the conventional one. This reduction was to the extent of 9.61 per cent at the level of cost 'A', which is the actual cost to be paid by the growers. The same method of sugarcane planting also resulted in the increase of cane yield to the tune of 12.96 per cent and gross production and net profit by 27.07 and 45.58 per cent over the conventional method. The production function analysis indicated that, the positive and significant production elasticities of the resource variables such as human and bullock labour, nitrogen and phosphorous fertilisers were responsive to the cane yield

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in both the methods of sugarcane planting and manure in case of strip method of cultivation. The marginal value product of these variables was more than their factor price indicating the efficient resource use. The strip method of sugarcane cultivation not only resulted in saving on the use of resources and reduction in the cost of cultivation but also indicated the efficient use of resources. The study advocates extension education programmes so that the adoption of strip method of sugarcane plantation technology would be widespread.

Input-Output Analysis of Farming Systems in South-Western Uttar Pradesh

Shalander Kumar[†], D.K. Jain[‡] and A.D. Upadhyay[†]

The study aims to identify the various farming system groups of small farmers and examine input-output relationship of enterprises under different farming systems. Of the total twelve blocks in the Mathura district, three blocks namely, Chhata, Farah and Sadabad representing diverse farming situations were purposively selected. A total of six villages, two villages from each block were randomly selected for the primary survey. The data on land holding, cropping pattern, livestock inventory and major source of income were sought. In addition, the factors like soil type, quality and availability of irrigation water, availability of credit, input delivery system, transport and marketing facilities were also collected from the respondents. The Leontief input-output model was used to workout enterprise input-output coefficients. The major farming systems identified in the study area were (i) Sugarcane-based farming system (FS-1) (ii) Wheat-mustard based farming system (FS-2); (iii) Potato based farming system (FS-3); (iv) Dairy-based farming system for landless farmers (FS-4) and, (v) Goat-based farming system for landless goat farmers (FS-5).

The study indicates that the sugarcane-based and potato-based farming systems are relatively more profitable. However potato-based farming is cost intensive and is associated with greater degree of risk and disease incidence. Livestock sub-system was a closely integrated component of the farming system and had stabilising effect on the farm income. The interdependence observed among the various components of farming systems on small farms suggested the need to adopt systems approach for the development of sustainable farming system. A strong need is felt for strengthening crop and livestock linkages in order to enhance the economic viability and for long term sustainability of farming systems. The strong livestock and crop linkages would also help in maintaining soil and water health, thereby checking the environmental pollution and hazards. The key issues emerging from the analysis of the various farming systems can be identified as (i) Non-sustainable land and water use policy, (ii) Shrinkage in common grazing resources as a result of conversion of CPR lands

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into cultivated lands and, overgrazing, (iii) Inequity in income generation, (iv) Increased risk in marketing of cash crops like potato due to lack of proper planning to deal with bumper production and (v) Lack of coordinated planning in the promotion of various sub-systems. Suitable policy measures like integrated planning, ecologically sound management of land and water resources, efficient marketing structure by organising small farmers and involvement of local people in the development initiatives and local capacity building for making appropriate use of available resources and for initiating non-conventional potential farm and non-farm enterprises would go a long way in making the various farming systems sustainable.

Resource Use Efficiency of Bt Cotton and Hybrid Cotton in Irrigated Area of Saurashtra Region of Gujarat State

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The study examines the resource use efficiency in the cultivation of Bt cotton and hybrid cotton in Rajkot district of Gujarat State. Using three stage stratified random sampling technique, in all 128 farmers who cultivated Bt cotton as well as hybrid cotton were selected by survey method through pretested questionnaires. Log linear production function was found to be better fit. The findings of the study indicated that chemical fertilisers, family labour, irrigation, other paid out cost and cropped area were positive and highly significant at 1 per cent level while the hired labour was positive and highly significant at 5 per cent level in the Bt cotton. In the hybrid cotton seed, chemical fertilisers, human labour, irrigation, other paid out cost and cropped area were positively and highly significant at 1 per cent level of significance. Seed played a negative and non-significant role in Bt cotton indicating the overuse of Bt cotton seed. This was due to non-adoption of the recommended practices by the farmers. Large incidence of pests like bollworms reduced production by hybrid cotton.

The results of decomposition analysis revealed that the income from cotton production in respect of Bt cotton growers was higher as they used higher mean levels of inputs as compared to hybrid cotton. It was also observed that the seed of Bt cotton brought about and downward shift in the threshold level of gross income from cotton production. The contribution of inputs saved was found to be 30.14 per cent in Bt cotton. It was observed that the Bt cotton growers were better allocators of family labour, hired labour, bullock labour and insecticides (pesticides) for sucking pest, while in case of seed, chemical fertilisers, insecticides/pesticides, irrigation and other paid out cost, hybrid cotton have an advantage over the Bt cotton production. It may be concluded from the results that in Saurashtra region, productivity of both Bt cotton and hybrid cotton can be increased by giving more number of irrigation. The results

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also suggest that in case of Bt cotton under irrigated condition, increased use of inputs like chemical fertilisers, family labour, other paid out cost and cropped area in the case of Bt cotton and more usage of inputs such as seed, chemical fertilisers, insecticides (pesticides) for bollworms and other paid out cost in case of hybrid cotton are desirable.

Effects of Technological Change on Production Performance and Resource Use Efficiency in Irrigated Maize Based Agro-ecosystem in Madhya Pradesh

P.K. Awasthi[†], N.K. Raghuwanshi[†] and J.K. Gupta[‡]

Maize has a great worldwide significance as human food, animal feed and finds diversified uses in a large number of industrial products. Due to its wide adoptability and productivity, this crop is cultivated in almost all parts of the state. It occupies a significant place amongst the coarse cereals in Madhya Pradesh. There have been large productivity gains due to past innovations in maize sector; however the same could not keep pace with the rising per capita demand for maize. There is thus, an urgent need to promote maize on priority basis by focusing research on this important sector. The extent of adoption pattern of new maize technology and their impact on yield, reduction in cost of production and resource use efficiency, have been analysed on the basis of the primary data collected from the 300 maize growers during 2002-03. The study area consists of three maize dominating districts, namely, Shahdol, Chhindwara and Mandsaur. The farmers of Chhindwara and Mandsaur cultivated mainly hybrid varieties of maize while those of Shahdol, a tribal dominating district are reluctant to do so. Improvement in yield and therefore, reduction in unit cost of production being the most common indicator has been used to measure the efficiency at farm level. In order to assess the adoption of new maize technology, a composite adoption index has been calculated for individual farmers. The resource use efficiency has been studied by using the semi-log production function and input-output relations for maize production have been established.

