Ind. Jn. of Agri. Econ.
Vol. 53, No. 3, July-Sept. 1998

Summaries

Ind. Jn. of Agri. Econ.
Vol. 53, No. 3, July-Sept. 1998

Energy and Sustainability

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Increase in energy consumption has been taken as an indicator of progress since the last century. According to recent figures, 82 per cent of all the energy consumed in the world is produced by burning fossil fuels, 7.5 per cent from burning biomass, 5.5 per cent from the use of hydraulic energy and 5 per cent from nuclear energy. Most of the energy, in other words, is non-renewable; it runs out as we use it, as the population increases; and it comes from fossil fuels, which on burning increase the amount of carbondioxide in the atmosphere. If we add to this the accumulation of nuclear waste, the problems of access to oil deposits, constant spillages during transport and all the different imbalances involved in the world energy system, the outlook is far from sustainable.

The inequalities speak for themselves; globally, less than a quarter of the world's richest population consumes almost three quarters of the energy commercialised in the world. For example, the average annual consumption per capita in the United States is 26 times higher than in India.

Opening the way to societies that make sustainable use of energy necessarily involves increasing and improving energy efficiency, both in supply technologies and in end-use technologies, at the same time using renewable energy sources instead of fossil fuels.

Choosing the right system for the transformation of primary energy sources into energy services such as lighting, cooling, cooking, mechanical force, transport, etc., and choosing the most suitable appliances and technologies in each case is fundamental. The truth is that a good standard of living is possible without wasting anything like as much energy. A series of relatively straightforward measures today allow a far higher level of comfort than in 1950, using one-third as much energy for heating water for washing in the home. On a global level, reducing our society's energy-intensiveness is the first step towards energy sustainability.

Economics of Energy Use of Groundnut Production in Khargone District of Madhya Pradesh

A.M.Rajput,† A.R.Verma‡ and Kailash Magar†

The paper examines the economics of energy use in groundnut production in Khargone district of Madhya Pradesh. The findings are based on an intensive enquiry of 75 groundnut growers, selected randomly from five villages in the Pansemal tehsil of Khargone district, conducted in 1996- 97. The farmers were grouped under three size-classes, viz., small (upto 2 ha), medium (2.1 to 4 ha) and large (4.1 ha and above). The number of farmers in each size-group, was kept in proportion to their number falling in each size-group. This tehsil

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was selected purposively as it had the highest area under groundnut in the district.

The study revealed that, on an average, the per hectare total cost of cultivation of groundnut amounted to Rs. 9,837. Among all the input items, the cost of seed was the highest, followed by hired human labour, rental value of land, machine power, bullock labour, fertilisers, manures, family labour, etc. It varied from Rs. 10,158 per hectare on the largest size-group of farms to Rs. 9,401 on the smallest one. On an average, the cost of cultivation per hectare of groundnut came to Rs. 7,892 on Cost A_1, Rs. 8,112 on Cost B_1, Rs. 9,362 on Cost B_2, Rs. 9,737 on Cost C_1 and Rs. 9,837 on Cost C_2 basis.

On an average, the yield of the main product in groundnut cultivation came to 15.33 quintals per hectare. The average value to total output worked out to Rs. 18,089. It was the highest, being Rs. 20,400 on medium size-groups of farms. The returns over Cost A_1, Cost B_1, Cost B_2, Cost C_1 and Cost C_2 on an average worked out to Rs. 10,197, Rs. 9,977, Rs. 8,727, Rs. 8,352 and Rs. 8,252 per hectare respectively. On an average, the cost of production per quintal of groundnut amounted to Rs. 436 on Cost A_1, Rs. 448 on Cost B_1, Rs. 517 on Cost B_2, Rs. 538 on Cost C_1 and Rs. 544 on Cost C_2. It was the highest on the large size-groups of farms. The average input-output ratio at Cost A_1, Cost B_1, Cost B_2, Cost C_1 and C_2 worked out to 1:2.29, 1:2.23, 1:1.93, 1:1.86 and 1:1.83 respectively. The returns per rupee of investment was also higher on the medium size-group of farms.

The analysis indicated that for augmenting groundnut production and modernising the processing industry, cheaper credit agencies should be established for providing credit agencies to the producers as well as to the market functionaries involved in the marketing of groundnut. The housing and storage facilities, both in mandi and villages are direly needed. Proper storage of groundnut at cheap rate will minimise the volatile movements in the prices of groundnut. Wherever possible, a large number of intermediaries should be eliminatd by organising producer's co-operatives. Co-operatives must, therefore, be encouraged to come forward in the marketing of groundnut so as to safeguard the interest in both the producer-sellers and consumers. The improvement of transport and communication facilities, strict enforcement of market regulation act, supply of electricity to processing units at cheaper rates and introduction of scientific methods of storage at farmer's level are some of the remedial measures suggested, which would go a long way in increasing the efficiency of groundnut marketing.

Level and Pattern of Energy Use in the Hill Farming System of Uttarakhand

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The study aims to find out the level and pattern of energy use in various agro-ecosystems and estimate the productivity of important input resources used under high hill (>1600 metres

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mean sea level), mid hill (900-1600 metres mean sea level) and valley (<900 metres mean sea level) farming systems of Uttarakhand region in Uttar Pradesh. The findings revealed that the average size of operational holdings was extremely small varying from 0.34 ha in high hills to 0.57 ha in mid hills, the net irrigated area to net sown area varying from 20 per cent in mid hills to 29 per cent in the valleys with cropping intensity of 155 per cent. Most of the area was occupied by cereals and pulses, in addition to cultivation of temperate fruits and off-season vegetables.

The annual energy budget estimated for various agro-ecosystems revealed that cereal based crop rotations had minimum energy input whereas vegetable based rotations experienced maximum input in all the three farming systems. The regression analysis indicated more than 69 per cent of the variation in energy output in all the agro-ecosystems due to variation in energy use of the five input resources (human labour, bullock labour, seeds, manure and fertiliser) considered for the analysis. This variation ranged from 69.30 for finger millet-fallow in mid hills to 94.09 per cent in pulses (mixed) - rapeseed and mustard agro-ecosystem of valley farming system. The regression coefficients indicated strong favourable impact of input energy used in terms of fertiliser and manure on energy output in most of the agro-ecosystems under all the farming situations. Therefore, the energy output can be increased manifold through use of more input energy in the form of manure and fertiliser in the hill farming system.

Role of Economic Parameters in Determination of the Use of Machineries in Agriculture - A Case of Maharashtra

S.N.Tilekar†, H.P.Rajguru* and C.A.Nimbalkar‡

The paper attempts to evaluate the use of farm machineries in terms of monetary values by the farmers in four regions (Western Maharashtra, Vidharbha, Marathwada and Konkan) of Maharashtra. A total of 240 sample farmers comprising small, medium and large farmers spread over in four regions were selected randomly representing each of the agro-climatic zones in the state. The data pertained to the year 1989-90.

The results indicated that the per farm value of farm machineries owned by all categories of farmers in Western Maharashtra was the highest compared to their counterparts in other regions being, on an average, Rs. 2,18,641, Rs. 52,893 and Rs. 6,246 on large, medium and

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small farms respectively. It was hypothesised that the size and the value of land holdings possessed, proportion of irrigated land to total holdings and net returns from the crop production activities would influence the use of farm machineries by the sample farmers. Surprisingly, machineries owned by the farmers in Konkan were negligible. Associated with the factor 'size of land holding', it was found that there was another related factor, viz., value of land holding which influenced the possession of farm machineries significantly with positive relationship between the two. Among the four regions, the average value of land was the highest in Western Maharashtra for all size-groups of farms.

The proportion of irrigated area was also found to have direct relationship, with the possession of farm machineries as it was 39.47 and 46 per cent respectively on small, medium and large farms in Western Maharashtra while it was very low in the rest of the regions on all categories of farms. The main source of irrigation is 'canal' in Western Maharashtra.

The relationship between net returns received from crop production activity and the average value of farm machineries indicated that these were Rs. 30,490 and Rs. 59,237 on medium and large farms in Western Maharashtra which exactly coincided with higher value of farm machineries, implying thereby positive and direct relationship between the two. The main contributors for higher net income in Western Maharashtra are the perennial and commercial crops like sugarcane, cotton and groundnut.

