PROCEEDINGS OF THE SYMPOSIUM ON "INCREASE IN AGRICULTURAL PRODUCTIVITY FROM NON-MONETARY INPUTS"

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RAPPORTEURS : 1. Dr. A. ROY
2. Prof. U. DASGUPTA

Dr. Prem Narain welcomed the Chairman and participants drawn from various research organisations including the All India Crop Improvement Projects. He explained the objective of the symposium and suggested that agricultural scientists and statisticians should identify their role how best they can help in solving the problems of small farmers who have limited resources for the cultivation of crops and as such, there is a need for identifying technologies which could maximise the production at low cost.

The Chairman introduced the topic of the symposium and suggested that in the abstracts of papers which were circulated among the participants here, he found that there are number of inputs which are considered as nonmonetary like irrigation, subsidy and manual labour, etc. and he was of the opinion that non-monetary input is of great value in respect of small and marginal farmers who cannot afford the risk of the monetary inputs and in areas where infrastructural facilities for distribution of inputs are not well organised, and also in areas where moisture stress limits the use of monetary inputs. However, he pointed out that non-monetary inputs are of great relevance even under conditions where monetary inputs are utilised. For example, without good crop management the utilisation of higher doses of fertilizers and pesticides may not lead to higher yield. The Chairman suggested that it is very pertinent that the role of monetary and non-monetary inputs be properly analysed.

Out of the 19 papers received, nine papers were presented by the different scientists representing various institutions. The role of non-monetary

inputs such as time of sowing, plant population per unit area, intercropping, utilisation of water at no cost, were discussed in the papers. The presentation were followed by lively discussions and questions on the various aspects in respect of the results presented by the scientists.

Considerable discussions evolved around inter-cropping and mixed cropping and effective statistical analysis of results of such experiments with appropriate methods. The various speakers suggested that no single method be appropriate under such circumstances. However, the use of LER, bi-variate method of analysis and analysis through conversion of the data into monetary or calorific value may be utilised for interpreting the results. However, it was felt that there is a need for further studies on proper statistical methods of analysis on inter-cropping and mixed cropping experiments.

The following recommendations emerged out of the deliberations :

(1) Non-monetary inputs which do not have cash involvement at the farmers' level can be effectively used for maximising agricultural production, such non-monetary inputs need to be identified for different agro-climatic situations and crops in order to be effectively utilised.

(2) For the conduct of the study on the effect of non-monetary input on crop production, statistical analysis particularly partitioning the role of monetary and non-monetary be carried out by various research institutes and agricultural universities.

(3) A symposium by the Indian Society of Agricultural Statistics be organised on "Identification of the statistical methodology for inter-cropping experimental data".

Detailed summaries of the papers submitted for presentation are given below :

1. Non-Monetary Inputs—Some Issues

by

C. C. MAJI[1]

Production consists of transformation of inputs into outputs with the help of technology. Depending on the purpose inputs are classified in various ways. One such classification recently introduced in agricultural production, particularly in India, is 'non-monetary inputs' and 'monetary inputs'. According to the accepted interpretation, 'non-monetary inputs'

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include those factors of production which do not necessitate any *direct* expenditure for their use. To be sure, planting geometry and plant population, date of seedling/sowing, practice of intercropping for control of weeds, pests, etc. fall under the category of 'non-monetary inputs'. It does not need a great perspicacity to see that these so-called non-monetary inputs stand for the method and the time dimensions or the quality of physical inputs. The transformation of a given quantity of fertilizer, water, etc., into the product cannot be efficient unless the input is applied at the right time and in an effective manner. Technological innovations make the same physical resources more productive by way of changes in the genetic composition of seed, time and method of application of these inputs. New knowledge regarding these qualitative aspects of the physical inputs obtained through years of research, both basic and applied, is embodied in the technology. Thus the 'non-monetary inputs' as these are now called, are products of research.

A discussion on some important issued related to 'non-monetary inputs' is necessary for a better understanding of the role of this category of inputs in production as distinct from that of the 'monetary inputs'. These issues are related to the conception, definition and measurement of the 'non-monetary inputs' as well their contribution to production, etc. Specifically, how do we distinguish between the 'monetary' and the 'non-monetary' inputs? Is the present 'definition' of non-monetary inputs based on direct expenditure satisfactory even though it does not satisfy both the necessary and the sufficient conditions? Inputs which do not involve direct expenditure cannot appropriately be called 'non-monetary' inputs. For example, family labour and other physical inputs supplied by the farmers themselves for which no direct expenditure is incurred cannot be termed as 'non-monetary' inputs. In other words, absence of direct cost may *at best* be regarded as the necessary but not the sufficient condition for an input to be classified as non-monetary input. Thus, the existing definition of non-monetary inputs seems arbitrary and lacks scientific rigor. Stated differently, inputs classified as non-monetary ones based on direct (explicit) and indirect (implicit) expenditure or on private and public expenditures does not seem logically sound. It is more appropriate to ask as to whether the application of a particular input involves any expenditure (direct or indirect, private, public or social) than to ask as to who bears the cost. Any man-made input has a cost, direct or indirect, associated with it regardless of who or which organisation bears it. Knowledge pertaining to better timing and the most appropriate method of application of an input is not costless. Private and public organisations engaged in research and development activities to generate new knowledge and technology are making huge investments and are, therefore, incurring the expenditure on behalf of the millions of farmers,

Besides, the country spends crores of rupees to disseminate newer knowledge to the millions of producers/farmers through demonstrations, training, education and such other activities. In addition to the direct public investment to improve the managerial ability of the farmer by equipping him with the knowledge of the correct and most efficient way of growing crops, livestock etc., the farmer has necessarily to take time off for undergoing training and education tailored for this purpose. Further more, the absence of the farmer from his farm has an opportunity cost which is often ignored.