The study revealed that a majority of the farmers are still low adopters and only 3 per cent were medium adopters of modern technologies, the trend being more prominent in the case of small and marginal farmers, though the adoption was also not encouraging even among the resource rich farmers. All the farmers irrespective of farm size, harvest better maize yield with composite/hybrid variety than the traditional variety. An appreciable reduction in the cost of maize production by adopting improved cultivars was observed in all the selected farms. It is because that with composite variety, the cost of production had come down by 2.78 to 19.40 per cent in comparison to traditional variety. The cost of production with hybrid variety

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had declined by 17.10 to 27.20 per cent in comparison to local variety. This calls for needed emphasis to be given to further boost the adoption of improved variety by the farmers. It has been observed from the resource use efficiency that human labour has been used in excess whereas fertiliser and irrigation have been under-utilised. The marginal value product of these two factors has been found higher than unity, indicating their use at sub-optimal levels. Technological advancement in maize production has favoured mostly the commercial-oriented large farmers, neglecting a large proportion of subsistence small and marginal farmers. The tools of biotechnology for the development of new maize variety are regarded as the most viable option. However, biotechnology being a costlier proposition, public and private collaboration in maize R&D calls for due consideration.

Resource Use Efficiency and Yield Gap in Production of Vegetables Under Irrigated Condition in Western Uttar Pradesh

M.K. Wadhwani and T.S. Bhogal*

The vegetable crops have been identified as an important component of diversification in agriculture for commercialisation of farm sector that are characterised by its much higher productivity, profitability level, employment and suitability in varied agro-climatic situations. The sector faces different pre-harvest and post-harvest constraints that are required to be tackled on priority basis. The specific objectives of the paper are (i) to study the gap in the adoption of technology and yield in production of vegetables; (ii) to evaluate the benefit-cost ratio of sample vegetables and (iii) to examine the resource allocation efficiency in the production of vegetables. The study is based on cross-sectional primary data collected from a sample of 80 vegetable growers, selected randomly from eight villages of Bareilly district of western Uttar Pradesh using multi-stage using sampling technique during 1997-98. The vegetables were selected on the basis of their share in total volume of vegetables traded in APMC, Bareilly during the study year. The tabular and Cobb-Douglas production function analysis were used to accomplish the objectives. The results of the study revealed a wide gap in the adoption of various technologies in all the sample vegetables, which varied between 10 per cent in okra (zaid) to 58 per cent in onion. The yield was also observed to be far below the potential yield. The net return was positive in all vegetables under study except okra. The maximum benefit-cost ratio of 4.22 was obtained from tomato. In general the efficiency of resources was sub-optimal.

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The weather parameters also influence their yield to a great extent. The present extension services seem to be inadequate in transfer of technology in vegetable agencies of the same. There is a need of integrating post-harvest management including marketing with the existing extension services. There is also need for establishment of professional bodies on the lines of HOPCOMS, MAHAGRAPES, NDDDB, etc., for modernising and organising vegetable trade in the country.

Resource Use Efficiency in Organic Farming of Pseudo-Cereals in Inner Himalayas - A Case Study of Malana Village of Himachal Pradesh

Ashok Kumar, S.K Sharma and Atul Dogra[†]

Mountain resources are more carefully managed when local communities have a say in the decision-making process and a significant degree of responsibility over resource use. In Himachal Pradesh, the most distinctive are the shrine villages. A study was undertaken to evaluate the resource use efficiency in the cultivation of pseudo-cereals, which include amaranthus and buckwheat in Malana village of Kullu district in Himachal Pradesh. Using simple random sampling (without replacement) technique, in all 101 farmers out of total of 272 households were selected. The study is based on both primary and secondary data for the agricultural year 2002-03. To examine the input-output relationship Cobb Douglas type of production function was fitted. It was observed that the village seems to have been devoid of even the basic facilities such as roads. Farming is purely organic with no use of chemicals and fertilisers. The area under amaranthus and buckwheat was 11.03 and 13.62 per cent of the total cropped area. The yield gap worked out to 47.45 and 56.64 per cent in amaranthus and buckwheat respectively. The gross returns were computed as Rs.10,407 in amaranthus and Rs. 27,097 per hectare in buckwheat. Thus, though labour intensive, buckwheat was more profitable than amaranthus. It was observed that regression coefficient of human labour, farm yard manure (FYM) and seed were non significant in amaranthus. However, in case of buckwheat regression coefficients of human labour and FYM were found to be significant. The regression analysis employing Cobb-Douglas production function revealed that one per cent increase in human labour and FYM, on an average, will increase yield of buckwheat by 0.3503 and 0.1555 per cent respectively, keeping all other inputs constant at their geometric mean level.

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Tubewell Irrigation and Water Use Efficiency between Owners and Non-owning Purchasers of Irrigation Water – A Study in West Bengal

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The paper attempts to evaluate the water use efficiency between the owners and non-owning purchasers of irrigation water. Specifically it aims (1) to study the crop pattern of the owners and non-owning purchasers of irrigation; (2) to work out the quantum of irrigation used for these crops; (3) to assess the nature and magnitude of input use and cost of cultivation; (4) to work out the gross and net returns from the cultivated crops and (5) to conclude with policy implications. Primary data were collected from 120 owners of tubewell and 120 non-owning purchasers of tubewell irrigation in two districts, viz., Nadia and Birbhum in West Bengal during the year 2004-05. It could be observed that the small and marginal farmers from either group are the main beneficiaries of tubewell irrigation. The *kharif* and summer paddy dominates the crop pattern of both the owner and purchaser cultivators. However, the share of *rabi* crops in the net cropped area is about 44 to 45 per cent. The nature of input use and cost of cultivation for the crops are more or less the same between the owners and the purchaser farmers. However, the owners have the tendency for over irrigation, while the non-owners have achieved the efficiency in irrigation by some adjustment and alteration in frequency watering. The yield rates between the two groups are more or less the same for all the crops, with slight variation for summer paddy and potato. Comparing gross and net returns between the owners and non-owners, it is found that the net return, though is more or less same for either group of cultivators, the latter has an edge over the former for the gross return. So, it may be concluded that both the owners and non-owning purchasers of tubewell irrigation are equally efficient in using irrigation water. It is suggested that the non-owning purchasers of irrigation should be encouraged to construct the irrigation structures of their own. The farmers may be educated to adopt a suitable crop pattern with high, medium and low water-intensive crops to avoid the problems of lowering ground water table and bring an economy in water use. Since the non-owning purchasers group of tubewell irrigation is equally efficient to utilise irrigation water, suitable policies and programmes are required to be evolved for smooth functioning of water markets by improving the supply of electricity and availability of diesel to ensure uninterrupted supply of water for irrigation.

