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NEW FARM TECHNOLOGY—ITS IMPLICATIONS IN AGRICULTURAL ECONOMICS

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It is perhaps customary for any President-elect of the Indian Society of Agricultural Economics to thank the learned members for the honour they confer on him by electing him to this office for the year. In my case, it is much more than that. I was elected to this exalted position *in absentia*, when I happened to be away to the United States on an observational tour to the Land-Grant Institutions in that country. The news of my election was conveyed to me there and I am, therefore, very conscious of the honour the Society has done me.

I consider my election this year a unique honour conferred on me for another reason. It may be a coincidence—but a very happy coincidence, indeed, for me—that I come to preside over the Annual Conference of the Society, which is being held at the U. P. Agricultural University, the first agricultural university established in the country, and which has done outstanding work in agriculture, basic sciences and the humanities under the dynamic leadership of its learned Vice-Chancellor, Dr. D. P. Singh.

Agricultural universities have laid the foundation of purposeful and problem-oriented inter-disciplinary research in agricultural economics. They are directly confronted with the problems of the agricultural sector and, therefore, with the pertinent problems of economic development of agriculture in the country. Faced with this challenge, they have successfully contributed to the evolution of new farm technology which opens up several alternatives in the decision-making process and creates a new market for the services of agricultural economists in the country. I have, therefore, thought it appropriate to address myself to the problems of new farm technology and particularly to its implications in agricultural economics, as I visualize them at present.

FOUNDATIONS OF NEW FARM TECHNOLOGY

Let me first make a brief incursion upon this realm of new farm technology. The development of high-yielding varieties of wheat, rice, and hybrids of bajra, maize and jowar is perhaps one of the greatest feats of biological engineering by the geneticists and the plant-breeders of this country. The new semi-dwarf wheats can yield as much as 60 quintals per hectare, as against 30-40 quintals yielded by the indigenous tall varieties. They are insensitive to the photo-period

* Presidential Address delivered on the occasion of the 30th Annual Conference of the Indian Society of Agricultural Economics held under the auspices of the U. P. Agricultural University, Pantnagar (District Nainital) on October 23, 1970.

and are less susceptible to rust, lodging and vagaries of weather in agriculture. Consequently, they have been adopted over large areas within an unprecedentedly brief period of three to four years. In fact, the adoption rate of semi-dwarf wheats surpasses the adoption rate in hybrid corn in the U.S.A. which, according to Griliches, was one of the greatest agricultural revolutions there, and yet it took about 9 years before it was adopted on a large scale by the functionally literate farmers of that country.

The development of T (N) I, IR-8 and Jaya is a break-through in the production of rice varieties. Their yield potential is up to 80 quintals per hectare, but they are more susceptible to bacterial diseases, more sensitive to the photo-period and more subject to risks and uncertainties in agriculture. Being a *kharif* crop in most parts of the country, it presents a serious water management problem and for these reasons, the adoption rate of these varieties is much lower than that of the new wheats. Unless pests and diseases of this crop are better controlled and new plant types, insensitive to the photo-period, and less subject to the vicissitudes of weather are evolved, a real break-through in rice production seems to be a remote possibility.

Cytoplasmic male sterility has been exploited for the production of such new hybrids as Pb. Hybrid Bajra No. 1 by the Punjab Agricultural University. Although this variety has been widely adopted in the country, the income elasticity of demand for this crop is likely to decline further with the rise in income of the population.

The hybrid maize has not become popular with the farmer, because it gives only marginal increase in yield over the local varieties and involves high fertilizer doses, which greatly enhance the cultivator's cost and wipe out his margin of profit from the hybrid relative to the local maize. Another difficulty facing the farmers is inadequate water management which may provide irrigation but not drainage. The difficulty of seed production in the hybrids has been overcome with the evolvement of synthetic varieties, but they do not have as high a production potential as the hybrids. Moreover, the attack of the corn-borer is more on the hybrids and composites than on the local varieties. Unless these problems are solved, the hybrid maize is not likey to make such a great impact on the farming population.