Application of the so-called 'non-monetary inputs' often increases the cost of production almost *directly*. A change in geometry of seedling/planting or an increase in the plant population enhances the labour cost as it is more time consuming and requires more seeds/seedlings. An input has quantity, time and method dimensions. The measurement and the apportionment of contribution of the qualitative aspects such as time and method of application of input like fertililizer is rather difficult. In addition, the measurement of the non-monetary inputs or the qualitative aspects themselves which are inseparable part of the physical inputs poses serious problem. Unless the quantification and measurement of the non-monetary inputs are taken care of their management for more efficient use may not be possible.

The more complex problem arises in understanding and measuring the inter-relationship between the monetary and the non-monetary inputs as well as between the non-monetary inputs.

The issues mentioned above are not exhaustive but indicative and normally point out certain ambiguities in terms of conception, definition, measurement and interactions of the non-monetary inputs which are required to be removed for an efficient management of this class of inputs *vis-a-vis* the others i.e. the monetary input. In conclusion 'non-cash' input seems a better nomenclature of the so called non-monetary inputs. As the supply of the non-cash inputs is primarily the responsibility of the Government and semi-government organisations, care must be exercised to ensure that it does not widen the income disparity. On the contrary, attempts should be made to bridge the gaps in agricultural incomes on farms with varying endownment of not only physical but also the non-cash resources/non-monetary inputs or the technical know-how.

2. Increasing Production of Dryland Crops through Non-monetary Inputs

by

S. K. DAS[2] and R. P. SINGH[3]

Majority of the dryland farmers in India are small and poor. Their capacity to invest, take and bear risks is extremely limited. They are, therefore, not in a position to adopt a technoloy, although it may be productive and viable, which requires investments in terms of cash inputs beyond his capacity. Some of the site specific technologies which require nil or low cash inputs and which are within the easy reach of the small farmers are discussed.

Use of improved seeds: For better utilization and higher yield, the replacement of traditional varieties by the improved varieties are advocated for dryland agriculture. The traditional varieties take long time to mature, their growth rhythm not matching with the rainfall pattern of the area, which results in low yields. Improved varieties are not only high yielders but also utilize available moisture better. As for example, the moisture use afficiency (kg/mm/ha) is 2.6 for RSK pearlmillet, the same being 6.5 for the improved genotype HB-3.

Timely sowing: For obtaining optimum plant population, sowing of crops at proper soil moisture conditions is important. This can be achieved only through timely sowing. For *Kharif* crops, sowing of crops with the onset of monsoon has been found rewarding. Advancing the sowing dates for the crops grown on residual soil moisture during *rabi* season is advantageous. However, it has been found out by regression analysis that crops differ in reduction in yield with delayed sowing. The per day percent decrease in yield for sorghum was found to be highest (4.24), followed by upland rice (3.17) and fingermillet (2.94). Reduction in yield increases as the sowing dates are delayed. Optimum dates of sowing have been worked out for different crops and for different regions by the All India Coordinated Research Project for Dryland Agriculture.

Timely weed control: Weed compete with crops for moisture, nutrients and solar energy. Under constraint situations, as is obtainable in dryland agriculture, timely weed control is extremely important. Type experiments were conducted at different dryland centres and the results revealed that the weed-free crop environment during the first 20-30 days is absolutely essential for obtaining high yields of cereals. It has been established that

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more than 100 percent increase in yield could be achieved due to timely and effective weed control.

Timely top dressing: As fertilizer is the costliest input, its efficient management requires precision in terms of amount and time of application so that maximum returns could be achieved from the investment in fertilizers. Results with upland rice obtained at Ranchi and Bhubaneswar showed that application of N in three splits enhanced the grain yield. Split application of N has resulted in increased yields for crops like sorghum, maize and pearl millet. Adoption of split application is recommended for obtaining increased yield from the same amount of N applied. Again, split application also helps save fertilizer under aberrant weather conditions.

Precision in seeding: Under dryland conditions, maintenance of plant population per unit area matching the available moisture is extremely important. It has been shown at Bellary and Bijapur that a population of safflower beyond 30,000/ha does not confer any advantage in terms of seed yield. Again, similar results were obtained when the inter-row spacings were made narrow (45 cm) or wide (90 cm). Optimum plant population for different crops have been worked out by the Dryland Project. By using low seed rate a saving can be effected on the expenditure of seeds. Adoptation of wider spacing helps in facilitating intercultural operations faster, thereby saving on energy.

Precision placement: Placement of fertilizer in precise relationship to the seeds increases the efficiency of fertilizer use manifolds, particularly in case of *rabi* crops grown on stored soil moisture. Deep placement of fertilizer was thus found useful in case of wheat in Ludhiana (Punjab), safflower in Ranga Reddy district of Andhra Pradesh.

Pest management through agronomic manipulations: For sorghum the peak build-up of ear head bug at Hyderabad usually occurs during the second week of September. The problem can, therefore, be avoided by completing the sensitive stage of crop growth i.e., grain milk stage before the peak build up of the pest. This can be achieved by early sowing. However, in case of castor, delayed sowing was found advantageous with regard to the incidence of semi-lower pest.

Other practices: Among the land treatments, off-season tillage and contour cultivation are considered as low-monetary inputs. Off-season tillage has been found quite rewarding. Contour cultivation helps in soil and moisture conservation and when coupled with other improved practices enhanced the yield of sorghum and castor substantially at Hyderabad. Practices has also been identified through which soil fertility

can be improved. These practices are (i) inclusion of legume in cropping system, and (ii) addition of loppings under alley cropping system with *suba-bool* (*Leucaena leucocephala*). About 20 kg N/ha can be saved for the succeeding crop if a legume like groundnut, cowpea, blackgram or greengram is taken as the preceding crop. Loppings of *subabool* could contribute N equivalent to 500 kg/ha. Non-monetary inputs can make a significant contribution to the productivity of dryland crops. In fact, some of the practices such as timely sowing, precision seeding are so crucial that any loss in yield due to the non-adoption of these practices can not be compensated by any other management practices. Adoption of practices involving non-monetary inputs has been considered as the first step in increasing the yields of dryland crops which should be followed by the monetary inputs for full realisation of potential from the resources available in dryland agriculture.