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A Comparative Study of Economic Efficiency in Production of Irrigated and Rainfed Rice of Chhattisgarh

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The study presents a comparative analysis of economic efficiency of resources in production of rice under irrigated and rainfed situations. Stratified random sampling technique was adopted for selecting the farmers. Primary data collected during the year 2000 from 202 sample farmers, 26 farmers covered under irrigated and 176 farmers in rainfed situations from two districts, viz., Raipur and Bastar, were analysed employing regression and functional analysis. The empirical findings of the study envisaged that rice occupied the highest cropped area, accounting for 69 and 77 per cent area among the sample farms of irrigated and rainfed situations. *Rabi* fallow was prominent in both the situations caused due to poor cropping intensity. The production efficiency of fertiliser in irrigated rice was positive and highly significant, family labour adversely affected the gross income of irrigated rice. The production efficiency of resources in rainfed rice was quite different. Fertiliser, tractor hours, family labour and seed was significant and affected the gross income of rainfed rice by 3.32, 1.47, 5.56 and 29 per cent, respectively. Other factors of production were non-significant in both the situations. Most of the resources were excessively or uneconomically used in irrigated rice caused due to declining returns to scale whereas, diminishing returns to scale was observed in the case rainfed rice. Under both the situations, resources were not utilised upto their potential, which retarded the gross income in rice production. None of the factors of production were found to be at their optimum level. The ratio of marginal value productivity at factor cost was less than unity in both the situations. It indicates that resources were used either excessively or too scanty in rice production. Analysing the inputs use and their costs and return in rice production it was evident that the cost on materials and labour inputs were comparatively more in the production of irrigated rice than rainfed rice while the profitability was marginally higher in irrigated rice. The cost-benefit ratio of Rs. 1.19 and Rs. 1.27 in irrigated and rainfed rice indicates that a negligible higher amount of profit was obtained by the farmers in the production of rice in both the situations.

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Resource Use Efficiency in Irrigated Rice Farms in Orissa

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The paper attempts to study the resource use efficiency on irrigated rice farms of Orissa particularly in respect to irrigation, fertiliser and area under high-yielding varieties and their impact on productivity. The required data for the study were drawn from *Orissa Agricultural Statistics*, Orissa for the period 1961-62 to 2003-04. Even with expansion of area under irrigation, area under high-yielding varieties and increase in application of fertiliser in the early years of 21st century, the productivity of rice has declined even in the irrigated areas. The productivity of rice and foodgrains have declined by 6.97 per cent and 5.77 per cent during 1991-94 to 2001-04 in spite of 21 per cent increase in area under irrigation, 89 per cent increase in application of fertiliser and 23 per cent increase in area under high-yielding paddy during the period. It appears from the study that rice and other crops have not responded properly to the application of irrigation, fertilisers and high-yielding varieties during the study period. In spite of increase in area under high-yielding varieties, fertiliser used and irrigation facilities, the productivity of rice and foodgrains have declined even to the extent of 13 to 20 per cent in the irrigated areas. The yield potential of paddy crop can be exploited by resorting to increased levels of fertiliser consumption, seed replacement, increased level of irrigation for yield and profit maximisation.

Resource Use Efficiency in Irrigated Mustard: An Economic Analysis of Surguja District of Chhattisgarh

K.N.S. Banafar and M.K.Thakur[†]

The paper examines the resource use efficiency in mustard crop in Surguja district of Chhattisgarh based on a study conducted in two villages of the study district, namely, Parsa and Bakhura in 2001-02. The primary data were collected through personal interview method with the help of pre-tested questionnaires and a sample of 115 farmers were randomly selected. The secondary data were collected in regard to the area, production and productivity of mustard. The Cobb-Douglas form of production function gave the best fit for the analysis. The results showed that average size of holding of sample households was 2.07 hectares. The cost of cultivation per hectare of mustard was higher on large farms as compared to small farms. The average cost of cultivation per hectare of mustard came to Rs. 4,210. The

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cost of cultivation depicted a rising trend with the rise in farm size. The average value of output per hectare came to Rs. 8,343. The higher value of output on large farms was associated with the higher expenditure incurred on modern farm inputs. Per hectare mustard production and input-output ratio increased with increase in farm size. A need is suggested for efficient utilisation of resources in order to enhance the productivity of mustard crop by reallocation of inputs used in mustard production. There is scope to increase the input use to raise the productivity of mustard.

A Critical Appraisal of Resource Use Efficiency in Livestock-Crop Enterprises in Punjab

P.S. Khattri and P. Kataria*

Livestock enterprise plays an important role for the diversification of agriculture, as livestock sector constitutes about 21 per cent of the total agricultural output. The analysis was done to shed light on the comparative economics of major livestock and crop enterprises. Besides, the existing resource-use patterns have also been critically appraised to suggest ameliorative measures for enhancing the resource use efficiency. Log-linear production function was employed for ascertaining the input output relationships. On the basis of primary data collected from 150 sample households randomly selected from five districts representing five agro climatic zones of the Punjab state, it was observed that among all the species of milch animals the profitability of crossbred cows was higher than that of buffaloes in zone III and zone IV and in all other zones it was the other way round. In the case of crop production, groundnut was the most profitable crop in zone I. Wheat crop was also profitable but the maize crop was a losing enterprise. American cotton was profitable in zone V and it was a losing proposition in zone IV. The paddy crop was conspicuous by its absence as the major crop in zone I and its profitability was lower than that of wheat in all other zones. From the production function analysis in the case of crossbred cows, electricity/diesel was the only input that was under-used in zone III among all the zones. The significantly excessive use was made of green fodder in zone I and IV, of dry fodder in zone I; of concentrate in zone III, IV and V and of human labour in zone IV. In production of buffalo milk, the only variable of veterinary expenses witnessed under-use in zone I among all the zones. Among other variables, green fodder, dry fodder, concentrate feed and human labour witnessed significantly excessive use in zone I or the other except zone V. As regards input output analysis for crop production, under use of fertilisers and manure in production of paddy was recorded in zone II and III of seed in zones II and V; of bullock labour in zone IV; and human labour in zone V only. The significant over use of irrigation in zone II; of

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human labour in zone IV; and of plant protection chemicals in zone V was also observed in the production of paddy. In the production of wheat, the under-use of manure and fertilisers was more pronounced in zone I, II and III. Besides the production function analysis also portrayed the significant under-use of human labour in the production of maize in zone I. The policy implication of these results is that the augmentation in the use of under-used resources and curtailment in the excessively used resources can go a long way to improve the profitability of livestock and crop enterprises.