Thus new farm technology is mostly confined to the adoption of semi-dwarf wheats and hybrid bajra. This is evident when we find that out of an increase of 6.6 million tonnes in the production of foodgrains in 1967-68 over the preceding peak of 1964-65, as much as 4.3 million tonnes was on account of the increase in production in wheat alone. Unless technological break-through comes in, the production of such cash crops as sugarcane, long-staple cotton and oilseeds will not be able to compete with foodgrain production just by manipulating the price structure of the former. In a developing economy, in which the population pressure is so high, we need not only more of food but also more of long-staple cotton, more of sugar and more of almost all other commodities. Unless a break-through in the production of each cash crop occurs, we shall not make much headway in the economic development of agricultural industry as a whole. Research effort should, therefore be intensified to achieve this objective.

PROBLEMS OF RAIN-FED AREAS

Areas with assured supply of water have benefited more by new technology than by the dry farming areas. Whereas high-yielding varieties have been developed for irrigated areas, suitable varieties are still not available, which can give high yields under rain-fed conditions. Since about 78 per cent of the acreage in the country depends on rains, there is a great need to develop varieties which give high yields under conditions of stress, and remedy imbalances and disparities in the farm income which might otherwise grow out of proportion in different regions of the country.

Problems of water management in the rain-fed areas are different from those of the irrigated areas. In the former, crop and agronomic practices have to be adjusted to available water supplies and to moisture conserved in the soils. Moisture storage in the soil, conservation of stored moisture and the proper utilization of the stored moisture are some of the important techniques which can be utilized to secure better returns from the natural rainfall in these areas. Usefulness of such practices as contour-bunding, contour-cultivation and deep ploughing for reducing run-off and for increasing moisture storage in the soil is well established. In certain areas, these simple practices may be enough to obtain adequate soil-water storage. But in certain other areas, the rainfall, even if entirely harnessed in a place, may not provide enough soil-water storage for raising a crop. In such areas, the field-water-harvesting technique has given promising results in some preliminary experiments conducted at the Punjab Agricultural University. More elaborate trials are under way to test the efficiency of this technique.

CONTENTS OF THE NEW FARM TECHNOLOGY

It is not merely the evolvement of the new germ-plasm, but its proper utilization in the cropping pattern by the farmers that will benefit the country. The introduction of short duration superior crop varieties has made it possible to adopt a system of soil and crop management which helps a grower to raise in quick succession several crops on the same piece of land. The Indian Agricultural Research Institute has recommended a scheme of relay cropping, involving *moong*, hybrid maize (Ganga-3), potato/*toria* followed by wheat, with an estimated net profit of Rs. 10,000 per hectare. These varieties have been tailored to fit in a tight schedule of farm operations. It will perhaps be easy to fix a rotation for 365 days, putting one crop after another, considering the days required for maturity, but it may be difficult to grow them in the field successfully owing to the following reasons :

(*i*) The rainfall on the sowing date may delay the sowings, or harvesting may have to be postponed because of adverse weather.

(*ii*) The maturity period for a particular crop may suffer a lot of variation. In the case of *kharif* crops, a delay of one week in sowing may result in delaying maturity by two weeks or even more. During winter, difference of even a month in sowing may cause a delay just of one week in crop maturity. For planning rotations, it is important to study resource restrictions, but perhaps equally im-

portant is to make the maximum use of such natural inputs as sunshine by promoting the maximum interception of sunlight.

(*iii*) Heavy emphasis on the introduction of a summer crop to be sown immediately after harvesting wheat is an excellent proposition on paper. But it is difficult to locate many farmers who will pay attention to the sowing of a summer crop without first harvesting and threshing the major wheat crop. Thus an intensive crop rotation may result in delaying the harvesting or sowing of the main crop and result in reducing the profit.

To overcome some of these problems, it is necessary that while any new germ-plasm is decided on, different disciplines work on it, so that its utilization is maximized. Any new plant type is to be sown under various ecological conditions, cultural practices, variable incidence of pests and diseases and specific situations existing on various farm organizations. It is, therefore, absolutely necessary that various disciplines, such as agronomy, plant protection and plant ecology are allowed to play their part in utilizing the new plant type and the agricultural economists are associated at all stages of planning crop rotations, so that the economic feasibility and profitability of an alternative cropping system could be evaluated before they are recommended to the farmers.