Production and Marketing Practices of Charcoal in Southern Tamil Nadu - A Paradigm Shift

C.Ramasamy and C.Sekhar*

A study was undertaken in the Southern Zone of Tamil Nadu with a view of examining the production and marketing aspects of charcoal in the state. The study involves a survey of tree growers, extension officals dealing with agroforestry schemes, non-governmental agencies, forestry experts and traders in the southern region of Tamil Nadu. A sample of 100 tree growing farmers was selected using a four-stage sampling procedure. In order to work out the returns to investment on agroforestry enterprise, an economic surplus model was employed. The study pertained to the year 1993-94. On an average, the yield of wood realised per hectare was around eight tonnes, fetching an income of Rs. 2,500 per year. The benefit-cost analysis revealed that production of raw material for charcoal production is a feasible one. The owners of prosopis do not harvest the wood. They sold their plantation as such either to charcoal producers or fuel wood traders. Charcoal producers and the traders estimated the yield and value of trees as they stood in the field and fixed the prices through negotiation. While harvesting, the wood above the ground alone is cut in order to allow coppicing. The analysis of marketing of charcoal revealed that the producers' share was around 48 per cent of the consumers' rupee and it could generate employment opportunities to the tune of 160 man-days per hectare per year. Besides this, the study has discussed the constraints and the appropriate strategies to protect the interest of charcoal producers and promote the production and marketing activities of charcoal.

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Estimation of Domestic Energy Use Pattern and Evaluation of Renewable Energy Sources Gadgets for Household Application in Coimbatore District, Tamil Nadu

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The paper seeks to evaluate the economic viability of biogas plants and to study the cost economics of select renewable energy sources (RES) gadgets in Thondamuthur block of Coimbatore district, Tamil Nadu. The study is based on data collected from a sample 100 households representing different farm and non-farm categories in a village from the selected block, pertaining to the year 1996-97. The study shows that large and medium farms used more of fuels for water heating. It was 2.65 kg and 1.35 kg for the large and medium farms respectively, while the average was 1.30 kg/day. The demand from large farms for electricity and kerosene for water heating was the highest with 0.80 kWh and 0.20 litres, while the average was 0.32 kWh and 0.14 litres respectively. Also for cooking, the large and medium farms' non-commercial fuel demand was 5.2 and 4.8 kg/day, whereas the marginal and non-farm categories used only 3.2 and 3.4 kg/day respectively. It is mainly because of frequency of cooking which was more in the case of large and medium farmers. The financial analysis of the biogas plants at 12.5 per cent discount rates suggested the construction of large size biogas plants for economic viability. The benefit-cost ratio and internal rate of return for 4 cubic-metre biogas plants were 2.72 and 50.43, whereas for the 1 cubic-metre plant it was only 1.28 and 22.64 respectively. Non-availability of dung for initial filling of biogas digester, scum formation, clogging of outlets, corrosion of drums in KVIC models were some of the problems perceived by the users.

The use of RES gadgets like solar cooker and water heater for domestic operations was found to be economically viable. The cost of preparation of one meal using solar cooker was calculated at Rs. 1.93, whereas it was Rs. 5.00 for the meal prepared from conventional gadgets using firewood and kerosene for a family of five members. And also the solar water heater can conveniently be used at a cost of Rs. 15.50 for heating 100 litres of water, which is lesser than the conventional heating methods using firewood.

The study suggests a number of policy measures for adoption such as solar cooker and water heater, utilisation of agro-residues for power generation using gasification principle and productively exploiting the manpower which is used for fuel collection in other occupations.

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Electricity Use Pattern in Borewell Dominated Agriculture

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An attempt has been made in the paper to study the electricity use pattern in Tamil Nadu among different categories of farmers and its implications for the efficiency issues. For this purpose, data have been collected from 64 electrified pumpset owning farmers in a borewell dominated village of Pudukottai district in Tamil Nadu, pertaining to the year 1997-98.

The study has analysed the farmwise data on pumpset installation, irrigation intensity, cropping pattern, productivity, electricity use and sale of water. As the cost of electricity is not known in the absence of electricity meter reading (due to 100 per cent subsidy), the cost has been estimated for different categories of farmers, which will be useful for assessing the extent of subsidy enjoyed by the farmers and the extent of loss incurred by the Tamil Nadu Electricity Board.

The results show that free supply of electricity has encouraged the poor farmers to go in for borewell and it has also brought in one more source of revenue for them, namely, sale of water for money. In many other agricultural aspects, there is not much difference among the different categories of farmers. Therefore, it can be stated that the electricity, that too free electricity, has made the poor farmers slightly better off. Irrigation intensity has got positive association with the electricity use and depth of the wells. Hence, deep borewells and electricity are most important for irrigation. The estimated cost of electricity used per rupee worth of agricultural produce is two and a half times higher (200 paise) for the marginal farmers than for the big farmers (80 paise), indicating the greater dependence of the marginal farmers on electricity for agricultural production. The cost of electricity used per acre is Rs. 20,200 and per household Rs. 81,890 per year. These figures simply show the uneconomical production (if electricity tariff is actually paid) conditions. As has been already argued by many, too much electricity is used mainly because it is 100 per cent subsidised. This situation certainly forces one to levy tariff at least on rich farmers who are capable of paying the tariff. However, as it was pointed out by the Chief Minister (who announced free electricity), this would force even the rich farmers to get a certificate to show he is a poor one. This is quite possible with the present kind of administrative set-up which is plagued by bribery. Hence administrative reform is a pre-requisite for any kind of reform.

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Economics of Energy Use in Crop Production in Central Uttar Pradesh

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The paper attempts to estimate the pattern and level of energy use in crop production and work out the economic benefits of energy use on bullock and tractor operated farms in district Kanpur Dehat of Central Uttar Pradesh. To study the above objectives, 60 farmers, representing marginal (below 1 hectare), small (1-2 hectares) and medium/big (2 hectares and above), reclassified into bullock and tractor operated farms were selected from six villages of two blocks in the district. The energy used in different farm operations supplied by different sources was converted into horse power hours by assuming that one adult man on an average develops 0.10 horse power and one pair of bullocks 1.0 horsepower. In the case of mechanical power, their rated horse power was used.

The average size of operated area on bullock operated farms worked out to 1.10 hectares while it was 4.12 hectares on tractor operated farms. Paddy and wheat were the predominant crops of the study area, which together accounted for about 47 per cent on bullock operated farms and about 49 per cent on tractor operated farms. The area under cash crops like potato and rapeseed and mustard was nearly double on tractor operated farms.

The total energy use per hectare of operated area came to 1104.65 horse power hours on tractor operated farms and 562.65 horse power hours on bullock operated farms. Thus it was nearly double on tractor operated farms compared to bullock operated farms. Mechanical energy content constituted 84 per cent of the energy use on tractor operated farms as against 57 per cent on bullock operated farms. Land preparation, irrigation and threshing are the main farm operations consuming the bulk of the energy on both categories of farms. The total cost of energy per hectare of operated area came to Rs. 25,125 on tractor operated farms and Rs. 12,879 on bullock operated farms. Thus it was nearly double on tractor operated farms.

The economic analysis showed that the tractor operated farms obtained 22.20 per cent more net farm income on per hectare basis than the bullock operated farms because of higher and assured irrigation facilities, higher intensity of cropping and use of more mechanical power which facilitated completion of different farm operations in time. Besides this, the tractor operated farms earned considerable income by sale of water and hiring out of tractor (custom services), which accounted for 16 per cent of the total income. The study concludes that the use of mechanical power acts as one of the important determinants for timely completion of farm operations, successful execution of multiple cropping programme and earning additional income by hiring out tractors and sale of water.

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Indirect Employment Effect of Mechanisation - A Case Study of Punjab Agriculture

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The paper attempts to estimate the effect of farm mechanisation in generating employment in the off-farm sector. Both primary and secondary data relating to all major components of employment generation in the off-farm sector for the year 1997-98 were used in this study. The data on employment generated by assembling and manufacturing units of farm machinery were obtained from the Directorate of Industry, Punjab, Chandigarh. The detailed information on major and minor repairs with regard to employment was obtained from the technical experts of the Punjab Agricultural University, Ludhiana. A sample of six filling stations was selected from the state, i.e., two filling stations were selected randomly from each agro-climatic zone. Similarly, two sale agencies of tractors and two sale agencies of diesel engines were selected randomly from each agro-climatic zone. The information in respect of employment generation in marketing, transportation and storage of additional produce due to mechanisation was gathered from different market committees. The estimate of additional produce was determined by consulting marketing experts. The estimated additional employment in agro- processing units was determined by taking secondary data about the number of agro-processing units and persons employed from the *Statistical Abstracts* of the Punjab State. The information regarding additional employment in creating infrastructure like sheds for farm machinery and tubewells was collected from the farmers. The number of financial institutions and percentage of loan advanced for farm machinery were also taken into account while estimating the employment in financial institutions.