Resource Use Efficiency in Salinity Affected Irrigated Farms of Haryana: A Case Study of Haryana Operational Pilot Project

R.S. Tripathi, P. S. Kumbhare and D. P. Sharma[†]

This study was undertaken in Haryana at Gohana block of Sonapat district where Haryana Operational Pilot Project (HOPP) was initiated in 1996-97. The project covered an area of 1236 ha divided into 12 HOPP blocks. The study is confined to a sample of 32 respondents selected from block number 11 having plots under sub-surface drainage (SSD) farming system and 19 farmers from non-drainage farming situation (non-SSD) in the district, pertaining to the year 2003-04. The primary objectives of the study are to assess the economic performance of major crops grown in the typical salinity affected irrigated farms under sub-surface drainage system and estimate resource use efficiency of the important inputs used for crop production in saline irrigated environment of Haryana. Cobb-Douglas production function was used to estimate resource use efficiency for the major crops grown under SSD and non-SSD situations. The economic analysis of crops is confined to rice (basmati) and wheat crops as these crops covered more than 90 per cent of the total cropped area in *kharif* and *rabi* season, respectively, on the selected farms. The study revealed that various factors like excess use of irrigation water, flooding and seepage from the central system caused a rise in the water table, which led to serious problems of salinity and waterlogging in the canal irrigated areas. The sub-surface drainage system showed a significant increase in crop yield and net return of the saline affected irrigated farmers. There was a slight difference in the cost of cultivation of rice and wheat crops with and without drainage system. The regression analysis using Cobb-Douglas production function revealed significant favourable impact on yield of rice and wheat crops under both the situations with and without drainage. Machine power and plant protection influenced the yield under without drainage wheat but showed excess use in rice without drainage situation. The analysis also suggested rational use of human labour in wheat production. The returns to scale indicated advantage of drainage

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farming system over non-drainage situation, as it was less than unity under without drainage and from 1.17 to 2.06 for drainage system.

The marginal value product (MVP) of fertiliser was the highest amongst all the five inputs considered for the analysis both for rice and wheat crops. The high MVP-marginal factor cost (MFC) ratio depicted remarkable scope for increasing the profitability on the farms by increased use of fertilisers in both the farming situations. The MVP-MFC ratio revealed tremendous scope for raising the income through more use of plant protection measures on the selected irrigated farms under drainage system. The human labour and machine power use was excess, in general as it showed MVP-MFC ratio less than unity. The productivity could be increased by rational use of human and machine labour at the existing pattern of crop production. The MVP of irrigation was extremely poor in rice and wheat crops grown under both the situations with and without drainage. The study draws attention of the farmers and policymakers towards adopting preventive and corrective measures to make the rot zone free from excess capillary water in view of the reduced efficiency of irrigation water as well as the other resources used for crop production in the saline environment.

Rice-Wheat Cropping Cycle in Punjab: A Comparative Analysis of Sustainability Status in Different Irrigation Systems

Anindita Sarkar, Sucharita Sen and Animesh Kumar*

The purpose of this paper is to strengthen the existing empirical base of sustainability status of the wheat-paddy cropping cycle in Punjab. For the purpose, four sample districts were selected representing different systems of irrigation at different stages: Faridkot (dominantly canal irrigated area); Amritsar (relatively new tube-well system which has shifted from canal irrigation); Ludhiana (over-exploited tube-well irrigation system and specialising) and Kapurthala (over-exploited tubewell irrigation system and diversifying). The temporal analysis extends over 27 years—from 1970 to 1997. Three aspects of sustainability of the wheat-paddy cropping system has been covered in this study - levels and growth of productivity, stability of productivity and water use efficiency in terms of rainfall and irrigation.

The underlying hypothesis was that over-exploited groundwater dependent agriculture would tend to show signs of stagnation and instability unless they adjust their water intensive cropping pattern. To a large extent this view has been validated through our analysis, where it has been observed that out of the two selected over-exploited tubewell districts, the one which has been diversifying (i.e. Kapurthala), had a significantly better performance in terms of most of the criteria used in this

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study, compared with the one increasingly specialising in favour of the wheat-paddy cycle (i.e., Ludhiana). Probably not surprisingly, the canal irrigated system is better-off or comparable to the specialising and over-exploited groundwater system in terms of most of the parameters used in the study. In sum, the results of the study suggest that diversifying agricultural systems in Punjab has potential to not only improve in terms of their overall sustainability status, but also would have a positive externality impact on the residual wheat-paddy cropped area.

Resource Use Structure and Efficiency in Chilli Cultivation in Thane District of Konkan Region

N.K. Kale, D.S. Navadkar, A.V. Gavali and D.L. Sale[†]

The present investigation was conducted with a view to study the resource use structure, to estimate per hectare cost and returns and also its resource use efficiency in Thane district of Maharashtra State. Dahanu tahsil of Thane district was selected purposively. Six villages having the maximum area under commercial cultivation of chilli were selected purposively. From each village five cultivators were selected from each size groups viz., small (<2 ha.), medium (2-4 ha.) and large (> 4 ha.) thus 15 cultivators from each village and 30 cultivators in each size group were considered: a total of 90 chilli growers spread over six villages of Dahanu tahsil and the data pertained to the year 2002-03. Cobb-Douglas production function, was fitted to the data to examine the input-output relationship. In order to examine the resource use efficiency, the marginal value product was compared with its factor cost. Chilli being the labour intensive crop, the cultivators depended relatively more on hired labour. The medium-sized group utilised more bullock labour. The study observed positive relationship between the size groups and the use of fertiliser ingredients and manure. At the overall level, the average per hectare cost of cultivation worked out to Rs. 58,648. The major items of cost were family labour and rental value labour. A direct relationship was noticed among all size groups in relation to net returns. The benefit-cost ratio was more than 1.73 in all the size groups. In a nutshell, the human labour, bullock labour and number of irrigations had significant influence on the value of output. The MVP-MC ratio for the land variable was greater than unity denoting higher resource use efficiency. However, fertiliser had negative impact showing that the fertiliser use should be minimised. The magnitudes of MVP-MC ratio revealed efficient use of most of the resources except fertiliser and other ingredients.

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Resource Use Productivity of Sugarcane Crop in Central Punjab

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The study attempts to examine the resource use productivity and marginal value productivity of various inputs used for sugarcane cultivation in central Punjab. Jalandhar district of Punjab was randomly selected. The study makes use of data regarding block-wise area, yield and production of principal crops in Jalandhar district for calculating weighted average productivity. On the basis of weighted average productivity, two blocks from the district, i.e., Bhogpur block with the highest productivity (highly developed block) and Jalandhar east block with the lowest productivity (least developed block) were selected. Thereafter, two villages from each block were randomly chosen. For comprehensive investigation, a total sample of 54 farmers were selected from two blocks. Cobb-Douglas production function was used to estimate the resource use efficiency by developing a functional relationship between output and inputs used in the production of sugarcane crop. The functions were fitted for both highly/least developed blocks, for different farm size categories and for the overall study. The primary information regarding output of sugarcane and various cost components such as seed, weedicides, fertilisers, plant protection measures, human labour and machine labour etc., were collected from these farmers for the year 2001-02. The analysis highlighted the scope for increasing the investment on nitrogen, phosphatic fertiliser, irrigation and plant protection measures and curtail the expenditure on seeds in the crop production process.

Pesticide Induced Externalities in Cotton Farming

R. Shanmuga Sundaram, Y. Eswara Prasad and D. Kumara Charyulu[†]

A modest attempt has been made to study the externalities due to pesticide usage in cotton farming in Salem district of Tamil Nadu State. The results reveal that human labour and plant protection chemicals were the major components of total cost of cultivation which accounted to 4.2 per cent and 24 per cent, respectively. Cobb Douglas type of production (double log model) function was fitted to estimate the pesticide use efficiency and its MVP/OC ratio was found to be 0.90 indicating excessive use of pesticides. Multiple linear regression analysis reveals that the expenditure on fertilisers, manures and pest-intensity have positively and significantly influenced the resistance externality cost. However, total family income was not significant to resistance externality cost.