Both the quantity and the quality of inputs affect output and the productivity of resources. A recent farm management study conducted in the Ferozepur district showed that the farmers of this district used only 50 per cent of the nitrogenous fertilizers and 30 per cent of superphosphate and potash recommended for semi-dwarf wheats. They used 0.51, 0.20 and 0.10 quintal per hectare of each of N, P and K against the recommended doses of 1.24 quintals, 0.62 and 0.30 quintal, respectively for semi-dwarf wheats. In the case of the tall wheat, the position was still worse. Only 0.19, 0.03 and 0.02 quintal per hectare of each of N, P and K was used against the recommended doses of 0.62, 0.39 and 0.20 quintal, respectively. In the case of American cotton, 0.29 quintal of N was used against the recommended dose of 0.49 quintal per hectare. Maize (*desi*) got only 0.28 quintal of N and 0.08 quintal of P and no K against the recommended level of 0.62 quintal of N, 0.30 quintal of P and 0.30 quintal of K respectively. From these data it could be concluded that our fertilizer use per hectare is still very low. The National Council of Applied Economic Research, New Delhi has estimated that the productivity of chemical fertilizers in value terms would be extremely favourable and an input of one rupee will yield an output of three rupees. The I.C.A.R. data collected from the field trials and demonstrations reveal that the net return on investment in fertilizers is in the average range of 50 to 300 per cent for different crops. The logical conclusion is to ensure an adequate supply of cheap fertilizers to the farmers to ensure increased productivity and greater agricultural production in the country. But fertilizers alone cannot achieve the dramatic results which we hope to get. It is the interaction between the potentially high-yielding seeds, the remunerative product prices and the modern inputs and particularly the adequate water supply, pesticides and additional power on the farm organization literally as a package which can achieve the desired results.

Adequate seed-bed preparation and the proper placement of such technological inputs as improved seeds, fertilizers and irrigation in metered quantities

should go a long way in obtaining a larger output from the same resources, or the same output from smaller resources. There is experimental evidence to show that ridged and raised seed-beds effect savings of 35 to 50 per cent in water application without any risk of diminution in crop yields, thereby enhancing the water-use efficiency which is extremely low in India because of the wild flooding, and the check-basin method of irrigation. This technique is ideally suited for small farms on which labour is not a limiting factor.

Once the contribution of quality inputs is recognized, the agricultural economist will be in a better position to separate the effect of quality of input from what is often attributed to the economies of scale in the farm management studies conducted in our country.

Perhaps I have wandered too long and over too wide a ground of new farm technology. But I have done it with a purpose to stress that an agricultural economist has got to be familiar with at least the major ingredients of the new farm technology to be able to identify its implications in agricultural economics. Now let me hasten to discuss some of the implications of this technology for agricultural economists.

Technical aspects dominated the initial stage of evolution. As a result, technical and economic problems were not tackled simultaneously. It is only after the new plant types became popular with the farmers that the economists got the opportunity to evaluate their economic potentialities. They made some hurried observations and came to the quick conclusion that a new plant type would not pay at the level of fertilizer use which was recommended for the tall indigenous varieties Possibly, some of them ignored the genetic potential of the new superior plant and the complementary relationships among the technological inputs and particularly among the major and micro-nutrients associated with the new technology. Consequently, they based their conclusions on inadequate evidence. Later on, these interactions among the technological inputs began to show up prominently and some economic analysis was made, which gave different results. A comparative study of the economics of high-yielding varieties of wheats in the Punjab showed that the yield level of Kalyan 227 was higher than that of C 306 even at the fertilizer level recommended for C 306, *i.e.*, 60 kg. of N and 30 kg. of P_2O_5. The yield at these rates worked out to be 36.83 quintals for C 306 and 40.90 quintals for Kalyan 227. The Mexican wheats would become even more profitable, if the recommended doses of N, P and K and such micro-nutrients as zinc were used as complementary inputs, because zinc deficiency is becoming much more apparent in those soils where the Mexican wheats have been grown for the last 3-4 years.