From the study of various components of farm mechanisation, which generated employment in the off-farm sector, it has been observed that employment was the highest in the processing units, followed by repair workshops of farm machinery, manufacturing and assembling units, marketing, transportation and storage, infrastructure and financial institutions, filling stations and sale agencies. If we sum up all the components studied which generate employment in the off-farm sector in the Punjab State during 1997-98, it was to the extent of 1519.55 lakh man-days per year. As the Punjab agriculture is going through a rapid transformation due to adoption of new technology, there is still a lot of scope for more employment generation in future in the state.

While attempting to analyse the impact of farm mechanisation, it should not be viewed only in terms of replacing or generating human labour employment. Rather the overall impact on the economy as a whole should be carefully analysed. There are sufficient empirical research studies which showed that the benefits of mechanisation are considered to be in terms of higher cropping intensity, higher yields, cropping pattern effects (shifts to higher value crops) cultivation of wasteland including reclamation and development of these lands.

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Ind. Jn. of Agri. Econ.
Vol. 53, No. 3, July-Sept. 1998

Economics of Energy Use in Agriculture in North-Eastern Zone of Tamil Nadu

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Energy is a critical input for agricultural production and its use pattern varied with the agro-climatic zones of the country. In this paper, the energy use pattern, cost of energy sources, energetic and economic ratios among the major crops of paddy, sugarcane and sorghum grown in the North-Eastern zone of Tamil Nadu were studied. Masigam village from Pemambut block of Vellore district was selected for the study and the farms were categorised into four groups based on the extent of area under different crops prevailing in the village. The study was confined to three major crops grown in the village, namely paddy, sugarcane and sorghum. The data on all commercial and non-commercial forms of inputs were collected for the three crops in the village. The commercial energy sources included seed, fertilisers and pesticides while the non-commercial energy sources included human and bullock labour and farmyard manure.

The total input energy use was the highest in sugarcane (48,558.70 MJ/ha), followed by paddy (9,091.54 MJ/ha) and sorghum (6,313.58 MJ/ha). Even though the total input energy use and output energy with 3,88,792.75 MJ/ha, were the highest in sugarcane, the output-input energy ratio (12.25) and benefit-cost ratio (1.55) was the highest in paddy, which should be exploited for sustained higher paddy production in the area. Non-commercial energy use was the highest in paddy with 5,747.43 MJ/ha and the important contributing factor was human energy with 3,021.89 MJ/ha which should be conserved by adopting mechanised activities. The benefit-cost ratio was less than unity in sorghum, being 0.69, which should be improved by recommending farmers to adopt improved technologies.

Comparative Economics of Farm Power in Haryana

U.K. Pandey, Dalvir Singh and K.S. Suhag*

Based on primary data of sample farmers of Hisar district in Haryana, the present study was undertaken with the following specific objectives: (i) to estimate the cost of bull-ock/camel and tractor power at farm level, and (ii) to conduct the break-even analysis of

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tractor vs bullock power operated farms. Multi-stage random sampling was adopted to select the ultimate unit of sample. Among the blocks of Hisar district, Hisar II block was randomly selected. Two villages from the selected block and 40 farmers from these selected villages were randomly selected. With the help of pre-structured schedule, the primary data for the year 1997-98 were collected from the selected sample farmers. To compare the economics of bullock/camel and tractor power operated farms over time, the data of sample farmers of Hisar district for 1981-82 were used. Besides averages and percentages, simple linear regression was also done to conduct the break-even analysis.

The analysis of data revealed the fact that (a) both initial capital investment and per hectare annual operating expenses in the case of bullock power operated farms is considerably lower than that of tractor power operated farms. But the out of pocket expenses are quite low in the former as compared to the latter category. (b) The per hectare annual costs have temporarily increased both in bullock and tractor power operated farms but their uses have also marginally increased. (c) For holdings below 10 ha, the bullock power is economical while beyond 10 ha, the tractor power is economical.

Thus, bullocks still seem to be the mainstay of farm power in Haryana. However, for the success in farming, the timeliness in completion of various farm operations assumes great significance and due to this consideration many small farmers are also induced for the ownership of tractors. The creation of dependable and efficient custom hiring facilities for helping the small farmers in reducing their cost on draught power seems to be a socially desirable step in reducing the degree of inefficiency in the use of draught power in agriculture.

A Comparative Economics of Use of Animal Energy and Mechanical Energy in Crop Production of Gwalior District (M.P.)

A.M. Jaulkar and V.N. Singh[†]

The paper attempts a comparative study of tractorisation vs. bulllock operation in Gwalior district of Madhya Pradesh, involving many aspects related with resource use efficiency, crop productivity, and net income. The study is based on data collected from a sample of 70 farmers comprising 35 each from tractor and bullock operated farms, selected from five

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villages in Morar block of Gwalior district, pertaining to the year 1996-97. The productivity of paddy, soybean, wheat, gram and mustard in the study area was higher by 10.62, 39.32, 23.95, 19.53 and 39 per cent respectively on tractor operated farms than on bullock energy using farms. The study has further brought out the fact that the per farm bullock labour energy requirement has continuously declined due to substitution of tractor in agricultural operations as a consequence of reduction of cost/unit of work and returns over investment on this resource. The cost and returns analysis indicated 58 per cent higher net return per hectare on tractor operated farms over bullock operated farms.

Need for the Promotion of Non-Conventional Sources of Energy in Tamil Nadu

S.Lakshmi*

An attempt is made in the paper to find out the allocation of plan outlay to the power sector, installed capacity, power generation, purchases, per capita consumption, category-wise sale of power, number of consumers and rural electrification status in Tamil Nadu. From the analysis it could be derived that the use of electricity is increasing year after year in all categories. One among the various solutions to the problem of power is to encourage the installation of biogas plant which can be used for lighting at home and for energising the pumpset for irrigation purpose. If the biogas plants are used for energising the pumpsets instead of going in for electricity, then the demand for electricity for irrigation purpose can be removed and to that extent the demand for electricity can be reduced. It is, therefore, necessary to create awareness among the public especially in rural areas to go in for the installation of biogas plants (those who are having enough cattle population), in order to use the gas for energising the pumpsets for irrigation purpose and for lighting at home and the industrial units to generate energy by themselves for their use. The large establishments, hotels, institutions, etc., should go in for the installation of biogas plants and the gas can be used for lighting. This will help to reduce the demand for electricity. There is no doubt that there are technical, economical and social problems relating to the successful functioning of the biogas plants. But if appropriate steps are taken to solve these problems, then it will be a boon to the society to solve the energy problem to a certain extent. Solar energy could also be harnessed to meet the energy requirements by the institutions, hotels, etc., which will help to reduce the demand for electricity.

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Impact of Tractor Drawn Implements on Energy Use, Cost and Returns in Rainfed Agriculture - A Case Study

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Though tractor drawn implements are available for soil and moisture conservation in rainfed farming, they are not very popular among farmers. Hence, to show the benefits of these implements to the farmers, a trial was conducted in Selakkarachal village of Sultanpet block of Coimbatore district in Tamil Nadu during 1989-90 under the All India Co-ordinated Energy Requirement Scheme of ICAR. Sixteen rainfed farmers were selected for using the tractor drawn implements. Among the sixteen, eight farmers used basin lister and Broad bed farmer-cum-seed drill (Treatment I), while Cultivator (Treatment II) was used by the remaining eight farmers. For the purpose of comparison, another sixteen farmers were selected and kept as control farmers. Maize and cholam were the crops grown under rainfed conditions.

The use of tractor drawn implements like Basin lister, Broad bed farmer-cum-seed drill and Cultivator helped to save the operation time and to conserve the monsoon rain water *in situ* resulting in better germination, crop growth and yield. Though the use of improved tractor drawn implements resulted in increased energy use and cost, the additional income realised from higher yield more than compensated the additional cost generated and more profit as compared to non-using farms. The level of mechanisation in the rainfed agriculture is still very low. The main reasons for this are small and scattered holdings, poor investing capacities of the farmers and non-availability of quality implements and machinery in the vicinity of villages. Since the investment required on agricultural machinery is quite high and these machineries could be used only for a few days in a year, the farmers give low priority for mechanisation in dry farming in comparison to other inputs. Hence, custom hiring of machineries and contractual field operations have to be popularised through proper extension education.

Problems and Prospects of Promoting the Use of Energy from Non-Conventional Sources

Brahm Prakash, D.K. Sharma and S.K. Garg*

The paper attempts to highlight the role of non-conventional sources of energy, identifies the problems and explains the bright prospects of the non-conventional sources of energy. Coal, oils, natural gas and electricity are the resources of energy which have been in use since long. But due to environmental pollution caused by coal and oils, deficiency of foreign exchange to procure oils from foreign countries, low generation of electricity and untapped potential of natural gas, there is a need to promote non-conventional sources of energy.