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Resource Use Efficiency in Canal and Tank Irrigated Paddy: A Case Study of Southern Transition Zone in Shimoga District

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An attempt has been made to analyse and compare the resource use efficiency in canal and tank irrigated paddy in southern transition zone of Shimoga district in Karnataka. The resource use efficiency analysis assumes greater importance in ascertaining whether production at the farm level could be increased profitably to an optimum level by changing the existing resource use pattern. The data were collected from 98 farmer respondents, 48 each from canal irrigated and tank irrigated paddy for the *kharif* crop season 2000-01. The Cobb-Douglas production function on per hectare basis were estimated. Similarly Marginal Value Product (MVP) of each rupee spent on the different inputs was also computed. The estimated production functions were significant and good fit for both canal and tank irrigated paddy. The production elasticities of all the inputs except farm yard manure and bullock labour were relatively higher in the canal irrigated paddy compared to tank irrigated paddy. The yield in tank irrigated paddy was lower than the canal irrigated paddy by 10.82 quintals. Relatively lower geometric mean values were reported in tank irrigated paddy compared to canal irrigated paddy for all inputs except farmyard manure. MVP of all inputs except plant protection chemicals and bullock labour were relatively low in tank irrigated paddy. Relatively low MVP of inputs was found with respect to human labour and fertiliser in tank irrigated paddy which might be due to the problems related to water management. Therefore, modernisation of irrigation tanks could enable the farmers to adopt better water management and ultimately to improve resource use efficiency as well as paddy yield.

Production Risk Management Using Crop Insurance Tool: A Case Study of Irrigated Wheat in Madhya Pradesh

S.B. Nahatkar, P.K. Mishra and B.B. Beohar[†]

Wheat is a staple food crop of majority of population of Central and North India. In Madhya Pradesh wheat is an important *rabi* season crop and about 70 per cent of wheat is grown under irrigated condition (partially 2-3 irrigated and fully irrigated 5-6 irrigation) and that too by groundwater resources and thus downside deviation of monsoon rainfall from normal annual rainfall affects productivity of wheat adversely

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especially under irrigated condition. Thus insurance of this crop under National Agricultural Insurance Scheme (NAIS) not only protects the wheat producers from anticipated risk but also supports the overall economy of the State in terms of creation of effective demand in input and consumer market. In this backdrop, an attempt is made to assess the impact of NIAS on risk management in the cultivation of irrigated wheat crop. Ujjain district of Malwa-Plateau is selected purposively as it has more than 95 per cent of wheat acreage under irrigation along with 54 per cent higher productivity as compared to average productivity of wheat in the State. The data from 30 beneficiary and 30 non-beneficiary farmers growing irrigated wheat were collected through survey method and the study relates to the agricultural year 2000-01. During the reference year this district was severely affected by drought. On an average 1.12 ha and 5.11 ha of irrigated wheat was insured through payment of Rs. 13.04/ha (subsidised) and Rs. 21.00/ha by small/marginal and other irrigated wheat growers respectively. There was 69 per cent shortfall in wheat yield due to drought on sample beneficiary farms (1,154 kg/ha actual yield and 1950 kg/ha threshold yield). The adoption index on both the categories of irrigated wheat growing farms was moderate indicating that the moderate expenditure was made to purchase inputs like seed and fertiliser. There is no problem of "moral hazards" of low adoption reported due to coverage of irrigated wheat under insurance as it is generally assumed that "insured farmers use less inputs in an attempt to maximise expected claims". The total operational cost on beneficiary and non-beneficiary farms was Rs. 6,638 and Rs. 5,590/ha respectively. Net benefit before claim on beneficiary farms was negative due to low yield, while it was positive, but very low on non-beneficiary farms. After settlement of claims against the insured sum, the beneficiary farmers earned a profit of Rs. 339.15/ha as against the profit of Rs.76.06/ha on non-beneficiary farms. The study brought out that even under extreme stress (drought) condition, crop insurance emerged as one of the best tools for production risk management and since this scheme follows group approach there is very little scope for moral hazards of low adoption.

Resource Utilisation and Optimal Rice Production in an Irrigated Area in Western Uttar Pradesh - A Case Study

B.S. Kalra*

A study was undertaken in Bulandshahr district in Indo-gangetic Plains in western Uttar Pradesh to examine the utilisation and efficacy of irrigation water use from different sources, i.e., canal, electric tubewell and diesel pumpset and to look into the optimal rice production strategies and resource availability constraints, if any. For the purpose, information from 130 farmers with fragmented holding was

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collected, of which 63 farms were canal irrigated, 37 electric tubewell irrigated and 30 were diesel engine irrigated fragments. The data revealed extreme variability in cultivation and input use practices related to paddy production indicating total absence of a package of practices. The study also revealed relatively lower productivities of land and water in canal and electrical tubewell irrigated areas in comparison to diesel engine irrigated areas, which, however, exhibited higher net income – total expenditure ratio. In this situation some farmers obtained very high yield levels and an attempt was made to demonstrate the attainable potential of the region by adopting the cultural practices and input use pattern of efficient farmers. A Target-MOTAD model was used and a risk-return frontier was worked out to devise four efficient plans with various levels of farm income and the associated input utilisation. The analysis revealed that, under Efficient Plans, farmers spent less money than the Existing Average Plan and obtained higher yield and income. Thus, lack of physical resources or the financial constraints did not emerge as the reasons for low productivity. Therefore, in view of a very high degree of complementarity among physical and managerial inputs, concerted efforts of all the institutions involved in development of agriculture is required to narrow down this gap, which otherwise entails little cost.

Resource Use Efficiency of Main and Off-Season Vegetables under Irrigated Conditions of Himachal Pradesh

Sajad Hassan Baba and Amitoj Singh Mann[†]

The present study intends to analyse the economics and resource efficiency of important vegetables during main-season as well as off-season under irrigated conditions of Himachal Pradesh for the year 2004-05. The study revealed that the state has made a good progress in vegetable production during the last two decades. The area under vegetables has almost doubled from 21,977 ha in 1990-91 to about 44,274 ha in 2003-04, while during the same period production has increased more than three-fold. The net returns of the vegetables were found to be much higher during off-season than that of main-season vegetables, mainly because of favourable market conditions prevailing in all the corners in the country. The results of Cobb-Douglas production function revealed that in the main-season coefficient of seed cost turned out to be positively significant for pea, garlic and radish indicating that farmers were making their expenditure on local variety seeds having low germination and it is suggested that this cost variable has positive impact on net returns, provided it is spent on improved seed varieties of potential genotype. During off-season all the crops except radish has shown significantly positive coefficient for seed expenditure. The coefficient of fertiliser expenditure appeared to be negative in case of peas,