MECHANIZATION WITHOUT ECONOMIC ANALYSIS

Similarly, some other technological changes are going apace without adequate economic analysis. Particularly, the mechanization of agriculture is proceeding in some parts of the country, according to the pattern of those countries where the machinery systems were designed to meet their specific needs and situations. Whatever might be the economic pattern of farm mechanization for their conditions, it will not necessarily be suitable for our conditions under which the size

of holding is relatively much smaller and management skills to operate the machinery system are relatively poor. Before such technological changes, as the large-scale mechanization, move too far, a system-analysis approach should be used for the economic selection of alternative machinery systems which suit the conditions of Indian agriculture and are directed towards the combined objective of intensive labour and high productivity agriculture. Unless efficient and matching equipment for different operations is made available in sufficient quantities to the farmers, the tractor power available with them is likely to be wasted to a great extent. An economic pattern of mechanization would involve the evolution of a complete machinery system which goes with the tractor and makes it possible to obtain a proper gradient of land, effective tillage, timely harvesting, threshing and transportation of farm produce. Similarly, it is necessary to purchase the entire versatile machine system for irrigation, shelling, crushing, threshing and chaffing with stationary power units, such as diesel engines and electric motors.

The economic management of farm power and machinery is one of the most potent factors affecting farm incomes in the country-side. If it needs only 5-7 HP to pump water from 10-20 feet below ground level, it would certainly be wasteful of energy if a 20-25 HP tractor were used as a stationary engine for irrigation. Similarly, the operation of small threshing machines with high HP tractors is an uneconomic use of available power. For economy, the machine should use no more power than what is necessary, because power is another cost of machine performance. The individual operation in the machine system must be adjusted and combined in such a manner that their overall performance is determined at the minimum cost to ensure maximum profits to the farm business. An economical pattern of mechanization for Indian agriculture should, therefore, be one which selects the correct size of the farm machine to keep costs low and make an effective use of the whole complex of farm machinery.

Following the system-analysis approach, a study undertaken to determine a suitable pattern of mechanization for crop farms in the Punjab showed that the crop farms in the study area could be partly mechanized with a 5 HP diesel engine or electric motor with a complete machinery system for doing stationary jobs, such as irrigation, shelling, threshing, cane-crushing and chaffing. These machines were found surplus during the peak periods even on large farms, pursuing a system of double cropping. The study further showed that these farms, following a system of multiple cropping with two crops a year, could be completely mechanized with a 14 HP tractor, serving as a versatile multiple purpose machine, both for field and stationary work. This tractor was found surplus to the requirements of even some of the large-sized farms. Besides, the diesel engine and the electric motor could not be fully utilized. The surplus in such cases could, however, be partly utilized by renting in more land and partly by custom-hiring for such operations as preparatory tillage in the case of tractors and threshing and irrigation in the case of engines and motors.

These findings are very meaningful in the context of present technology. The experience of rapidly developing economies, however, shows that growth and improvements in technology will further raise the demand on power availability because of the ever-increasing need for faster operations. Particularly, such

operations as land-levelling and mechanical harvesting which do not form the normal components of the existing pattern of farm mechanization would become an essential part of the field production techniques of the future. Keeping such developments in view, the energy level in agriculture could be built at a little higher level and even 18 to 20 HP tractors could perhaps be utilized to their optimum capacity.

ECOLOGICAL IMPLICATIONS

Again, ecological considerations central to the development planning and decision-making assume greater importance in the context of implications of the new technology. The U.S. experience shows that the large-scale use of persistent insecticides does not pose direct toxicity hazards, but they may result in environmental pollution. Their residues may persist in the plant, soil or water for a long time. Many of them are known to accumulate in the body fat of the animals and are concentrated through food chains. Such residues may produce various diseases, particularly cancer.

Some environmental disruption is an unavoidable concomitant of development, but as ecologists and other environmental scientists insist, harmful effects can often be anticipated and minimized, if development is preceded by a careful study of economic aspects of the ecological problems. The U.S. experience shows that normally no public accounting is done of such harmful side-effects for which the nation has to pay a heavy price, if the environmental problems are not controlled simultaneously. Agricultural economists can make a great contribution to the proper understanding of direct and indirect costs of such technical changes as cause environmental pollution, water pollution and hazards of pesticide residues.