3. Effects of Non-monetary Inputs in Increasing Crop Productivity in Meghalaya and Implications of Statistical Analysis in Interpreting the Results

by

R. P. AWASTHI,[4] U. K. HAZARIKA[5] and D. N. BORTHAKUR[6]

Based on experimental results an attempt has been made in this paper to highlight the role of various non-monetary agronomic practices viz., optimum planting time, plant density, cropping systems and planting arrangement in increasing crop yield under two main systems of farming prevalent in the region namely (A) Shifting cultivation characterised by mixed cropping on steep slope and (B) Permanent upland and valley cultivation characterised mostly by mono-cropping. Some of the relevant findings are summarised below:

(*A*) *Shifting Cultivation*

Runoff plot studies conducted to assess the effect of different systems of cropping and management practices in arresting erosion losses and thereby improving the crop yields on steep slopes $> 60\%$ revealed the superiority of grass cover in reducing the runoff, soil and nutrient losses. Among arable cropping, sole cropping of rice followed by mixed and toposequential strip cropping although provided some protection against erosion losses but they were not so effective as grass cover. Thus there appears to be great need to integrate crops with grasses and fodder legumes, horticultural

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crops trees or combination of all the three so as to evolve more effective systems of cropping to reduce the erosion losses for sustained productivity. Further, considering the steepness of slope, it may also be desirable to try cheap mechanical measures like contour bunds grown with grasses.

(*B*) *Permanent Upland and Valley Cultivation*

(i) *Rice.* Under high altitude conditions of Meghalaya (1790 m) optimum transplanting of rice was found to vary between Ist to 10th June because any delay beyond this date caused drastic reduction in yield ranging from 40 to 60%. The observations recorded on mean air temperature during different growth phases indicated that on account of delayed transplanting when mean air temperature goes below 14°C during reproductive phase, it caused heavy reduction in yield.

Under low altitude conditions of Meghalaya the optimum sowing time was found to vary between last week of April to Ist week of May. When the sowing was delayed from 5th May to 20th May, the grain yield was reduced from 16.0, 20.2 and 23.7 q/ha to 9.2, 11.7 and 4.5 q/ha in case of rice varieties Mirikarak, Pusa-33 and IET 3257 respectively.

Under high altitude condition, higher plant density of 10 lakhs/ha obtained by adopting a spacing of 10 × 10 cm was found to be optimum whereas under mid-altitude condition (950 m) plant density of 6.6 lakhs/ha attained by adopting a spacing of 15 × 10 cm proved to be optimum under transplanted condition for obtained higher yield.

(ii) *Maize.* Under high altitude condition of Meghalaya the optimum sowing time was found to vary between 2nd week of April to Ist week of May for getting higher yield.

The optimum spacing was 45 cm from row and 20 cm from plant to plant.

(iii) *Inter-cropping system.* Under high altitude conditions of Meghalaya to augment productivity per unit areas and time, intercropping of soyabean and fingermilled with potato in alternate row arrangement was found quite promising. As judged from the values of land equivalent ratio, it resulted in maximum yield advantage of 78 and 75% respectively.

Intercropping of soyabean with maize recorded an yield advantage of 55% over sole cropping of maize.

Inclusion of soyabean as intercrop with maize also resulted in an economy of 60 kg N/ha thereby clearly indicating the complementary effect of maize + soybean intercropping system in nitrogen use efficiency.

In an other trial, the performance of different varieties of pigeon pea were evaluated under sole as well as intercropping systems with maize with the main objective of increasing the yield of intercrop of pigeon pea

without adversely affecting the yield of main crop of maize. The study revealed the superiority of pigeon pea varieties like H 77-208 and UPAS-120 as intercrop with maize under mid-altitude conditions of Meghalaya.

Statistical Analysis

Some of the difficulties faced in analysing the data generated from the studies from runoff plots, watershed based farming systems, intercropping systems involving (i) Screening of crops and its varieties for better compatibility, planting arrangement, optimising row ratios and fertilizer doses etc. have been discussed. In view of inadequate information available on statistical methods for analysing the data on various aspects of inter and mixed cropping systems, a need for collaborative research has been emphasised.

4. Non Monetary Inputs in Agriculture

by

B. N. TYAGI[7]

Strictly speaking, no input is non-monetary. Theoretically, each input can be allocated a monetary value. However, one can classify the inputs in the following categories:

(i) Output per unit of input is finite and small;
(ii) Output per unit of input is finite but large;
(iii) Output per unit of input is either infinity or very large.

In Agriculture, farmers adopt a new innovation provided they get Rs 2/- to Rs 3/- per rupee of investment. Thus, for all practical purposes, inputs falling in category (iii) can be termed as non-monetary inputs. Again monetary character of an input is a complex function depending on area and social and political framework.

Crop production can be described by the function:

$$p = (\theta_1, \theta_2, \ldots, \theta_m, \phi_1, \phi_2, \ldots \phi_n) \qquad (1)$$

where p is the production, $\theta_1 \ldots \theta_m$, are the money value of traditional material inputs, viz., seed, fertilizer, water, pesticides, etc., and $\phi_1, \ldots, \phi_n$ are non-monetary inputs belonging to category (iii). Given the function (i), our problem is to maximise p subjects to the condition that

$$\sum_{i=1}^{m} \theta_m = K.$$

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Thus, even choosing an optimum combination of monetary inputs with the above restriction can be termed as non-monetary input.

In Indian conditions, labour is one input which can be allocated to category (iii) in certain conditions. Cost of production studies clearly indicate that the crop production and animal husbandry programmes hardly offer gainful engagement to half the working force in agriculture. Crop production programmes oriented to utilize more and more labour would add immensely to the net product from agricultural sector. It is sometimes argued that labour is a very costly input in crop production and example of Punjab is cited where agricultural labourers are paid as high wages as Rs. 30/- per day. But the conditions in eastern U.P., Bihar, Madhya Pradesh and Rajasthan are totally different where labour is available at a very cheap rate. If more and more labour is utilized in such areas and at such points of times where demand of labour from traditional agriculture is minimum, then labour can also be termed as non-monetary input.