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cauliflower and radish in main-season and cauliflower in off-season, indicating that the cost should be minimised and the fertilisers need to be applied as per scientific package and practices. A significantly positive coefficient of irrigation expenditure in case of garlic in both the seasons suggested the need for judicious application of irrigation to improve its productivity. The coefficients of plant protection expenditure turned out to be positive and significant in case of cauliflower (main-season), radish and pea (off-season) suggesting that attention should be paid toward reducing the insect-pest incidences of these crops. But the coefficient for the same in case of radish (main season) turned out to be negative and significant indicating that the cost spent in excess in this crop during main season which need to be decreased. During main season labour cost in cauliflower cultivation could be increased to manage the farm in view of its positive impact, while these costs need to be decreased in case of cauliflower and radish during off-season. The bullock labour cost posed a problem only in the cultivation of pea. Since this crop is laid on farms with steep slope these costs are much as compared to that in plains. The gross/net returns could be improved if positive and negative coefficients of the regression are taken care of. It was observed that vegetable cultivation particularly during off-season has potential to raise the standard of living of the hill farmers and Government should strengthen their efforts in this direction by providing irrigation infrastructure in other regions, especially for off-season vegetables.

Economics of Different Irrigation Systems in Hindkush Himalayas with Particular Reference to Himachal Pradesh

S.P. Saraswat*

The study attempts to evaluate the impact of different irrigation systems, viz., flow (khuls), tubewell, lift and tanks, of farm economy in Himachal Pradesh. For the purpose of the study a sample of 20 farmers from the command area of each selected irrigation system is drawn randomly. For control sample 20 farmers having no irrigation facilities with similar farm size in the close vicinity of the command area are selected. In all 40 farmers in each irrigation system were selected for detailed study. The state is more or less dependent on rains with only 22 per cent of total cropped area irrigated. The average size of holding of sample farms ranges from 0.47-0.38 ha/farm in flow irrigation system to 2.77-2.73 ha/farm in lift irrigation system. There is marginal shift in cropping pattern in the command area of flow and tubewell irrigation system in low hill region. A remarkable shift is noted towards vegetable crops in command area of lift and tank irrigation system selected in mid-hill region of the state. The yield of crops is substantially higher on irrigated farms than the unirrigated farms of all irrigation systems under study. The use of manure

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and chemical fertilisers is relatively more on irrigated farms than that in unirrigated farms. The use of plant protection measures is also higher in command area of tank irrigation system. The use of bullock and machinery power in various agricultural operations is also more on irrigated farms than unirrigated farms in all the irrigation systems under study. The net returns per hectare of cropped area on irrigated farms ranges from Rs. 9,666 on tubewell to Rs. 73,225 on tank flow irrigation system. The analysis reveals that irrigation is an important and crucial component which helps the farmer a great deal by way of increasing the productivity of field crops, besides solving to a larger extent the problem of unemployment as well. The direct field observations also reveal that the desired goals could not be achieved by the farmers. Some of the policies suggested are as follows: (1) Regular supply of electricity to the tubewell and lift irrigation is essential for providing appropriate quantity of water for irrigation, (2) Pucca water channels should be constructed in command area of flow, tubewell and lift irrigation system. The farmers should be imparted with the technical knowhow for this conversion along with financial assistance, (3) In lift and tank irrigation system farmers can economise the use of irrigation water through sprinkler, drippers, piped channels, PVC pipes for water conveyance, etc., and sufficient subsidies/financial assistance should be provided to marginal and small farmers for the purpose. (4) The farmers should be made aware about agronomic practices for maintaining moisture, time and extent of irrigation for the particular crop.

Irrigation Performance in Farm Economy: An Experience of a Tribal Village

Dalbir Singh, Arun Shrimali and Andre Ling[†]

Large scale irrigation projects and employment/income generation schemes have often failed to address poverty in a sustainable and pro-poor manner. This paper looks at the case of a minor irrigation project in a tribal village in southern Rajasthan to reveal how such small programmes can contribute to sustainable rural livelihoods and, in particular can benefit the poorest of the land-owning poor. Using a combination of individual and participatory research techniques, data was collected from a group of 24 small and marginal farmers regarding farming practices, agricultural production and financial returns on investment. Farmers were grouped into five categories according to their wealth status and variations in the distribution of benefits from the irrigation scheme were measured on the basis of these categories. The minor irrigation project under study was found to contribute significantly to various dimensions of the farm economy of poor (small and marginal) farmers from a tribal village. The findings suggest that such schemes can and do result in

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diversification of the cropping pattern, particularly during the *rabi* season, increased productivity and also generate a sustainable flow of income and food sustenance for the households. These interventions are also pro-poor that they confer a comparatively greater benefit to the poorest of the poor. The importance of participatory management systems in ensuring that benefits from such systems are equitably distributed was also noticed although this is an area for further investigation. The study provides important insights that could prompt the policy makers to promote such minor irrigation systems through participatory management structures as one of the strategies in the quest to eliminate poverty.

Resource Efficiency of Ground Water Potential by Tubewell Irrigation in Rajsamand District of Rajasthan

P.S. Rao*

A study was undertaken in Rajsamand district of Rajasthan to examine the resource use efficiency of irrigation water and the effect of groundwater on cropping pattern, production of crops and elasticity of factor inputs. Amet tehsil of Rajsamand district has been selected and the data was collected in one round for *rabi* season only from 10 farm families on the basis of production performance, use of water for marble industries and extent of resource use by canvassing a specially prepared schedule. The average irrigated area under irrigation for each tubewell was 3.31 hectare. Out of 10 tubewells, 60 per cent owners were selling water through tankers for marble industries and rest 40 per cent owners have no such opportunities due to problem of link roads. On an average 12 tankers were sold per day by an individual tubewell owner. Lucerne is the main green fodder crop in the area where water scarcity is very acute and the farmers gave emphasis on milch animal. The cropping pattern has been changed totally by the farmers due to water scarcity. There is shifting of crop enterprises to dairy enterprises in the area. The yield level of all the crops is very high and greater than the national average. A high yield was noticed mainly due to the intensive utilisation of resources and assured water supply for the crops, and economic use of water. The overall expenditure per hectare was the highest on irrigation followed by fertiliser and labour. Thus it can be concluded from these functions that the contribution to the value of the produce by cropping pattern is negative for all types of tubewells under study. The highest contribution to the value of the produce is registered from irrigation input. It is obvious from the magnitude of coefficient of multiple determination that most of the variations in gross value of produce is positively explainable by the significant factors of production.