Such examples could be multiplied. If nothing else, they bring out at least one thing very clearly. Rather than remaining in the lead, the agricultural economists are sometimes compelled to do post-mortem examination in all those situations where they are given a back seat and are not associated with the analytical studies of the new technological developments. As a result, technical and economic problems are not tackled simultaneously. Then it comes like a rude shock to the agricultural economist when he finds that most of the work he had done was based on the existing technology and that it had become obsolete overnight. This has happened to many of us. I cannot illustrate it better than picking up an example from my own work. I vividly recall that one fine morning in 1967, when I was asked to address the scientists of the Punjab Agricultural University on economic aspects of the new semi-dwarf wheats, I found that most of my work on partial budgeting, full budgeting, the production function analysis and the application of programming techniques to the data generated from the tall improved wheats of the Punjab provided no answer to the problem I was confronted with. I made some desperate efforts to put some of the new data together to present some economic analysis of this problem, but realized more than ever before what implications the new farm technology had for agricultural economists.

RISK AND UNCERTAINTY ASSOCIATED WITH NEW FARM TECHNOLOGY

The most important ingredient in the picture is the expected variance which would be attached to the new technology, but this dimension of the problem is often ignored by the technologists. Farm management studies conducted in the Ferozepur district of the Punjab show that the lower limit of the 95 per cent confidence interval for the mean yield of the semi-dwarf wheat is higher than the upper limit of the mean yield for the tall wheat. This can be seen from Table I.

TABLE I—MEAN YIELDS AND COEFFICIENT OF VARIATION OF SEMI-DWARF AND *Desi* WHEATS IN THE FEROZEPUR DISTRICT, 1968-69

(*quintals per hectare*)

Particulars	Semi-dwarf wheat	Tall wheat
Mean yield	22.46	13.63
S.E. of mean	1.76	2.26
Coefficient of variation	7.84	16.58

In spite of the higher level of yields and income obtained from the new wheats they suffered from inter-plot and inter-year variations in yields and in levels of income obtained from them. This is quite in contrast with the situation in mature economies, where as a result of stabilization of the new technology, the yield and income levels have been stabilized, thereby raising the average level of the income of the farmer much higher than they are obtained from the situation prevailing in the developing economies. A part of this variation in yield can be explained by the varying level of fertilizer dosage applied to semi-dwarf wheats.

RISK REDUCTION THROUGH INSTITUTIONAL ORGANIZATION

I do not want to get into a debate here whether the institution-building in Indian agriculture made only marginal contribution or acted as an "accelerator" for agricultural development. Institutions *per se* did not trigger the new farm technology. But recognizing that the new farm technology is more vulnerable than the old one, it is imperative to evolve some institutional framework which would reduce risk and uncertainty in agriculture to the minimum. Most farmers, and particularly the small ones, hesitate to adopt new innovations in agriculture because of their inability to absorb losses in the precarious economy of their farm organization. Developing countries can solve this problem by providing built-in stabilizers through carefully designed institutional organizations. Crop insurance schemes have their own hazards and cannot be recommended on a large scale because of the risks and financial losses involved in them. But there are several institutional organizations which could be geared to provide such services as :

(*i*) an assured market,

(*ii*) an assured price, and

(*iii*) a proven technical know-how.

Sugarcane factories in India have made a good start in this direction. They try to provide the latest technical know-how to the sugarcane growers in the factory area, make advance contract with them to lift specified quantities of sugarcane through co-operative sugarcane societies and guarantee a minimum price to the sugarcane growers. But they normally restrict their contract to one crushing season and make it difficult for the farmers to adjust their cropping pattern. These institutions will do well to extend their contract over a period of 3 to 5 years to make it possible for the farmers to adopt their system of cropping accordingly.

Somehow, this institutional approach of reducing risk and uncertainty in agriculture has not been extended to other enterprises. In fact, this concept of area planning has not caught the eye of the planners. Since new technology is generally more vulnerable, the Planning Commission needs to pay more attention to promoting such an institutional structure.