5. Possibilities of Increasing Productivity of Coconuts from Non-Monetary Inputs

by

PRAFULLA K. DAS[8]

Considerable scope exists for increasing the productivity of coconuts in India by adopting proper spacing and correct method of planting; transplanting healthy and hybrid seedlings; following regular cultural practices, microirrigation and phytosanitary measures.

In certain parts palms are close spaced and in some other parts they are widely spaced. Both the systems are detrimental to productivity as close spacing leads to stresses in moisture, nutrients, light and air; while wide spacing gives rise to unexploitation of these resources to the fullest extent. For this crop 7.5m × 7.5m spacing is considered as optimum. Surface planting, which is a common practice in the East Coast, should be avoided as this zone is prone to both drought and cyclone resulting to severe casualities. On the other hand, in waterlogged areas, the seedlings need to be planted on mounds made of soil. Thin, lanky and stunted seedlings should be discarded for transplanting as they will not give good yield whatever after care is given to them.

Coconut hybrids are characterised as early bearing-cum-high yielding-cum-high stability-cum-disease tolerant cutivars whereas, the local talls are deprived of these attributes. It is therefore, advisable to plant hybrids.

8. Central Plantation Crops Research Institute Kasaragod-670 124, Kerala.

The growing of hybrids in village environment is often contested for their supposed lack of adoptation to environment and management of smallholders. The Out-Research-Programmes have revealed beyond doubt their adaptability to wider range of ecosystems and management.

Being a perennial tree crop, coconut needs regular and continuous cultural operations in right manner and right time for assured high productivity. Care of young palms gives a long lasting effect and therefore there should not be any neglect at that stage, eventhough the crop only yields after a long gestation period.

Adoption of microirrigation system by buying unserviceable earthen pots, old tins, bamboo pipes etc. around the basins of palms and filling water as and when needed serves as drip without involving any monetary inputs and influence the productivity of palms considerably.

Phytosanitary measures in coconut gardens can reduce the disease and pest menaces to a considerable extent.

If the farmers can be properly educated about the merits of the adoption of these technology there is no reason why the coconut productivity will remain as low as it is today.

6. A Study on Statistical Assessment of Intercropping

by

P. N. BHARGAVA[9] and B. L. CHOUDHARY[10]

In dryland areas the intercropping system helps in improving the productivity of the land per unit of time. Additionally, this provides employment for a longer period, utilises the available resources such as sun light, soil moisture etc., provides protection to the soil from rain, weeds etc. and provides greater stability in production over different seasonal fluctuation. To identify the suitable system and the practice within a system, number of suitable statistical designs and their method of analysis have been identified in the past. The statistical designs suggested for the investigations on this aspect are more or less similar to those adopted under single crop experimental programme. The methods suggested in the past, are principally converting the data obtained from both the crops into uni-variate either converting the yield data into calorific value or monetary value or land equivalent ratio (LER). In the present paper, the concept of LER and its uses have been discussed through the detailed analysis of the experiments planned during 1982-83 under All India Croodinated Agronomic Research Project at Parbhani (Maharashtra) for studying the method of planting for the main crop and fertilizer schedule for the intercrop.

9,10. Indian Agricultural Statistics Research Institute, New Delhi

Using notations of Mead and Willey (1980), LER is defined as

$$\text{LER} = L = L_A + L_B = M_A/S_A + M_B/S_B \text{ and } A = L_A/L$$

where M_A, M_B are the component crop yields from an intercropping system S_A, S_B are the corresponding sole crop yield which can be thought of as standardising factors for the mixture yields. L_A,L_B are the component LERs for the two individual crops and A is the proportion component of A crop to the total LER.

The advantages of the LER are :

1. it provides a standardised basis so that crops can be added to form combined yields, in theory it also means that LERs themselves can be compared between different situations and between different crop combinations,
2. the comparison between individual LER (L_A and L_B) can indicate competition effects, and
3. of the primary importance, the total LER can be taken as a measure of relative yield advantages as for example, an LER 1.2 indicates a yield advantage of 20% (or strictly speaking that 20% more land would be required as sole crops to produce the same yield as intercropping).

Obviously the value of LER depends upon he choice of S_i's, thes tandardising factors which can however be selected in many ways. The LER has certain limitations as follows:

1. The LER is defined as a ratio, large values can be obtained because of large yields in intercropping but also because of small yield in Corresponding crops, and
2. The difficulty in using LER as a measure of biological efficiency comparing different situations is the implicit assumptions that the harvested proportion of the two crops are exactly those that are required under each situation. This particular limitation raises some difficulties in comparisons between LERs with different yield proportions. A set comparison also implies that either yield proportions are equally acceptable.

To overcome the second limitation, Mead and Willey (1980) introduce the concept of 'Effective LER' which however permits the cultivator to grow on a fixed proportion of area the intercrop and in the remaining area, the sole crop so that combined yield proportion obtained from the piece of land is equivalent to that required by the cultivator. Subsequently this concept was however extended by Jennett (1984) which permits the grow-

ing of different intercrop systems simultaneously on the same piece of land. The expected biological efficiency under such planning can also be worked out easily.

The analysis of data of the expt. cited above however suggests that the skip row method of planting for jowar crop and the application of fertilizer to the intercrop at 100% of the recommended level provides the maximum yield advantages and the value of LER was around 1.78. For the required proportion of jowar yield (p) namely, for $p = .5$, .6 and .7, the proportion of area under intercrop and sole crop for each system were worked out. The corresponding ELER were also obtained, as for example, for $p = .7$ when skip row method of planting is adopted for jowar and fertilizer application to arhar is 100% of the recommended dose, the area to be aportioned among the intercrop and sole crop in the ratio of 3 : 2. The corresponding ELER was 1.48. In case the cultivator desires to grow two intercrops simultaneously, the effective LER for different combinations were also worked out. It was found that the values of LER would be in the range of 1.5 to 1.7 for this system when the skip row method of planting for jowar and 50% fertilizer application to arhar is combined with normal method of planting of jowar and 100% fertilizer application to arhar.