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Before selecting a resource of energy, one should opt for that energy resource on which one can be relied upon, pollution free, high energy value, easily available and economically viable. Non-conventional energy and wind energy fits well on these standards. One has to evolve a system for the management of collection, transportation, storage, handling and preparing these non-conventional sources for energy production on a large scale. These sources like animal waste and plant biomass are available in large quantities and are suitable for heat energy and power. Efficient storage, reasonable turn down ratio, grid operation, voltage and frequency synchronisation are some of the problems associated with wind energy and power utilisation. More land area requirement and environmental problems are also associated with wind generated energy. Solar energy power projects have similar drawbacks. These resources have very bright prospects. Sincere efforts should be made to save the energy in agricultural production and processing and a rational energy pricing policy should be evolved which can accelerate the growth of the non-conventional sources of energy.

Farm Energy Use in Haryana

B.S. Tomer and Kiran Kapoor†

An attempt has been made in the paper to study the trends in the size and composition of work animal population and farm mechanisation during last three decades in Haryana State. The study is based on secondary data taken from livestock census for different years from 1966 to 1992. The data pertained to number of work animals, farm machinery and cultivated area. The state was divided into three zones having high, medium and low area under irrigation, to study the variations in trends and composition of work animals and use of farm machinery.

The study revealed that farm mechanisation in the state increased at a faster pace since the dawn of the green revolution. The cultivated area per tractor and tubewell in the state decreased from 712 and 216 hectares in 1966 to 25 and 7 hectares in 1992 respectively. The work animal population in the state showed a declining trend since 1977 and it has declined by 25 per cent in 1992 considering 1966 as base. However, upto 1977, both sources of energy, i.e., farm machinery and work animals have shown an increasing trend. This was mainly because of greater requirement of farm power for intensive cultivation induced by the green revolution.

The study also indicated that the composition of work animal population was also changing with the development of agriculture. The population of bullocks was declining and the number of he-buffaloes in the total work animal population has increased. The percentages of bullocks and he-buffaloes have changed from 87 and 3 per cent in 1966 to 62 and 20 per cent in 1992 respectively. It was mainly because the buffalo was being preferred over the cow as an economic milch animal in the state.

Further, the requirement of farm energy per unit of area was higher in high irrigated areas where intensive cultivation was adopted as compared to low irrigated areas. The study

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revealed that in high irrigated zone, the cultivated area covered per work animal, tractor and tubewell was 2.8, 19.0 and 4.6 hectares respectively, while the corresponding figures in the low irrigated zone were 7.5, 40.5 and 7.1 hectares.

Energy Use Pattern of Rural Households in Ahmednagar District: A Case Study

P.P. Pawar, H.R. Shinde, D.L. Sale, S.B. Dangat and S.S. Salunke*

The paper attempts to study the present pattern of utilisation of various energy sources in Varvandi village (taluka Rahuri) in Ahmednagar district of Maharashtra. Data on crop production, cattle raising and household activities were obtained through personal interviews, pertaining to the year 1992-93 and village level information was obtained from revenue and panchayat office. The various energy sources comprised firewood, dung cake, kerosene, electricity, fertilisers, human and animal labour. Among the energy sources, firewood provided 32 per cent energy, followed by animals (26 per cent), human labour (21 per cent), electricity (10 per cent), kerosene (5 per cent) and diesel (2 per cent). Marginal farms accounted for the highest share of firewood, dung cake, and kerosene use, followed by medium, small and large-sized farms. The use of electricity, fertilisers, farmyard manure, human and animal labour was found to be the highest on medium sized farms, followed by large sized and small sized farms. Firewood being a major source of energy in rural households its production should be increased on intensive basis through social forestry, individual plantation, afforestation of fallow land, etc., to meet the energy needs of households.

Energy Use for Crop Production in Uthamapalayam Block, Madurai District, Tamil Nadu

T. Alagumani†

An attempt has been made in the paper to evaluate and compare the levels and patterns of energy use in mechanised and non-mechanised farms in Madurai district of Tamil Nadu. Uthamapalayam block was purposively selected based on the highest number of tractors per thousand hectares of net area sown. Five villages were selected based on the same criterion. The sample size was fixed at 60. Thirty farms owning tractors were selected at random and were distributed among the villages in probability proportion to the number of tractors borne by each village. An equal number of non-mechanised farms was selected from each village. The pattern of energy use on farms was studied through conventional analysis.

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An overall comparison of sourcewise energy consumption by different crops grown under wet and garden situations in mechanised and non-mechanised farming systems revealed that the human and bullock energy use was relatively higher in non-mechanised farms and mechanical energy use was higher in mechanised farms. There was no significant difference in electricity use for crop production between farms. Irrespective of the systems of farming the percentage of electrical energy utilisation to total energy consumption by each crop in garden land cultivation was uniformly very high ranging from 62 to 87 per cent of total energy use by each crop depending upon the nature of crop. The above facts indicated the scope for substitution of mechanical energy for human and bullock energy in the event of mechanisation.

Trends and Determinants of Energy Use in Haryana Agriculture

A.C. Gangwar,* K.N. Rai,* S.P. Singh* and S.N. Singh**

The paper attempts (i) to study temporal use of different sources of energy inputs in agricultural production and (ii) to examine the determinants of energy inputs use in agricultural production in Haryana. The study is based on time-series data collected from published sources. Compound growth rates in energy use in agriculture were estimated fitting exponential equations for inputs energy using time-series data 1966-67 through 1992-93 in the case of draught animals and agricultural workers and 1966-67 to 1995-96 for energy inputs. In order to examine the determinants of energy use from different sources in agricultural production linear multiple regression equations were fitted. Compound growth rates were worked out for four different time periods, viz., Period I (1966-67 to 1976-77), Period II (1977-78 to 1987-88), Period III (1988-89 to 1992-93/1995-96) and Period IV (1966-67 to 1992-93/1995-96).

The study reveals that in the case of energy use in agriculture from conventional sources, use of human energy increased continuously in spite of minor variations observed in decadal growth rates. In regard to animal energy use, bullock energy use declined sharply reflecting negative growth rates in periods II, III and IV. Growth rates for energy use from he-buffaloes, horses and ponies and mules were positive for each of the time periods studied. It may have happened on account of creation of more avenues for small transportation work which could economically be done by animals only. Thus with diversification of rural economy on account of increased agricultural income, total animal energy use showed positive growth rate in period III. Energy use from non-conventional sources increased continuously but at a decreasing rate along with agricultural production reflecting positive association between its use amd agricultural output.

As far as the determinants of energy use are concerned, total agricultural investment, net agricultural income and cropping pattern were found to be important factors determining animal energy (total), bullock energy and tractor energy use in agriculture. In general, the main determinants of energy use from other non-conventional sources of agriculture were

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average yield of foodgrains, acreage under high-yielding varieties, total agricultural investment and per cent area irrigated to net sown area. The findings show some degree of association between non-conventional energy use and human energy and transport animal energy use.

A Comparative Economics of Energy Utilisation in Rice Cultivation under Irrigated and Rainfed Farming

M.R. Chandrakar and A.K. Koshta†

The study examines (i) the variation in the form and extent of energy utilisation in the production of rice under irrigated and rainfed farming situations, (ii) the cost use efficiency in the production of rice along with variation in its inputs distribution under both the situations and (iii) the energy and cost gap for the production of rice under irrigated and rainfed farming situations in Raipur district of Chhatisgarh region of Madhya Pradesh. The primary data on cost of rice cultivation were collected by survey method from all the farm families of Amdi (92) (irrigated village) and Tarpongi (196) (rainfed) villages in Raipur district. The data pertained to the year 1995-96.

Operationwise energy hours spent for the production of rice were comparatively more under irrigated than under rainfed situations. Maximum energy hours spent were on human labour and the minimum on tractors in both the farming situations. Aggregate energy requirement for the production of rice was 160.36 MJ/ha and 8,429.83 MJ/ha under irrigated and rainfed farming situations respectively, which are considerably higher than those for rainfed rice. Rainfed rice production required lower magnitude of energy units than those under irrigated rice production. Consequently, the cost of production per hectare for rainfed rice was lower than under irrigated rice production. The sourcewise energy use was the highest on fertilisers in both the situations. However, maximum energy was used in terms of cost on human labour. The output obtained in terms of energy under irrigated farming was about two times more than that under rainfed farming. The differential levels of energy use clearly reflect the differences in the productivity between irrigated and rainfed rice. Total output-input energy ratio was more under rainfed rice than under irrigated farming situation. The benefit-cost ratio was 0.76 and 0.58 under irrigated and rainfed rice respectively. Renewable energy use efficiency was higher (64.58 per cent) under rainfed rice than under irrigated rice (35.12 per cent). There was a reverse trend in non-renewable energy use efficiency.