Private enterprise could be encouraged to get into this business. Hindustan Levers have made some efforts in this direction. They made a good beginning by providing an assured market to the growers of peas, provided them with cheap loans for purchasing modern technical inputs, such as improved seeds and fertilizers at concessional rates, and even guaranteed the minimum price for the crop. But they missed two fundamental aspects of the problem. They hardly realized that the farmers of the area needed more help on the technical side, because they did not possess adequate skills and managerial ability to handle the new enterprise. Thus a farmer growing peas should be told which varieties he may grow and he should be provided with their seed. He may also be advised on their seed rates and hence an optimum plant population. He should also be recommended which fertilizers and herbicides to use, and also advised on suitable application rates. Thus the manufacturing industry in the field of crop and livestock management should be chiefly concerned with making the chosen enterprises more efficient, and thus more attractive to the farmer.

Again, the farmer paid a price for the crop which was lower than the open market price and took too much time to adjust it to the market conditions. As a result, it weakened the goodwill of its business with the farmers, which takes a long time to develop.

Food Specialities Limited, Moga did almost the same thing. They provided cheap loans to the farmers to buy improved breeds of dairy animals and more nutritious feeds at concessional rates. But they seem to have added the cost of cheap loans to the price they paid to the farmer for the supply of milk and in the process ignored the basic factor that that price was not remunerative when considered in the context of the recent technological break-through in the production of foodgrains, which made it more profitable than milk production. Consequently, they did not make much headway. As soon as the milk

price was adjusted to make milk production more profitable than foodgrains production, the farmers responded to this stimulus, expanded their investment in milk production and supplied all the milk that this plant needed.

Somehow, some agro-industries have got the mistaken impression that they would make more money in periods of scarcity rather than in periods of plenty. They seem to be too much concerned with short-term goals, forgetting that such practices did not pay over long periods. They are, therefore, not moving forward to provide an institutional organization which would solve the problems of scarcities. Maybe, the planners of this country can give some more thought to this problem and promote such institutional frame-work which provides the farmers proven technology, assured market and assured prices over at least the period of the Five-Year Plan. This approach has a great potential and may be pursued vigorously.

TECHNO-STRUCTURE

A well-designed techno-structure will be necessary for the successful implementation of such programmes. Most of these organizations either employ an agronomist, or a soil scientist or an economist to advise them on these projects. They do not have all these disciplines adequately represented on their organization. As a result, these organizations do not secure optimum results. Recognizing the interplay of various disciplines, the techno-structure should be orientated accordingly, and all these disciplines represented on these organizations. This will help the agricultural economists to demonstrate what they could contribute to the success of various business organizations.

POLICY IMPLICATIONS

There are some other economic and social implications of the new farm technology which the agricultural economist can analyse and help the policy-makers to appreciate better the policy implications arising from such developments. The recent break-through in the technology of foodgrain production must affect the pattern of income distribution, particularly in the rural areas. The big farmer is not always the innovator, but his resource endowment emboldens him to take risk and adopt a new technology earlier than the smaller farmer does. Also, he has greater access to the extension agent, research institutions and institutional credit. As a result, he may profit by an innovation much more than the small farmer, even when the major components of the new farm technology, such as new seeds and fertilizers are divisible in character and could be adopted both by the small and big farmers. There is evidence to show that because of the divisible nature of the new farm technology, farm incomes of small farmers are also rising, although those of the big ones are rising faster.

To examine the degree of concentration of income per head among the districts of the reorganized Punjab and the trend of this inequality over 1960-68, Gini's ratios were worked out under the assumption of log-normality income distribution. The study showed that there was not much variation in the income distribution per head among the districts. The Lorenz curve for each year was very close to the lines of equal distribution (egalitarian line) and Gini's ratios were

0.09 from 1960-61 to 1962-63, 0.06 from 1963-64 to 1964-65 and 0.09 from 1965-66 to 1967-68.