7. Increase in Livestock Productivity from Non-monetary Inputs

by

B.B. P. S. GOEL[11]

and

K. B. SINGH[12]

Every input has a money value. However, since no immediate payment is involved in twoi nputs viz. family labour and management. These can be assumed to be non-monetary and also their availability for production somewhat flexible so that there is scope for manipulation with them. In India, there is a complementary relationship in agricultural and livestock production and the farmers are often faced with the problem of allocation of his resources, including cash, between them. The problem of exploiting the family labour and available managerial skill in increasing livestock productivity is similar to that in agricultural production. As a part of the managerial input decisions such as how much of the produce to sell and when and where so that the return per unit of investment in monetary terms is maximum are more important in the case of livestock production

11. Food and Agriculture Organisation, Nepal
12. I. A. S. R. I., New Delhi.

than in agricultural production, for the simple reason that most of the livestock products are easily perishable under normal conditions.

Though no statistical studies seem to have been undertaken in India to directly quantify and estimate the increase in livestock productivity from non-monetary inputs in physical or value terms yet there is ample evidence available in literature to show that non-monetary inputs such as full exploitation of family labour and managerial skill can sizeably contribute to increasing livestock productivity. The present paper surveys some of the available literature on the relevant studies carried out with regard to bovines, ovines, swines, poultry and their products under farmers' condition carried out at I. A. S. R. I. and else where.

Use of optimal feedmix for feeding the livestock considerably increases milk, meat and work output of animals. Grazing of animals involves a little extra labour and cows and buffaloes which are grazed in addition to being stallfed yield significantly more milk than their stallfed counterparts. Improved breeding, with lot of emphasis and facilities being provided by government free of cost, is more or less a non-monetary input and contributes substantially to increase productivity of various species of livestock and poultry. Prevention against diseases and timely treatment of sick animals with free government veterinary facilities available, also constitute non-monetary inputs in so far as India is concerned and influence the productivity of livestock. Management practices such as how the animals are housed, cleanliness of the stalls, providing clean drinking water, timely feeding and milking and washing of the animals are also known to have significant effect on the productivity of cows and buffaloes and other livestock. Providing timely service to the dry animals reduces the dry period of cows and buffaloes and increases their productivity. Slaughtering of the animals at their optimum age yields higher return per rupee of investment.

Proper utilization of by-products of livestock such as dung, droppings, slaughter house by-products, hair bristles and carcasses also contribute to higher economic return on livestock without any additional monetary requirements.

8. Role of Non-monetary Inputs in Increasing Crop Productivity

by

G. B. SINGH[13]

Use of high value seeds, fertilizers, pasticides and irrigation has been pivotal in increasing agricultural production during the recent years. It is

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estimated that for one unit increase in nutrient, 9-10 units increase in food production is achieved. Similarly application of critical irrigation over no irrigation is known to increase crop productivity universally. However, it is not possible for most of the farmers, of our country to pay for recommended levels of inputs because of high prices of improved seeds, fertilizers, irrigation and pesticides. Agronomic experiments conducted all over the country for a number of years have shown that management of inputs for crop production makes very significant differences in productivity. Experiments conducted on sowing time for kharif and rabi crops, both have indicated the desirability of sowing the crop at a time when soil and climatic parameters are suitable for germination and crop growth. Even if we have applied sufficient amount of fertilisers and other costly inputs, desirable production level cannot be achieved if the crop is not sown at the optimum time. Similarly, the selection of suitable varieties, size of seeds and depth of sowing makes significant differences in the expression of crop. Plant population is another important aspect of management which has marked effect on overall production. Experiments conducted at a number of places have shown that even the direction of rows in fields affect the production level significantly. The efficiency of fertiliser use varies to a great extent on the use of balanced fertiliser dose and appropriate method of its application. With the same cost of fertiliser, a balanced ratio of NPK will affect the crop production favourably. It has also been seen that appropriate water management is key for obtaining the adequate response of water input. Irrigation at critical stages of crop growth and at a time when soil is depleted of moisture, helps better crop production. Wherever water management is not judicious, ill effects on soil productivity can be very commonly seen.

Non-monetary inputs, thus play a very significant role in improving the crop productivity. Management skill in crop production does not cost anything, but pays a lot. With the same investment in seeds, fertiliser irrigation and pesticides, a farmer, who knows how to manage these inputs efficiently, can achieve high efficiency of production per unit of input. Since majority of our farmers are poor, and cannot afford costly inputs, the transfer of technology relating to efficient utilisation of non-monetary inputs will go a long way in helping majority of our farmers and thereby increasing agricultural productivity in the country.

9. Effect of Management Practices in Increasing Productivity of Rice and Wheat in India

by

S. K. RAHEJA[14] and P. C. MEHROTRA[15]

Of the various factors influencing the productivity of a crop, the non-monetary inputs require special attention since they are expected to increase the production of a crop without involving any extra financial burden on the farmer. The gain in yield resulting from the adoption of the four non-monetary inputs viz. seed variety, source of seed, timeliness of sowing and timeliness of irrigation was studied with the help of data for rice and wheat crops in typical districts. Proper choice of an appropriate seed variety showed an average increase in the yield of rice crop by nearly 6 Q/ha and that of wheat by nearly 5 Q/ha. Use of seeds from institutional sources resulted in an increase of yield by about 2 Q/ha for rice as well as wheat. Sowing of rice and wheat crops at the normal recommended dates benefitted by giving an extra yield of nearly 3 Q/ha each for rice and wheat. Irrigation of the crops at the normal time resulted in an increase of average yield of rice and wheat by about 4-5 Q/ha. Adoption of these improved practices/inputs would thus bring in on an average an extra yield of 10-15 Q/ha.