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An Economic Analysis and Resource Use Efficiency of Canal Irrigated Paddy vis-à-vis Tubewell Irrigated Paddy in Faizabad District of Eastern Uttar Pradesh

J.P. Singh[†]

The present study attempts to work out the costs and returns, input-output relationship and to study the resource use efficiency of canal irrigated vis-à-vis tubewell irrigated paddy and to suggest suitable policy implications in Faizabad district of Eastern Uttar Pradesh. Milkipur block of Faizabad district was selected randomly as it was perceived as a rich source of canal as well as tubewell irrigation. Thereafter, a list of villages was prepared alongwith acreage under paddy from selected block. Two villages were selected randomly using PPS considering acreage under paddy crop. Two clusters covering eight villages were selected. In all 100 farmers were selected proportionately from four classified size groups, viz., below 1 ha (marginal), 1-2 ha (small), 2-3 ha (medium) and 3 ha and above (large). The study pertains to the agricultural year 2003-04. The overall average size of farm worked out to 1.56 ha. On an average per hectare cost on canal irrigated and tubewell irrigated paddy was observed to be Rs. 13,522 and Rs. 15,067, respectively. Returns to scale with respect to canal irrigated paddy cultivation was characterised by decreasing trend upto medium size of farms and thereafter, it indicated an increasing trend. Elasticity of production for irrigation inputs (canal and tubewell) on all sizes of farms was statistically non-significant whereas, rest of the three inputs invariably showed a reverse trend. The marginal value product is positive and more than unity in case of canal irrigated (medium and large farms) and tubewell irrigated paddy cultivation (large farms). In terms of policy implications, it is suggested that discharging of canal water be made available during the period (June to September) and in the alternative year the canal should be cleaned up in order to check the loss of water and erosion of bank canal. The state government should take steps to increase more electricity hours and reduce the electricity charges for the farming community.

Resource Productivity, Returns to Scale and Resource Use Efficiency on Wheat Farms of Hisar District of Haryana

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The study undertaken during the agricultural year 2001-02 was aimed at examining the resource use efficiency of wheat farms in Hisar – II block of Hisar

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district of Haryana. Based on the primary data collected from the 60 respondents scattered in two villages of Hisar-II block it was observed that diminishing returns to scale in all the three groups as well as for the whole sample in wheat crop were in operation since returns to scale was lower than unity. On an average, the production elasticities of the variables human labour, seed expenditure and irrigation exerted positive and significant influence on gross returns. There was a negative resource use efficiency of fertiliser indicating that inefficiency of resource use prevailed and expenses on it need to be curtailed. The production function analysis clearly brought out the operation of diminishing factor returns and decreasing returns to scale in wheat cultivation. The estimated marginal value products of all the inputs of wheat were tested using 't' test, to find out whether marginal value product and opportunity costs are significantly differing. The opportunity costs for all the variables were considered to be one-rupee. The utilisation of the inputs – mechanical labour and plant protection measures – were not at optimum in the case of small farms because there were significant differences between MVP and OC as the marginal value products were much less than acquisition costs (1.00). In the case of medium and large farms, the ratio of MVP/OC was negative in fertiliser indicating the need to reduce the expenditure on this input. In the case of all farms of Hisar-II block (cotton-wheat cultivation belt) the expenditure on input seed needs to be curtailed and the expenditure has to be increased on inputs like irrigation and human labour to reach the optimum level.

Resource Use Efficiency of Paddy Crop in Three Regions of Nagarjuna Sagar Command Area in Andhra Pradesh

U.L. Jyothirmmai, S.M. Shareef and V.T. Raju[†]

A study was undertaken in Nagarjuna Sagar left main canal to examine the resource use efficiency of paddy crop in the irrigated farms. The left main canal was divided into head, middle and tail regions considering the distance from the off-take point. The first division of the canal (head region) with the maximum length and ayacut was considered and three distributories representing head, middle and tail based on the location with respect to distance from the main canal was selected. A total sample of 120 farmers distributed in head, middle and tail regions were selected using random sampling technique. Data were collected and analysed by employing Cobb-Douglas production function to study the resource use efficiency. The gross returns of crop was taken as dependent variable, while inputs like irrigation water, seed cost, labour cost, fertiliser cost and management index were identified as independent variables. Irrigation water was found non-significant in head and middle regions. Seed was found to be non-significant in middle and tail regions. Fertiliser

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and labour were found non-significant in head and tail regions respectively. The marginal value productivity of irrigation water was the highest in tail region when compared to other regions. The marginal value products was less than one in head and middle regions indicating excessive use of this input.

Production Elasticity and Returns to Scale on Different Farm Size Groups: A Sample Study of Dairy Farmers

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The paper attempts to examine the production elasticities with respect to factor inputs using multi-stage stratified sampling technique. The analysis is based on primary data collected by survey method in the adopted villages of Bareilly district. A sample of 80 households consisting of 29 small, 26 medium and 25 large farm size dairy farmers were selected. The sample households were categorised based upon the herd size, viz., small - upto 1-2 animals; medium - 3 to 4 animals; large - more than 4 animals and the data on input-output and other factors were collected. Multi-linear regression analysis was carried out for estimating the productivity of resources across farm size categories and marginal value productivity (MVP) of various resources were also worked out to examine resource use efficiency. The production function analysis revealed that green fodder and concentrate with positive regression coefficient was found to be highly significant, indicating strong linkage with production which needs to be used more intensively to improve productivity. The production elasticity of feed and fodder were positive for all categories of households indicate scope for increasing the productivity of bovines. The dry fodder was positive but less than unity, showing its excessive use in farm production.

Impact of Technology on Resource Use and Productivity of *Kharif* Paddy in Maharashtra

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The paper attempts to examine the extent of technology adoption, changes in resource use and costs and share of technology in the increased productivity in Maharashtra. The implementation of National Agricultural Research Project (NARP) during the years 1983-84 to 1996-97 provided the yardstick for pre-technological and post-technological period. For the study, the years 1980-81 and 2000-01 were treated as pre-technological and post-technological period, respectively. The sample of the study consisted of 60 paddy growers selected for each of the period from three agro-

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climatic zones, viz., very high rainfall zone, transition zone and high rainfall zone. All the resources under study, excepting human labour, have showed increasing trend in their utilisation. The per hectare use of human labour declined during the period by 20 per cent. The use of manure was relatively low in *kharif* paddy. The productivity of *kharif* paddy increased considerably and the per hectare cost of cultivation increased marginally with substantial increase in the gross returns. A crop loss was observed during pre-technological period while it was found profitable during the later period. The productivity has considerably increased and the share of technology in this increased productivity was only 6.41 per cent. At the same time, the overall sustainability index in terms of yield was about 94 per cent. It indicates that present technology adopted by the sample farmers is not sustainable.

The study suggests the following policy measures: emphasis on evolution of short duration, photo insensitive, high fertiliser responsive, disease resistant, high-yielding varieties of crops, improvement in cultural practices, speedy and effective diffusion of new crop production technologies, increased supplies and use of new forms of inputs, effective conservation of soil and water and exploitation of additional water resources which have remained yet to be developed. Also research efforts aimed at evolution of low cost technologies are expected to contribute for increased production in the state.