The yield gap of rice showed improper energy allocation in the production process of rice. Looking at the importance of rice crop in terms of their acreage, production and consumption,

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there is a necessity to increase the energy allocation to fulfill the yield gap in rice crop for various operations. Therefore, the yield gap of rice can also persist on adequate recommended energy level.

Comparative Economics of Animal Energy and Mechanical Energy Use in Potato Cultivation

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The paper examines the economics of animal energy and mechanical energy in potato cultivation in the Phoolpur tehsil of Allahabad district of Uttar Pradesh. The potato growers have been categorised into three groups according to the level of mechanisation, viz., fully mechanised, partially mechanised and non-mechanised farms. Using multi-stage random sampling technique, ten farmers from each category making a total sample of 30 farmers have been selected for the purpose. The required information was collected through well structured schedules.

It was observed that the level of energy use per hectare was the highest on fully mechanised farms, followed by the partially mechanised farms and was the lowest on non-mechanised farms. However, the net returns per hectare was highest on partially mechanised farms, followed by non-mechanised farms and the lowest on mechanised farms. The output-input ratio was also the highest on partially mechanised farms, followed by mechanised farms and non-mechanised farms. The study concludes that partial mechanisation is most suited for potato cultivation.

Employment Effect of Machine Power Use in Crop Farming in Different Agro-Climatic Regions of Rajasthan

P.M. Sharma,† K.A. Varghese† and Puran Singh Jaitawat‡

The paper attempts to assess the pressure of human workforce, draught animal power and machine power on land in different agro-climatic regions of the state of Rajasthan and to examine the extent of substitution of human labour by the use of machine power in place of animal power in crop farming. The rural human workforce of the state is prone to severe problems of unemployment and under-employment, which make it necessary to create additional employment opportunities to the workforce or alternatively to shift part of the

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workforce engaged in agriculture to non-agriculture sector. The surplus labour in the farm families in the state alone is 46.5 per cent, which varies from 25 per cent in the south humid region to 64 per cent in the western dry region. The supply of animal power through indigenous male cattle and camel is also increasing in all the regions of the state as a natural process. Only 28.7 per cent of the available draught animal power is in use in the state and the remaining 71.3 per cent is surplus at the state level, which varies from 67.8 per cent in humid south-eastern plains to 81.9 per cent in the western dry region of the state. The substitution effect on human labour employment due to tractor in place of bullock has been estimated as 62 per cent which means that mechanisation reduces human labour employment in relation to bullock power use.

It has also been proved that the time efficiency in the use of machine power over bullock power varies from region to region for the same operation and from one operation to another in the same region. Unless capital intensive machines like tractor are put to gainful work for stipulated work days, it may give rise to diseconomy in the use of such machines by farm households. The increased use of such machines will add to the extent of under-utilisation of bullock power and under-employment of farm family labour. Unless the time efficiency gains as a result of mechanisation offsets the cost of under-utilisation of bullock power and under-employment of farm family labour, mechanisation cannot be considered as a viable alternative to traditional sources of farm power for states like Rajasthan which is prone to lot of risk in crop farming. Mechanisation must be selective in view of the high rate of substitution taking place for human labour and animal power which have only very limited scope for alternative uses.

Productivity and Energy Use Efficiency in Punjab Agriculture - A Temporal Analysis

Bant Singh, Rachhpal Singh and Jaswinder Kaur*

An attempt has been made in the paper to estimate the output and energy use in the cultivation of principal crops of wheat, paddy and cotton in Punjab at three developmental stages during the post-green revolution period 1972-73, 1982-83 and 1993-94 and to make an economic analysis with respect to costs and returns from these crops during the three periods. The study brought out that with the development and adoption of improved technology since the late sixties and early seventies, both productivity and energy use per hectare of the crops raised have consistently increased. Since productivity increased at a faster rate than the increase in energy use, the energy use efficiency has considerably improved over time for all the three major crops of the state. The study also revealed that

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there has been continuous improvement in the economic efficiency (output-input ratio) in the cultivation of major crops of wheat, paddy and cotton. The whole analysis proved that Punjab farmers are rational and conscious in the use of farm resources.

Energy Use Pattern in Haryana Agriculture

V.K. Singh, R.K. Khatkar and Sushil Kharinta†

This paper aims to study the ways in which energy produced from different sources is being used on different size-groups of farms and change in energy consumption on these farms over time in the state of Haryana. Specifically, it tries to examine the energy use pattern on different size-groups of farmers and study temporal variations in differnt principal crops.

On the basis of primary data pertaining to two time periods, i.e., 1973-75 (period I) and 1996-98 (period II) taken from the farm records of 30 sample farmers scattered in three districts, viz., Karnal, Hisar and Mahendergarh selected under the project "Comprehensive Scheme to Study the Cost of Cultivation of Principal Crops in India - Haryana", it was observed that the relative shares of chemical and mechanical energy have increased in total farm energy use over the time period of about two decades on all the farm size-groups. The relative share of mechanical energy use has increased from 14 per cent to 29 per cent on small farms, from about 19 to 23.5 per cent on medium farms and from 20 per cent to 23.50 per cent on large farms during period II over period I. The corresponding figures for increase in chemical energy use were from 8.69 to 24.96 per cent, from 6.69 to 35.11 per cent and from 2.74 to 32.38 per cent on small, medium and large farms respectively. The tractor energy use has also increased during the period on small farms. However, there was a decline in tractor energy use on medium and large sized farms during the period under reference. The decline in tractor energy use may be attributed to more use of other mechanical energy in the form of combine harvester, lesser use in land preparation due to lack of time owing to intensification of cropping and decrease in size of holdings due to continuous fragmentation of holdings. The total energy use has increased on all the categories of farms mainly due to mechanisation and more use of chemicals in agriculture.

Mechanisation of agriculture has resulted in a decline of human and bullock labour energy due to displacement of these traditional renewable sources, which is not a healthy sign keeping in view the surplus availability of these sources. A similar trend was observed in cropwise analysis of energy use pattern. The temporal increase in the ratio of input-output energy in almost all the crops showed efficient use and conversion of input energy into output energy. But keeping in view the uncertainty about non-renewable sources of energy and their higher social cost, the need is emphasised to use more of renewable sources of energy in the form of human, animal, hydrological and solar energy which are in abundance in our country.

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Comparative Economic Analysis of Tractor and Bullock Power Use in Crop Production in District Sitapur (U.P.)

S.R. Yadav,* Raj Kishor, Nasir Husain** and T.R. Singh***

The paper attempts to examine the comparative economics of tractor and bullock power use in major crop production, based on data obtained from 50 tractor operated and 50 bullock operated farms, randomly selected from five Gram Panchayats in Khairabad block in Sitapur district of Uttar Pradesh. The data pertained to the year 1996-97. The study showed that the average size of holdings, area under irrigation, intensity of cropping and the area under crops were higher on tractor operated farms as compared to bullock operated farms. The cost of cultivation of sugarcane, paddy and wheat was found to be lower on tractor operated farms than that on bullock operated farms. Similar was the case in the use of different input factors. The total input cost on tractor operated farms was lower than that on bullock operated farms, because of economies of large scale farming and efficient use of resources on tractor operated farms.

The total cost of energy use in different agricultural operations in the production of sugarcane, paddy and wheat on tractor operated farms was found to be lower than that on bullock operated farms. It was due to timely, effective and better use of resources on tractor operated farms. Cropwise gross income, average family labour income and farm business income were also higher on tractor operated farms than on bullock operated farms. The input-output ratio of sugarcane, paddy and wheat came to 1:1.67, 1:1.43 and 1:1.65 respectively on tractor operated farms which were higher than on bullock operated farms.

The study revealed that utilisation of human labour in crop production in different farm operations was lower on tractor operated farms than on bullock operated farms. Thus human labour use was being replaced by tractor power in crop production.

Energetics and Economics of Wheat Cultivation in Different Agro-Climatic Zones of Madhya Pradesh and Its Future Requirements

C.L. Thakur†

The requirements of energy and cost for growing wheat under five agro-climatic zones of Madhya Pradesh and the input energy requirements in future are discussed in the paper. One village from each of the five wheat growing agro-climatic zones of the state was selected for the study. It is observed that irrigation operation required a major quantum of energy involving higher cost among all the farm operations. Electricity accounted for a higher proportion of energy consumed among the total energy used from different sources, followed

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by human labour energy. The energy output-input ratio varied from 2.5 to 4.6 and the benefit-cost ratio varied from 1.43 to 2.91 in the selected villages. The average energy requirement for wheat crop was less than the recommended energy by 35 per cent. The energy and yield gap will have to be minimised if the farmers of the villages were to use the fertilisers at recommended level. The productivity of crops is determined by several factors, viz., energy/cost use pattern and technology level of the farmers including agro-climatic conditions.