10. Non-monetary and Low Monetary Inputs in Rice Production

by

K. G. PILLAI[16]

The varietal improvement work during the 70's has a salutary effect in improving the productivity of rice and raising the ceiling on average yield level of rice in many rice growing areas of the country. The current emphasis however is more on identifying suitable varieties and appropriate management and cultural practices more suited to and/or relevant to the high yielding varieties recently developed which at the same time could help reducing the total bill on agro based inputs to a considerable extent. It has been observed in many cases that it is possible to harvest fairly high level of economic yield with moderate use of fertilizer provided due emphasis is given to the associated cultural and management needs of these varieties. In the present paper the results of the expts. planned under AICARP to study the effect of method and time of sowing, plant popula-

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tion, method of application of fertilizers and the time of harvest are discussed.

From the expts. planned under AICARP to study the effect of time and method of sowing on different durations of varieties has suggested that transplanting of medium and long duration varieties should be completed by June for the northern part of India while varieties of early duration should be used for delayed planting beyond June-July for upland rice. The practice of waiting too long so as to receive more than 120 mm of rainfall is more deterimental than seeding before rains.

For upland rice method of drilling or dibbling ensures uniform germination, fertilizer application and weed control. This method gives an additional yield of about 2 Q/ha. It is also observed that the shallow (2-3 cm.) and close (20 × 10 mm.) planting gives a better yield and also helps in improving the fertilizer use efficiency whereas deep and bunch planting generally inhibited the tilring and therefore reduces the yield. Proper water management also plays an important role in overall productivity. Shallow sub-mergence from 2-4 cm. of standing water is quite good for dwarf varieties particularly for the first 3-5 weeks after sowing or planting. The split application of urea is found to be superior as compared to the conventional method of *N* application. It is observed that an additional yield of 3-5 Q/ha can be obtained through the split application of urea. For rainfed low land rice areas root zone placement of *N* as urea super granules has been found to be superior than split urea application particularly at 28 and 56 kg *N*/ha. Balanced use of *N*, *P* and *K* fertilizer is yet another way of improving the productivity of fertilizers specially under low level of input use. The timely harvest will also minimise the crop losses due to grain shedding, lodging and by bird damage. Therefore it will be useful if the harvesting is completed when the panicles turn yellow without waiting for complete leaf senescence.

11. Increase in Agricultural Productivity Through Non-Monetary Inputs

by

P. K. CHAKRABORTY[17]

Agricultural Productivity is the function of ecotype, environment and inputs. Present day agriculture is highly dependent on non-renewable sources of energy such as fertilisers, pesticides etc. These costly inputs are beyond the reach of millions of small and marginal farmers who lack the resources to adopt on integrated approach to production through costly improved practices and inputs.

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Non-monetary inputs, when advocated to the farmers, will be readily accepted because these will be within his reach and ability.

Crop management is the most important non-monetary input. Improved crop husbendry, viz., (i) adequate tillage operation, in relation to nature of soil and crop including land levelling and land shaping; (ii) use of quality seeds of a particular crop; (iii) planting date planting pattern and crop density; (iv) meeting nutritional needs of the crop through use of locally available manurial resources (organic manure, biological source viz., green-manure, azolla, blue green algae, rhizobium etc.); (v) satisfying the water needs of the crop through supply of water at the right time, inadequate quantity and by suitable method; and (vi) protecting the crop from weeds, pests and disease by adopting integrated schedule of operations and the important non-monetary inputs for higher agricultural productivity.

Use of non-monetary inputs will improve the agricultural productivity but this alone will not enable the farmers to get optimum yield unless non-monetary inputs are supplemented by agricultural chemicals, mechanisation and other investments.

12. Increased Productivity of Wheat by Inexpensive Hydration—Dehydration Treatments of Stored Seed

by

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and

A. K. MANDAL[19]

The loss of vigour and viability of stored wheat seed under warm-humid storage conditions could be very effectively slowed down by mid-term hydration-dehydration treatments such as soaking for 2 hours in water or in a dilute solution of sodium phosphate (dibasic, 10^{-4} *M*) followed by drying back before restorage. Dipping in water or sodium phosphate solution for 2-5 minutes only and then keeping the wet seed covered for 4 hours (with or without further soaking in water or solution for another one hour) also proved to be a very effective method of seed hydration. In the midstorage treatment it was, however, necessary to thoroughly dry the seed at least upto the original moisture content before restorage. In relatively high vigour seed lots, preconditioning of the seed for 24-48 hours with moist sand (5% sand moisture content; 3 Kg. sand per Kg. of seed) enabled slow and very effective seed hydration with considerable ease of

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drying. The mid-term treatments, depending on the vigour of seed and storage conditions gave 15-30% increase in final yield.

Presowing treatment of low and medium vigour wheat seed by soaking-drying, employing relatively longer soaking durations, gave better and more uniform field stand and increase in yield to the extent of 10 to 20% depending on the vigour and viability of the seed at treatment. In this treatment, which was given only a day before planting, the seed was only surface-dried to facilitate sowing. Use of salts such as sodium chloride (10^{-3} *M*), sodium phosphate (dibasic, 10^{-4} *M*) and zinc sulphate (2×10^{-4} *M*) in the presowing soaking-drying treatment gave additional improvements over water-soaking-drying alone. It was observed that the yield increase was due to significant improvement in number of grains per ear and 1000-grain weight.

Although the exact mechanism by which the beneficial effects are brought about is yet to be elucidated, the treatments are recommended for large-scale adoption in view of the simple methodology involved and little monetary input by the farmers.

13. Increase in Agricultural Productivity from Non-Monetary Inputs

by

A. R. DESHMUKH[20]

and

SHRI S. W. GOVITRIKAR[21]

Non-monetary agricultural inputs may include those inputs which do not necessitate any direct expenditure in terms of money. If this definition is accepted, non-monetary inputs would include farmers own labour, his family labour and all other inputs which are supplied to him by himself. But inclusion of these items in non-monetary inputs is in contradictions with the studies on cost of cultivation, where the imputed cost of inputs like family labour, farmers own labour and all other inputs supplied to him by himself are considered as cost items. Therefore the above definition cannot be accepted.