Resource Use Efficiency of Major Crops: A Study of Western Uttar Pradesh

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A study was conducted to evaluate resource use efficiency of major crops under the present level of technology in the Western Uttar Pradesh. The study is confined to six major crops of the region, namely paddy, maize, bajra, wheat, sugarcane and potato, which together accounted for more than 75 per cent of gross cropped area. The study made use of farm level cross-sectional data of the mid-nineties collected from 232 sample farmers of different categories selected through stratified random sampling technique. The Cobb-Douglas form of function was used due to its several inherent advantages. The variables earlier considered on per farm basis were transformed on per hectare basis as 'area under the crop' was highly correlated with all the independent variables.

The results of the study indicated that diminishing marginal productivity prevailed for different resources used in the production of the selected crops in Western Uttar Pradesh. None of the resources had shown significant impact on all the selected crops. Though all the explanatory variables except

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irrigation had shown positive and significant impact on two or more crops in the region, the impact of irrigation, a crucial natural resource, was found to be positive and significant in case of wheat yield only, while its impact was negatively significant on paddy yield, due to overuse thereof. It emerges from the results that the productivity of all the variables varied to a great extent among different crops in Western Uttar Pradesh. The empirical findings reflect the existence of resource use inefficiency in the major crops of western Uttar Pradesh, with varying intensity. There exists inefficient use of resources like seed, irrigation and bullock and machine in some of the crops. Bullock and machine power was found to be in sub-optimal use in sugarcane ratoon crop. It was also observed that use of seed is not efficient in the two important cereal crops namely paddy and wheat. In the case of paddy notably sub-optimal use is quite apparent, however, inefficiency in seed use in wheat crop is reflected inspite of quite a high level of seed use on account of poor management practices in terms of use of poor quality seed and late sowing particularly on land released from sugarcane ratoon and potato crops, etc. Inefficiency with respect to irrigation level is also visible in paddy and wheat crops. Besides excess use of irrigation in paddy crop was observed though its a monsoon crop, while sub-optimal use existed in case of wheat crop. Nutrient use in the region was found to be efficient in all the major crops. The resource use in most of the cases are sub-optimal indicating scope of enhancement of the productivity of the major crops in the region by changing the level of use of such resources.

Technical, Allocative and Scale Efficiencies of Rice Production in Union Territory of Pondicherry

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This study has used data envelopment analysis (DEA), a non-parametric approach to measure the efficiency of paddy farms in the Union Territory of Pondicherry during the year 2003-04. The results indicated that about 12.62 per cent of the farmers who operated the rice farms belonged to the most efficient category (90-100 per cent) and 23.45 per cent in the least efficient group (less than 50 per cent) with a mean technical efficiency of 64 per cent. The allocative efficiency measures also indicated that about 15.86 per cent of the farmers belonged to the most efficient category and 21 per cent in the least efficient group with a mean allocative efficiency of 76 per cent. This suggested that the average farm was producing only about two-thirds of the potential output level. It was also further indicated that there was a

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probable increase in the output level by 36 per cent in the short run. The main allocative efficiency measure indicated that the rice farmers could reduce the costs by about 24 per cent by adopting appropriate technologies and management practices. The returns to scale coefficient were fairly distributed, suggesting that there is no systematic pattern of farms being too big or too small, since the scale efficiency results only reflect the farm size in the sample. About more than one-third of the farmers belonged to the most efficient scale group and 4.18 per cent of the farmers operated the farms in the least scale efficiency group. The majority of allocative inefficiency can be attributed to over use of labour, fertiliser and chemicals and this situation warrant policy revisions. This may be due to single window input delivery system that supplies agricultural inputs at subsidised rates by the Government. Concerted efforts are essential to bridge the gap between awareness and adoption of technologies by strengthening the agricultural extension system.

Resource Use Efficiency of Soybean in Rajasthan

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A study was conducted to measure the resource use efficiency of soybean to indicate the productivity of individual inputs. Jhalawar district was selected on the basis of highest soybean area and production among all the soybean growing districts of Rajasthan State. One tehsil in the selected district and three villages in the selected district and three villages in the selected tehsil were randomly selected. The soybean growers of each village were divided into three farm size groups, viz., small (upto 2 ha), medium (2-4 ha) and large (above 4 ha). Twenty farmers from each village were randomly selected in proportion to their size of holding to make a total of 60 farms in all. The data were collected for the agricultural year 1999-2000. Resource use efficiency was estimated by fitting the Cobb-Douglas type of production function to the farm level data. The study revealed that among the four input variables, i.e., seed, farm yard manure, human labour and fertiliser, tried in production function analysis, the elasticity coefficient of three inputs were positive on small farms. In case of medium farms three input variables, viz., farm yard manure, human labour and fertiliser had positive coefficient. However, only two variable inputs, i.e., farm yard manure and human labour were statistically significant on large farms. Remarkably, farm yard manure input was statistically significant in all the three size groups of farms. In small farms, the MVP/FC ratio for farm yard manure and fertiliser were greater than unity indicating that the investment of one additional rupee on farm yard manure and fertiliser would yield an additional return worth Rs. 1.09 and Rs. 6.48, respectively. Farm yard manure, human labour and fertiliser gave additional return to the tune of Rs. 1.08, Rs. 5.03 and Rs. 7.55, respectively, on per rupee additional

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investment on medium farms. The important input variables on large farms were farm yard manure and human labour which gave additional return to the tune of Rs. 1.62 and Rs. 5.24 respectively, on per rupee additional investment. Thus, there exists scope for increasing the production of soybean by increasing the use of these input variables.

Resource Use Efficiency in Punjab Agriculture: A Spatio-Temporal Analysis

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The study focuses on the spatio-temporal analysis of resource use efficiency of key factors of production for agricultural crops in different agro-climatic regions of the Punjab State. The data from Comprehensive Scheme to study the Cost of Cultivation of Principal Crops in Punjab for the years 1985-86 and 2000-01 have been used to meet the objectives of the study. To study the efficiency differentials among the various farm size categories, three size groups, viz., small, medium and large were formed. The size-group wise analysis revealed that the land resource was efficiently used on all farm situations in the state during both the study years except on large farms in zone I during 1985-86, and on small and medium farms in zone II during 2000-01. On small and medium farms during 2000-01, the inefficient use may be due to lower productivity of cotton crop on these farms which the large farms had reversed due to better access to technology. The ratio of MVP of labour to its corresponding wage rate was not statistically different from unity on all the farm categories during both the study years indicating the optimum utilisation of this resource. The study reported the over use of farm machinery and implements by large farms during 1985-86 in zone I, and by small as well as large farms in zone II during 2000-01. This may be due to the excessive investment on this capital input. The expenditure on fertilisers and manures was at optimum level on all the farm situations in both zones during 1985-86, except on large farms where fertiliser use had become excessive. However, the analysis for 2000-01 revealed that farm returns could be increased by increasing the use of fertilisers on all farm situations except on large farms in zone I. During 1985-86 it was noted that there was excessive expenditure on livestock on small farms in both zones and by medium farms in zone I, while on the other hand in 2000-01, the same was found at optimum level on all farm situations.

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