The adoption of high-yielding varieties, expansion of irrigation facilities, mechanisation and fertilisers-diesel-electricity combination have pushed the demand for commercial energy to a new height. Based on the energy requirements for wheat production and the area under wheat in 1995-96, the energy requirement was projected for the year 2005-06. For irrigated crops, the main source of energy was fertiliser, followed by electricity and diesel. However, for rainfed crops, maximum energy was consumed in the form of seeds. The projection revealed that the enery requirement for wheat production in 2005-06 would increase by 6.3 per cent over the energy needs in 1995-96. The increase in 2005-06 in the use of electricity, diesel, fertilisers and pesticide chemicals would be 8.4, 10.0, 31.2 and 6 per cent respectively over the requirements estimated for the year 1995-96. The requirement of seeds may be expected to increase for wheat by 5.3 per cent over the year 1995-96.

Impact of Tractorisation on Employment and Resource Use: A Study in Cuddalore District, Tamil Nadu

K.R. Jahanmohan and K.R. Sundaravaradarajan*

The paper seeks to study the impact of tractorisation on labour employment and energy efficiency in Vriddhachalam block of Cuddalore district of Tamil Nadu. The specific objectives of the study conducted in 1993 were (a) to examine the effect of tractorisation on both human and bullock labour use (b) to find out the resource use efficiency of tractor and non-tractor farms. Using the multi-stage stratified random sampling technique, data were collected from a sample of 50 tractor farms and 50 non-tractor farms from seven villages in Vriddhachalam block in Cuddalore district of the state.

The study revealed that after the introduction of tractors, there was displacement of bullocks maintained on tractor farms to the extent of 90 per cent. The major operations like preparatory tillage, stubble removal, bund formation and threshing were done by tractors. On tractor farms, displacement of human labour occurred for the first and second season rice crop. The use of human labour on tractor farms increased by 10.53 per cent and 3.66 per cent for sugarcane-planted and sugarcane-ratoon crops respectively as compared to non-tractor farms. On tractor farms, 1.11 man-day and 0.31 man-day were displaced for the first and second season crop respectively. The income function revealed that on tractor farms the gross area cultivated, quantity of nitrogenous fertilisers used and tractor hours hired

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were significant variables influencing the gross income which is used as a measure of resource use efficiency. On the non-tractor farms the quantity of nitrogenous fertilisers used and tractor hours hired were significant variables influencing the efficiency.

The tractor power made feasible a quick and timely performance of farm operations and facilitated the use of all inputs at higher levels, thereby contributing to the increase in the farm income. Since the commercial crop, namely, sugarcane occupied a sizeable area in the study region, the tractor use had countered the labour displacement. The food crops like rice led to labour displacement because they had limited employment potential and was less labour intensive.

Energy Use Pattern in Rice Cultivation: Orissa Experience

Parshuram Samal[†]

The paper analyses the energy use pattern in rice cultivation considering data for the period 1971-92. The study is based on Cost of Cultivation data collected from the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India and the area and production statistics, collected from the Directorate of Economics and Statistics, Government of Orissa. The temporal changes in energy use for five periods, i.e., 1971-75, 1976-80, 1981- 85, 1986-90 and 1990-92 were computed and compared. Both energy use pattern in rice cultivation.

The study revealed that the important sources of energy input in rice cultivation were animal and human labour, seed, manures and fertilisers in descending order. With passage of time, fertilisers emerged as the important source of energy for rice cultivation in Orissa. The compound growth rate of energy from fertilisers during 1971-92 was also impressive at 8.5 per cent per annum. The energy contribution from machine labour was negligible during the period, although during the recent period (1990-92), machine labour use has started picking up. While energy use from human and animal labour grew at the rate of 1.15 and 1.30 per cent respectively during 1971-92, there was no growth in energy inputs like seeds and manures. There was stagnation in the use of animal energy in the recent period due to increasing use of energy from machine sources. The share of fertiliser energy in rice cultivation increased from 10 to 26 per cent while the share of energy from the other four sources decreased to 74 per cent. The share of animal labour and human labour has decreased from 28 and 27 per cent to 25 and 24 per cent respectively, though the absolute level of energy use from these sources has increased. The share of seeds and manures has decreased from 21 and 15 per cent to 16 and 9 per cent respectively. The total energy input in rice cultivation during 1971-75 period was found to be 6,122 MJ per hectare, which has increased to 8,533 MJ per hectare during 1990-92. The energy input-output ratio was 3.7 during 1971-75, which has improved to 4.5 during 1990-92 due to increased use of fertilisers and introduction of more location-specific varieties. Though insignificant, the negative sign of

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the growth rate of manures is an indication of the declining use of manures. Therefore, it is suggested that increased use of fertilisers should be made judiciously along with manures to increase rice production in the state and to sustain the crop yield.

Energy Use Pattern of Soybean-based Rainfed Cropping System of Sehore Development Block of Madhya Pradesh

H.O. Sharma and S.B. Nahatkar*

In Madhya Pradesh the introduction of soybean, especially in rainfed areas has brought about many changes in the cropping pattern and energy use. In north-eastern and central parts of Madhya Pradesh soybean accounts for more than 80 per cent of the kharif cropped area. After soybean, in the rabi season mainly, rainfed wheat and gram are grown by the majority of the farmers. Therefore, a study on energy use pattern of soybean based cropping system was undertaken considering 187 sample farmers from five purposively selected villages of Sehore development block in Sehore district of Madhya Pradesh. The results of the study showed that scale economy is operative in terms of input energy use under both the systems (soybean-wheat and soybean-gram). Input energy use was higher for soybean-wheat cropping system (7,886 MJ/ha) as compared to soybean-gram (7,667 MJ/ha) cropping system. Seed-fertiliser technology was the major source of energy use and the large farmers substituted human-bullock labour with electro-mechanical energy. Still chemical energy use was marginal under both the systems. The input-output energy ratio shows that 1.00 MJ input energy use produced an output energy of 7.57 and 8.15 MJ in soybean-wheat and soybean-gram cropping systems respectively. On the basis of recommended package of practices (RPP) the input-output energy gap was estimated. It was observed that an additional 1.00 MJ input energy produces an additional output energy of 7.06 and 9.86 MJ respectively in soybean-wheat and soybean-gram cropping systems respectively. This shows that there is still scope for additional energy use in soybean-gram cropping system as compared to soybean-wheat cropping system but the possibility of wider adoption of this system exists only if early maturing soybean varieties are introduced in the area because gram can be grown just after the harvest of soybean (upto mid-October) without loss of *in situ* moisture from farmer's field.

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Impact of Tractor Use in Agriculture - A Study in Agra Division of Uttar Pradesh

Balishter and K.M. Mithlesh†

The paper makes an attempt to examine the impact of tractor use on cropping pattern, cropping intensity, farm output and human labour employment in Aligarh and Etah districts in Agra Division of Uttar Pradesh, selected on the basis of availability of tractor power per hectare (H.P. available per hectare). The study is based on data collected from a random sample of 200 farmers - 100 farmers selected from ten villages in Tappal block in Aligarh district with the highest availability of tractor power (1.13 H.P./ha) and an equal number of farmers selected from another ten villages in Jalesar block with the lowest availability of tractor power (0.39 H.P./ha). The selected farmers were grouped under three categories, viz., small (upto 2 ha.), medium (2-4 ha.) and large (above 4 ha.). The sample consisted of both tractor and non-tractor farms. The data were collected by personal interviews and pertained to the year 1992-93.

The results of the study indicate that on an average per hectare availability of tractor power on sample farms worked out to 7.24 H.P. in Tappal block and 6.30 H.P. in Jalesar block. The per hectare availability of tractor power on small, medium and large farms was higher in Tappal block as compared to the corresponding size-groups in Jalesar block, it being on an average, about 15 per cent higher in the former and it is this difference which played a critically important role in raising production and productivity.

Among the different farm activities, tillage utilised the maximum tractor power in both the blocks. Threshing and transportation of farm produce are the other farm activities where too a sizeable amount of tractor power is used in both the blocks. The overall intensity of cropping was about 210 per cent in Tappal block and about 204 per cent in Jalesar block. The intensity of cropping on small and medium farms was higher in Tappal block while on large farms it was higher in Jalesar block due to the fact that no sugarcane was grown in the latter. The overall average cost of inputs per cultivated hectare in Tappal block was higher by about 12 per cent than in Jalesar block due to more intensive use of machinery, fertilisers and irrigation in the former which are the main components of modern farm technology. Average per hectare physical productivity in Tappal block was higher by about 17 per cent than in Jalesar block. The net output per cultivated hectare in Tappal block was higher by about 45 per cent as compared to Jalesar block. Sizewise it was higher in Tappal block by about 55 per cent on small farms, about 50 per cent on medium farms and about 32 per cent on large farms, which is due to availability of more tractor power and use of crucial inputs like fertilisers, irrigation, etc.