Out of four factors of productions viz. land, labour capital and organization, rent of land and wages of labour, mostly in kind, accounted for practically all the items of cost of Agricultural production in the past. Financial accounting was not known in agricultural let alone cost accounting. In this sense all inputs were non-monetary inputs in the field of agri-

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culture. This picture is gradually changing in last 3/4 decades. Due to various lagislative measures regarding land reforms, rent item cost of agricultural production is loosing its importance. Cultivators have to purchase hybride and high yielding varieties Seeds, Chemical fertilizers, pesticides, fungicides, insectisides etc. These are all monetary inputs. Barter system has given way to monetary system. Practically all agricultural inputs are required to be paid for now a day.

If the principle of 'opportunity cost' is regiourously applied, monetary inputs would account for roughly 90% cost of agricultural production. Contribution of non-monetary inputs is very minor if not negligible. Considering all these points it seems reasonable that non-monetary inputs may be defined as those inputs which are not marketable, which are non-priced and those whose cost cannot be imputed.

The decision making functions performed by a cultivator, his initiative, his enterprise, his managerial skill, and his expertise which are not paid for, neither taken into account even are real non-monetary inputs. These non-monetary inputs surely increase agricultural productivity. Other non-monetary inputs are, subsidy of all types given by Government, research findings of experimental research stations and extension services rendered by Government. Further the agronomic practices viz. optimum period of planting, optimum plant density and intercroppinging can be considered as non-monetary inputs, if these do not involve extra monetary cost.

14. Climatological Consideration for Stabilising Agricultural Production in the Arid and Semi Arid Regions of Rajasthan

by

B. V. RAMANA RAO[22] and Y. S. RAMA KRISHNA[23]

The crop production in the arid and semi arid regions of Rajasthan is subjected to vagaries in the distribution of rainfall during southwest monsoon season. There is considerable influence of the date of commencement of sowing, rains on crop production in the arid districts. In addition strong winds prevail during the summer and monsoon season resulting in considerable increase in the water use of the rainfed crops and irrigated crops. Studies carried out at Central Arid Zone Research Institute, Jodhpur indicated the possibilities of increasing the water use efficiency through the application of micro shelter belts. Favourable microclimatic conditions induced through the improved system of planting compared to conventional uniform row planting will also enable in increasing the productivity of rainfed crops like Pearlmillet and moong.

22, 23. Central Arid Zone Research Institute, Jodhpur.

The studies on the influence of moisture regime on the percentage of forest area in Rajasthan indicated that there is scope for improving afforestation in the transitional belt between the semi arid and sub-humid regions and for adoption of silvapasture system and agro-forestry in arid regions.

15. Non-monetary Inputs (Imputed Costs) in Indian Farming—A Study from Karnataka

by

D. VASUDEVA RAO[24]

In any Farm Business Study, the prominent cost is contributed from the labour component. The involvement of labour, being a must, in the farm activities, the interesting feature would be to explore and familiarise with the role and content of family labour (human and animal), in the ultimate production. Apart from the labour component some more inputs like seed, Farm Yard manure, working capital, skills etc. are used, without spending money from out of their pocket. The imputed costs have got a great relevance in the context of poor and small farmers.

Under Malaprapha irrigation project, in Dharwar district of Karnataka, two villages were studied to assess the impact of irrigation, on the (socio-economic) levels of living of the beneficiaries (wet farmers) vis-a-vis the non beneficiaries (dry farmers). 209 wet cultivators and 98 dry cultivators belonging to 8 land holding classes were selected from the two villages, on the probability proportional sampling method. The farm business as a whole was studied through specially structured questionnaire. An intensive micro level study of each farmers' input structure and composition, output, returns/profits etc. showed that the role of non-monetary inputs is evident and glaring in the small farmers, while the role of hired/purchased inputs in conspicuously large in higher LHS. The imputed costs are also more in the dry cultivation than in wet cultivation.

16. Non Monetary Cropping Practices for Higher Production and Protection—A Review

by

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Eighty three million ha. of agricultural land is being affected by various

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types of soil erosion. Soil erosion on cultivated fields can be reduced to a great extent by adopting simple soil conservation measures like contour cultivation, strip and mixed cropping, suitable crop rotation and other agronomic practices like advancing the date of sowing, use of suitable crops and varieties. These soil conservation measures can be adopted without spending any substantial amount over traditional method. Experimental results of the Central Soil and Water Conservation Research and Training Institute and its various regional centres indicated clearly that by adopting these measures there is a definite increase in the yield of crops and also reduce soil erosion over traditional methods.

Contour cultivation. Contour cultivation conserves soil fertility, increase crop yield and reduces runoff and prevent soil erosion when compared with up and down cultivation in the major soils in India.

Experiments at Octacamud (deep lateritic soils) have shown that by adopting contour cultivation, the potato yield was increased from 126 to 134 q/ha. Further the runoff was reduced from 52 to 29 mm and the soil loss from 39.3. to 14.9 tonnes/ha. Nutrient loss was observed Rs. 333/ha/yr in the case of up and down cultivation and Rs. 130/ha/yr in the case of contour cultivation. At Dehradun (Alluvial soil), by adopting contour cultivation on maize crop, 30% reduction in runoff and 48% reduction in soil loss (from 28.5 to 19.3 tonnes/ha) was observed as compared to up and down cultivation. At Kanpur (alluvial soils), it was observed that contour cultivation increased the *jowar* grain yield by 4.4 q/ha as compared to up and down cultivation and reduced runoff and soil loss by 61% and 28% respectively. Contour cultivation also conserved 11.2 kg N, 10.5 kg. P_2O_5 and 44.8 kg K_2O/ha in one season alone. Similarly on vertisols with 3% slope at Bellary (Karnataka) contour tillage increased the grain yield of *jowar* by 35-60% over the traditional method of up and down cultivation.

Strip, Intercropping and mixed cropping. At Dehradun, strip cropping of maize (2 rows) and soybean (8 rows) reduced the soil loss to the extent of 54% and runoff by 42%. It also gave 40% extra income as compared to pure crop of maize. In an another experiment two rows of cowpea in between maize crop gave 90% canopy as compared to 69% provided by maize alone.