To examine the disparity in income distribution within a district, cross-sectional data on farm family income (per farm/per head) obtained from the Farm Management Scheme conducted in the Ferozepur district were used. Gini's ratio of concentration of income came out to be (*i*) net income per farm 0.34, (*ii*) net income per head 0.24, (*iii*) the size of the holding 0.3.

It was evident from these figures that the disparity in income distribution on per head basis was much more within a district than among the districts. The analysis of net income per farm showed even greater inequality (Gini ratio being 0.34) among farms of different sizes. This may be mostly because of the disparity in the sizes of holdings for which Gini ratio was 0.33.

The degree of concentration of farm family income was also examined for the Ludhiana district, based on the farm family income data collected in the study entitled 'Farm and Farm Family Investment Pattern in Ludhiana (Punjab) and Hissar (Haryana) districts.' The Gini ratio came out to be 0.40 for 1966-67 and 0.59 for 1969-70, which meant that the disparity in the farm family income increased from 1966-67 to 1969-70 and this trend needs to be kept under a careful watch.

But what is a matter of real concern is not so much the present disparity in income between the small and the big farmer, but what the latter does with his increased farm income. Empirical evidence shows that a substantial portion of increased income of the large farmer was spent on the purchase of such technological inputs as new seeds, chemical fertilizers and on hired labour. A recent study on the farm family investment pattern conducted by the author showed that the production expenditure formed 40.29 per cent of the farm family income in the case of large farms and only 23.42 per cent in the case of small farms. So long as a considerable proportion of farm income was spent by the large farmers on the purchase of new inputs, this proportion would go to those industries which manufacture inputs for the agricultural sector. This will broaden the income distribution, and to that extent agricultural development and broad income distribution become complementary to each other.

Research has been intensified in the agricultural universities to evolve such high-yielding semi-dwarf varieties and hybrids as will stabilize the foodgrains economy at a higher plateau. This should make it possible for the farmers to cut down their unit cost of production and for the Government to stabilize the foodgrain prices at appropriate levels. The major benefits of such technological developments will go to the landless labour, tenants, small farmers and the low income urban labour, because their income elasticity of demand for food was very high. A fall in foodgrains prices over a time should raise their real income.

A recent study conducted by the Punjab Agricultural University, Ludhiana showed that up to the expenditure of Rs. 43 per month per head, the propensity to consume food varied from 0.85 to 0.77. Thereafter, it dropped to 0.69 for the expenditure class of Rs. 43 to 75. After the expenditure level reached Rs. 75

and above, it further dropped to 0.53. This finding has a great implication in agricultural growth and income distribution and could not be overlooked. Studies of this nature and several others which examine the economic and social implications of the new farm technology should help the policy-makers to rationalize their policy and adopt such measures as will promote complementarity between agricultural development and broad distribution of income.

SOCIAL IMPLICATIONS

There are social implications of the new technology which need to be studied more carefully. It calls forth a rational confrontation with the problems of structural and institutional changes which the rural communities have to undergo if they are to reap the benefits of the improved technology. But there is a greater lag in ushering in structural changes in institutions than in the adoption of new technology at the farm level. To resolve these problems, institutional linkages and new forms of socio-economic integration should be promoted.

We have very meagre evidence on the responses of the rural communities to the recent changes in agricultural technology and its accompanying social consequences. In spite of an organizational lag in adopting new technology, there is an overweaning orientation towards landholding and agricultural enterprises and under the impact of new technology the resource combination on the farms is undergoing certain changes. As a result, many areas in India are experiencing farm labour shortage and a rise in the wage rates. Farm management studies in the Ferozepur district show that a casual field labourer got on an average a daily wage of Rs. 5.55 in 1967-68 and Rs. 6.39 in 1968-69, as against a daily wage rate of Rs. 2.60 during the period 1954-55. Failing to resist the demand for higher wages by farm labour, the farmers will be inclined to hasten the pace of farm mechanization. This trend will have to be kept under careful watch and research efforts will have to be intensified to develop a pattern of farm mechanization which is suited to the conditions of Indian agriculture and does not push out farm labour faster than the secondary and tertiary sectors of economy can absorb profitably.