Human labour use both per cultivated hectare and per cropped hectare was higher in all farm size-groups in Tappal block than in Jalesar block. Both tractor use and human labour use per cultivated hectare decreased with the increase in farm size in both the blocks. There is positive relation between intensity of tractor use and intensity of human labour use in

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both the blocks. With the increase in the use of tractor, human labour use also increased in both the blocks. Thus it may be concluded that the impact of tractor use is positive in terms of the degree of commercialisation, cropping intensity, productivity, income and also in terms of human labour employment. There exists further scope for tractor use in the area under study.

Economics of Use of Animal and Mechanical Energy in Crop Production

Surendra Singh,* C.J.S. Pannu* and K.C. Dhawan**

An experiment was conducted at the Research Farm of the Department of Farm Power and Machinery, Punjab Agricultural University, Ludhiana, to study the energy economics of use of bullocks as well as of tractor power for paddy-wheat crop rotation. Paddy was manually transplanted and wheat was sown by bullock/tractor drawn seed-fertiliser drill. Electric motor was used as a source of irrigation. The energy ratio for paddy was 2.58 on bullock farm and 3.48 on tractor farm. Specific energy requirement was the lowest (7,134 MJ/ton) on tractor farm and maximum (9,640 MJ/ton) on bullock farm. Gross return from the bullock farm was Rs.7,165 per hectare which was lower than on the tractor farm (Rs.10,395 per hectare). Similarly, the benefit-cost ratio was also low (1.19) on bullock farm and it was 1.68 on tractor farm. However, the energy ratio for wheat was more (5.42) on bullock farm as compared to tractor farm (4.27). This is only due to low energy input on bullock farm. The benefit-cost ratio was also slightly high (2.20) on bullock farm as compared to tractor farm (2.03). The cost of cultivation is also more or less the same on both the categories of farms for both the crops of paddy and wheat. But tractor as a power source saves a lot of time in various operations and does the operations in time, which is otherwise not true on bullock farms. A pair of bullocks required 49.4 hours to prepare a field of one hectare for paddy transplanting whereas tractor required 11.7 hours. Similarly, seedbed preparation for wheat crop required 54.5 hours by a pair of bullocks whereas the tractor required 15.4 hours per hectare. There is a saving of 70-80 per cent time with the use of tractor and it also reduces human drudgery which otherwise is involved in the use of bullocks. Therefore, tractor as a farm power source is better than a pair of bullocks as it saves time and requires less maintenance as compared to bullocks which need daily care and maintenance.

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Electricity Use in Indian Agriculture

Nilabja Ghosh[†]

Agriculture, the largest sector in Indian economy, has traditionally depended on animal and human power for its operations but is rapidly moving towards mechanisation and energised groundwater irrigation based on commercial energy. In a comparative view, agriculture is found to be rapidly increasing its electricity consumption, even relative to industry and the economy as a whole. But energisation in agriculture has a short history, starting with the mid-sixties, while the same in industry is growing through decades.

Energy use is growing faster than the GDP in the sector and electricity consumption for every unit value of output generated is also increasing. But in industry the intensity of energy use has been nearly stable for the past two decades or so. The elasticity of the electricity intensity of production with respect to the size of the sector is also high. Agriculture is also increasing its share in the nation's electricity consumption even while its share in the national output is coming down. It appears that the agricultural sector is yet to become efficiency oriented in its operations, as is true of industry. Part of the reason for the delay in such adjustments may be the price policy since the real rate of electricity tariff in agriculture is coming down continuously and is negatively correlated to the electricity consumption.

Although electricity consumption per hectare is found to be positively correlated to capital intensity of production, land utilisation level and land productivity, lack of cointegration among the variables prevent any conclusion regarding the causal role of electricity consumption. Across states, which vary greatly in electricity consumption, there is no correlation between electricity use and variables like land utilisation and employment generated, although cereal yield rates are positively related to electricity use per hectare. In general, the southern and northern states have larger number of energised wells and consume more energy per hectare compared to their eastern and western counterparts. It seems possible that affluent states with high per capita income, many of which also enjoyed high agricultural productivity, invested more in tubewells and other machinery and consumed more electricity per hectare and also per capita. However, it does not follow that such states also enjoy high growth rates in agriculture. In fact, the eastern states having very low electricity consumption registered high growth rates in agriculture. Whatever association is observed between electricity consumption and various performance indicators in agriculture like crop yields may be part of the overall development process and the actual contribution of energy use to greater employment and productivity prospects in agriculture certainly deserves serious investigation.

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Energy Requirements in Horticultural Crops: A Study of Apples

D.V. Singh*

An attempt has been made to determine the energy requirements of apples, an important commercial and horticultural crop of Himachal Pradesh. The study is based on data collected from 126 apple orchardists of different size-classes selected from three villages, one each from Kullu, Mandi and Shimla districts of the state, pertaining to the agricultural year 1995-96. The study revealed that non-commercial energy items are the main sources of energy inputs for apple production in almost all categories of orchardists of the state. Among non-commercial sources, forestry products (timber wood, leaves and litter) are the main sources of energy. Similarly, chemical fertilisers and pesticides accounted for 90 per cent of commercial energy used on an average by the orchardist. Picking and packaging of apples alone accounted for more than 51 per cent of energy requirements. Animal draft power is not used in apple cultivation in the state. All categories of orchardists depended on common and public resources for more than 84 per cent of their energy needs for apple cultivation. Hence, the appropriate option is to go for massive afforestation on public and private lands and encourage the use of commercial energy sources (re-usable synthetic/corrugated fibre board cartons for fruit packing, etc.). This is more important in rural areas where the availability of energy items from natural resources is declining.

An Economic Assessment of Energy Use in Potato Cultivation - A Case Study of Nalanda District (Bihar)

R.N. Yadav, B.B. Singh and B.S. Gupta†

Technological improvement in agriculture has tremendously increased the use of energy input especially in potato production. The paper attempts to make an economic analysis of energy use in potato cultivation, based on data collected from a sample of 60 farmers randomly selected from two villages of Biharsharif block in Nalanda district of Bihar, pertaining to the year 1996-97. Cobb-Douglas production function was employed for analysis of data. The study revealed that in potato cultivation the per hectare use of energy was estimated to be nearly 6,547 megacalories of which manures/fertilisers and seed contributed a major share of 92 per cent. The contribution of other sources of energy was very nominal varying from 1 to 3 per cent of total energy consumed. A similar pattern of energy use was observed among different size-groups of farms. Further, the output-input ratio in potato cultivation worked out to 2.56 and this ratio was found to be more than 1 for all size-groups of farms, which clearly indicates that the farmers are efficient in potato cultivation in the project area.

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The regression analysis indicated that 96 per cent of the variation in output energy is explained by all the energy resources included in the function. The elasticity of production of irrigation energy was found to be the highest being 0.781 and significant at 5 per cent level. It is followed by seed energy (0.4209) and farm size (0.4026) which were significant at 5 per cent and 1 per cent level respectively. The elasticities of other energy resources were found negative which shows that there were over-utilisation of these energies in potato cultivation.

Impact of Tractorisation on the Absorption of Human Labour in Agricultural Operations in Jaunpur District of Uttar Pradesh

D.K. Singh*

An attempt has been made in the paper to examine the impact of tractorisation on the absorption of human labour in agricultural operations in Jaunpur district of Uttar Pradesh. This district in the lower Gangetic Plain zone was selected for study because it is most progressive in terms of farm mechanisation. A sample of 28 tractor users and an equal number of non-user households from four villages were selected from two blocks of the district according to pick and choose method. The reference period of the study is 1997-98.

The study showed that the number of tractor users was the maximum in the large size-group (4 - 10 ha). Non-users of tractors belonged to the small size-group with less than 2 hectares. The allocation of area under cereal crops was higher on tractor operated farms than on bullock operated farms. As against this, the proportion of area under pulses and oilseeds to cropped area was lower on tractor operated farms.

The study revealed displacement of human labour in agriculture due to tractorisation in the district. The maximum displacement of labour occurred in paddy, followed by pulses and oilseeds due to use of tractors in the kharif season. The per hectare absorption of human labour was comparatively lower in almost all rabi crops on tractor operated farms as compared to bullock operated farms.

The operationwise displacement of human labour use was maximum in threshing, followed by ploughing and sowing on tractor operated farms which worked out to three times less than on bullock operated farms. The magnitude of surplus labour has been increasing in the agricultural sector because of tractorisation. The need is emphasised for finding employment for them in non-farm activities.