At Kota, intercropping of *jowar* and *arhar* in alternative lines 30 cm apart gave total grain yield (34.2 q/ha) as compared to *jowar* alone (24.8 q/ha). The runoff and soil loss was also reduced to about 10%. Similarly, at Agra, intercropping of *bajra* with cowpea increased the total grain production (18 to 38% increases) and reduced the runoff and soil loss as compared to pure crops. In ravine lands of Vasad (Gujarat) cowpea as a inter-

crop with redgram or caster helped in increasing the yield of base crop and also gave an additional yield of intercrop resulting higher production and stability.

At Chandigarh, mixed cropping of maize and groundnut was found to be superior than rest of the mixture or pure crop.

Crop Geometry. At Dehradun, the normal spacing for maize crop is 60 cm between rows and 30 cm between plants (about 55,000 plants/ha). It has been observed that by keeping the plant population constant and increasing the row spacing from 60 cm. to 75 cm. and plant spacing within the row from 30 cm to 24 cm there is no reduction in the yield of maize crop. However, the soil loss has been reduced from 20.6 to 18.5 tonnes/ha and runoff from 40% to 34% of rainfall.

At Bellary, influence of plant geometry in relation to soil moisture distribution pattern and crop yields has been investigated with respect to *jowar* crop. According to these studies wider row spacing (90 cm) had given higher yield over narrow row spacing (45 cm.).

Time of sowing : At Dehradun, the yield of maize and paddy crop was maximum when sown in the beginning of last week of June (maize 30.5 q/ha, paddy 35.7 q/ha) and minimum when sown after the expiry of first week of July (maize 21.3 q/ha, paddy 27.1 q/ha). Similarly for rainfed wheat crop (HD 2021) the best sowing time is between first to third week of November.

Late planting of tobacco crop at Vasad (Gujarat) reduced the yield considerably (14th July—17.1 q/ha, 2nd September—13.8 q/ha).

At Bellary, advancing sowing time of *jowar* from mid-late October to third week of September increased grain yields by 43%. Increase was much more with the improved crop varieties. This practice also results in lesser shoot fly attack.

17. Effect of Non-Monetization of the Consumption Pattern of Food Items in Haryana State

by

D. K. JAIN[27] and R. K. PATEL[28]

An attempt has been made to examine the rates of non-monetization and the ratio of specific kind to total kind expenditure for major commodity groups across eight occupation groups especially structured for the purpose on the basis of family budget data for 32nd round NSS (1977-78) for 4253 rural households of Haryana State. The cash and kind expenditure elasticities for each item-occupation combination were estimated on

27, 28. N.D.R.I., Karnal (Haryana).

the basis of best fitted Engel function. On a facile view, it was observed that the cash and kind components of item expenditures were considerably influenced by occupational factors. Cultivators had a cash expenditure pattern different from those of agricultural labour and households with non-agricultural occupations. The highest rate of non-monetization was observed for milk and milk products followed by cereals and pulses. Among milk items, 'other milk products' had the highest rate of non-monetization followed by liquid milk and ghee and butter. Cultivator (owners) followed by cultivator (tenants) had the highest rate of non-monetization for all items of consumption. The ratio of item specific kind expenditure to total kind expenditure also revealed considerable interoccupational differences. The highest ratio was observed for businessmen and retail traders and lowest for service category. The cash expenditure elasticities were observed to be different from kind elasticities for most of the item-occupation combinations.

18. Non-monetary Inputs for Increasing Production of Agricultural Crops

by

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Due to uncertain and erratic distribution of rainfall farmers do not dare to invest more money in Agriculture. Under these circumstances non-monetary inputs play an important role in Agricultural production especially for small and marginal farmers. Some of the important research work carried out in Marathwada Agricultural University, Parbhani, on this aspects is briefly reviewed in this paper. The results indicate that land preparation before onset of monsoon helps in better utilization of rain water. Contingent crop planning under weather abberation helps in stabilising the economic condition of the farmer. Timely sowing helps in increasing the yield of crops and also reduces the incidence of pest and diseases. Maintaining optimum plant population is basic need for harvesting the maximum yield and adoption of sequence and intercropping with leguminous crops helps in maintaining the fertility of soil and productivity of crops. Utilization of non-monetary inputs technology on the scientific basis is the need of Indian Agriculture.

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19. Studies on the Utilisation of Sewage (A Non-monetary Input) to Increase FISH Production

by

A. K. ROY[33] and APURBA GHOSH[34]

Sewage is a cloudy fluid arising of domestic and industrial wastes containing mineral and organic matters. Sewage contains all the essential major and minor fertilising elements generally used in fish culture. Because of its richness in nutrients in readily available form for fertilising fish ponds, it helps promote rapid growth of fish food organisms. Raw sewage is detrimental to fish life for its high biochemical oxygen demand and obnoxious gases content. Before application of sewage in culture system its treatment is essential either through conventional sewage treatment plant or through non-conventional waste stabilisation method. Fish culture utilising sewage of different form has been successfully done in India and abroad with the resulting range of productions 2-9 ton/ha/ye. Central Inland Fisheries Research Institute has developed technologies for nursery, rearing and grow out pond management technologies of composite carp culture with sewage effluents and also deserved the tremendous potentiality of monoculture of *M. rosenbergii* in such ecology.

An evaluation of the economics of composite fish culture with Indian and exotic carp indicates that 50% of the total expenditure is being incurred on input like seed, fertilisers and supplementary feed. Sewage fed composite fish culture with the same species reduces 80 per cent of input cost. Input cost with sewage fed composite culture had been worked out to be Rs. 2250/ha as against Rs. 11,705/ha incurred in composite fish culture using supplementary feeding and fertilisers inspite of the fact that production rates from both the systems are almost identical. Judicious utilisation of sewage effluent will reduce countries fertiliser demand and supply gap and fertiliser import bill as well.

Mobilisation and application of this enormous non-monetary resource which otherwise go waste if extended countrywide will not only save our ecology from pollutional hazards but also boost up aquaculture and agriculture productions.

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