Again, the impact of technology on the structure of a community can be delineated under three broad categories:

(*i*) the relation of people to land;

(*ii*) the person-to-person relation;

(*iii*) and the institutional aspects.

In the distribution, ownership and the control of land, several significant changes can be traced directly to the influence of technology. In highly developed economies, such as those of the U.S.A., technology has brought about an increase in the average size of the farms, but in India, the average size is gradually diminishing because of the high pressure of population on land in the absence of gainful farm family employment in the secondary and tertiary sectors. Thus economic aspirations are highly concentrated upon land. Technology is associated with an increase in the proportion of owner- and part-owner-operated farms and an

erosion in the position of tenancy which is accentuated by an increase in productivity. There is already some evidence to this effect in Indian agriculture and this trend needs to be examined carefully for its effect on the structure and operation of the farm organization.

Inter-personal Relations

The changes connected with the impact of technology in the sphere of inter-personal relations are those which deal with social differentiation, social stratification, social processes and socio-psychological characteristics.

As in the case of industrialization, agricultural development is intimately associated with demographic changes in a society. The high rate of population growth (2.2 per cent per year) which is not likely to go down for another decade in India, if unchecked, will definitely hinder the pace of agricultural development. It reduces per capita output through its effect on human resources, material resources, economic organization and technology and on social and cultural factors. But this is not fully appreciated by the rural masses. There is, therefore, an urgent need to study the relationship of demographic change to economic development at the micro level (at village and family level). Such studies should demonstrate to the farmers how a rapid growth of the village population affects the resource endowment of their village, their size of holding, income per head and the state of economic development. It may be difficult for them to visualize the implications of a rapid rate of population growth at the national level, but if they knew how this rising trend in population would affect their own resources at the micro level, they would appreciate this problem much better. Hence the need for intensifying such studies.

In the sphere of social stratification, it is generally assumed that all the strata of the community are not equally benefited by the new technology. And it has shown its influence upon the group structure. In sharing the technological know-how, the agriculturists today lay material stress on selective orientation rather than on community-wide participation. It has also influenced the religio-socio-economic *jajmani* system by promoting contractual relationships. This, in turn, has fostered higher inter-and intra-generational occupational mobility among the lower castes than that among the higher castes, and this is a happy development.

In the matter of inter-group relations, the economic status has influenced the leadership structure and the sense of communitiness. The leadership structure is caste-based, but it is diffusive and fluid. The successful farmers are emerging as new leaders in the community. The spirit of communitiness is flagging and there is more and more outer-directedness, especially among those who belong to the upper strata of the community and among those whose economic interests are not directly satisfied within the community.

Again, differentiation is noted between the big and small farmers because of income differences. This has further influenced the caste-based traditional modes of social differentiation, community participation and, consequently, the

standards of social prestige, which are more and more influenced by material rewards and occupational satisfaction in the community.

Exploratory studies conducted by the Punjab Agricultural University showed that the coefficient of correlation between material rewards and the social prestige was 0.65 and the occupation and social prestige was 0.81. Today, higher status is being accorded to persons with higher education, land ownership and progressive farming and mechanical skill in place of the traditional 'caste.'

Thus the whole social matrix, *viz.*, the community social structure, its organizational pattern, the inter-group relations, standards of social prestige, the mode of social stratification, community participation and leadership structure is experiencing the impact of the recent technological change. Careful studies will have to be planned to keep these trends under watch and arrest those which would cause strains in the social matrix of the society. It is here that the pertinent problems of the interplay of the social and economic aspects need to be examined carefully by the sociologists in collaboration with the agricultural economists. As the pace of technological changes moves faster, such problems will become even more complex in dimension and cannot be solved without building up a strong programme in multi-disciplinary research.

Let me conclude by saying that I look upon this organization of the Indian Society of Agricultural Economics, as I have seen it grow, as one of the most important agricultural organizations in the country. This organization, I fervently hope, will have a far-reaching influence on the evolving of a strategy of agricultural development which results in better living for the masses of the country without causing many social strains. This all-India organization of agricultural economists has a unique opportunity to provide the larger vision that is needed for a better tomorrow and we must all strive hard towards reaching this goal.