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Economic Viability of Wind Power Generation in Tamil Nadu

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In India, wind energy is a good source of non-conventional energy particularly for windy locations in coastal terrains in Southern Tamil Nadu, Kerala, Gujarat, Maharashtra and Lakshadweep. In this paper, an analysis of economic viability of wind power generated by Tamil Nadu News Print Papers Limited (TNPL) in Perungudi and Devarkulam wind mill projects in Kayathar and Muppanthal regions respectively in Tamil Nadu has been made using the cost-benefit analysis. The monthwise production trend shows that wind power generation is maximum from May to September as the wind velocity is higher during this period. A similar trend has been observed with all other units in the sample area. The average production of wind power is found to be increasing in both the projects of TNPL. A cost-benefit analysis has been made to find out the economic viability of the wind power projects. It is observed that in both the sample locations, namely, Devarkulam and Perungudi, the net present value showed an increasing trend and it is found to be viable for the industries which have erected wind turbines in the sample area. The findings of this study suggest that the entrepreneurs who have installed wind mills are facing difficulties in meeting the fixed cost which is rather huge for an individual unit to bear. Therefore, the concerned government departments should provide effective incentives by way of increasing the price paid to wind power, lowering the charge for electricity of their respective units, assisting financially with considerable concession and subsidies. Also, the wind mill producers may be given duty concession, so that it is available at a lower price for the wind power generating units. Of all the sources of renewable energy, wind energy is economically viable and therefore, more private and government investment must come forth to exploit the opportunity.

The economic analysis carried out for the industrial sector has conclusively shown that wind energy is the cheaper source of energy which internalises the external costs for conventional electricity and forms a desirable component in the energy mix. Wind energy deserves to be included in the energy policy which will result in reduction of global warming and environmental damages to provide least cost to the nation. Economically speaking, the wind power projects are cost effective and their development in Tamil Nadu should be encouraged.

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Determinants of Level and Form of Energy Use in Haryana Agriculture

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A study was conducted in Karnal and Kurukshetra districts of Haryana to analyse the determinants of level and form of energy use in agriculture. Primary data were collected from a sample of 252 farmers representing small, medium and large size holdings. The results of correlation analysis revealed that farm size was positively correlated with total energy use in all the crops except potato. Energy purchasing power was negatively correlated with the total energy use in all the crops except sugarcane which was having an insignificant effect. In the case of net returns, positive correlation was indicated in paddy, wheat and sugarcane crops and negative correlation in potato with energy use. Family size was significantly positively correlated with the total energy input use only in sugarcane and berseem crops. In sugarcane crop, all factors were found to be significantly positively correlated with energy use except energy purchasing power. All factors were found non-significantly negatively correlated with the total energy use in potato crop.

The variations in energy consumption were mostly due to energy purchasing power in paddy and wheat and due to the farm size alone in sugarcane. Such variation in potato crop is explained by all the four factors but none was found to be significant. In fodder crops, namely, jowar and berseem, farm size and energy purchasing power have mostly caused variations in energy use.

Nature and Extent of Energy Use in Agriculture - A Case Study of Mahendergarh District in Haryana

Himmat Singh,† R.K. Grover† and Alka Suri‡

The paper attempts to estimate the nature and extent of energy utilisation in different size-groups of farms in dry and irrigated zones of Mahendergarh district of Haryana. The study has shown that in both the dry and irrigated zones of the district, maximum energy was utilised by wheat and bajra crops and minimum by guara and jowar crops on almost all size-groups of farms. The contribution of human and animal sources of energy was found decreasing in all the crops as the size of farms increased. But the contribution of mechanical, chemical and electrical sources of farm energy increased with the increase in farm size. The total energy consumption for all crops was found more under irrigated conditions as compared to dry farm situations. This was due to the fact that the consumption of electricity, fertilisers, insecticides/pesticides, etc., which are energy intensive inputs, was more on irrigated farms for all the crops grown. The study has suggested that the share of human and animal energy should be reduced because their per unit relative cost is more than the other

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sources of energy. The use of energy available from farm machinery, fertilisers and irrigation should be increased as far as possible to increase the yield of various crops. More emphasis should be given to the use of inexhaustive sources of energy in place of exhaustive ones. Renewable sources of energy should be used more by replacing non- renewable ones. And finally, more field oriented research should be conducted to reduce the energy consumption by the crops without adversely affecting their yield levels.

Impact of Electricity Subsidy for Irrigation in Punjab Agriculture

B.R. Garg and K.K. Jain*

The paper examines the extent to which State Government policy in Punjab with respect to subsidy on electricity has succeeded in harvesting the full potential of modern agricultural technology by analysing the area under principal crops and their production over the period 1980-81 to 1995-96; human labour employed in agriculture due to change in cropping pattern; extent of farm mechanisation and insecticide use over time and the impact of change in cropping pattern on fertiliser use, pesticide use, groundwater table, etc.

Electricity subsidy in Punjab agriculture has helped to bring about 58 per cent of the net sown area under groundwater irrigation and enabled the state to contribute 38 per cent of rice and 69 per cent of wheat to the central pool. Paddy, wheat and cotton are the principal crops in the state. The increase in the number of tractors over time showed that major operations like preparatory tillage, sowing, interculture, harvesting and threshing, etc., for these crops are mechanised in Punjab. It was also noted that human labour use per hectare in the production of these crops declined by almost 23 per cent over the study period. It is disquieting that fertiliser use and particularly pesticides use per hectare increased over time by more than the increase in the productivity of paddy, wheat and cotton. The water table has gone down in paddy growing regions due to heavy drawal of water from the ground while the problem of waterlogging has increased over larger areas in the south-west districts of Punjab.

It may therefore be concluded from the study that electricity subsidy for agriculture has realised its objective of bringing more area under irrigation and raising foodgrain and fibre production in the state. The situation at present is such that to sustain the productivity of these crops more and more fertilisers and pesticidies are required to be used which may cause many ecological problems. As the human labour employed in agriculture decreased over time following the existing crop pattern, there is an urgent need to find employment in more employment intensive crop enterprises which may be introduced in Punjab agriculture. Lowering water table in the central zone of Punjab may require additional investments in irrigation structure and increase the cost of operation which may affect the small farm productivity. On the other hand, rising water table in the south-west districts of Punjab may affect the area under cotton over time and make the agricultural lands uncultivable.

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To save increasing expenditure on fertilisers and pesticides, green manuring and integrated pest management need to be practised. To employ human labour in agriculture more labour intensive crops should be introduced into the existing crop rotation in Punjab agriculture or alternative employment must be found in agriculture processing industry at small scale level. Less irrigation intensive crops should be grown in the central zone of Punjab to sustain the water table.

Pattern and Economics of Energy Use in Hill Agriculture: A Case of Himachal Pradesh

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In this paper an attempt has been made to analyse the energy use pattern on different sizes of farms in different hill zones of Himachal Pradesh, to study the economics of energy use in agriculture on different sizes of farms in different hill zones and to suggest policy measures for rational energy availability and utilisation for development of hill agriculture on sustainable basis. For the purpose of study, a sample of 150 farmers were selected from Kangra district in low hills, Solan district in mid hills and Shimla district in high hills and information about the energy utilisation, cost of production and returns from crops on farms were collected by survey method for the agricultural year 1995-96. The study revealed that because of agro-climatic endowment the farming systems differed in different zones; cereals and fruit-based cropping pattern are predominant in low hills while vegetable based farming is practised in mid hills and only fruit farming in high hills. Commercial crops are more labour and capital intensive than cereals. Human labour use is the lowest in low hills as compared to mid hills and high hills. In vegetable based area bullock labour use is also higher than on cereals based. The use of fertiliser and pesticides increased from low hills to high hills. In low hills energy use is 5 times less than in mid and high hills, and bullock labour use is 2.5 times less, this is because of mechanisation of low hills. Energy input cost in total cost is the highest in mid hills because of very high labour utilisation. The returns from vegetable based farming system in mid hills was the highest as compared to the farming systems in high hills and low hills.

To mitigate the problem of surplus farm labour energy the State Government should take effective steps to establish rural based small scale industries using local raw material. Seasonal industries also hold feasible claim and should be encouraged. A large scale compost preparation programme should be started in all zones. The use of high-yielding variety seeds, fertilisers and plant protection material in crop production should be increased and financial arrangement should be made for easy availability of these inputs and distribution should be made at village level. Due to topographical impediments the possibility of mechanisation or semi-mechanisation is limited, hence suitable farm technologies like farm implements should be made available. The utilisation of surplus energy like human labour and bullock labour is very essential since alternative sources of its employment in the modern industrial sector are limited and the state economy is basically agriculture dominated.

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