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TECHNICAL PECULIARITIES OF AGRICULTURAL SUPPLY¹

SHERMAN E. JOHNSON AND K. L. BACHMAN

Agricultural Research Service, United States Department of Agriculture

IN this era of rapid change it is appropriate to consider the technical peculiarities of agricultural supply. Our analysis can be sharpened by ascertaining the varying responses on farms that represent different stages of mechanization and other technological advances, with resulting changes in output per worker and commercialization of farming.

The widely differing forms of organizational structure represented by *mechanized commercial farms* as compared with the more numerous *subsistence farms* are associated with correspondingly differing factors that affect the supply of farm products. Our attention is focused first on the conditions of supply peculiar to mechanized commercial farms. At the other extreme we consider the subsistence farms, on which traditional production methods are used with resulting low output per worker. Between these extremes are farms in different stages of transition to the use of improved technology. Output per worker on most of these *semi-commercial farms* is also rather low, and labour still constitutes a high proportion of the total input of resources. We discuss semi-commercial farms in the same section as subsistence farms because the supply responses tend to be similar. But we recognize that as farms become more commercial, the responses merge into those observed on commercial farms.

Agricultural Supply Conditions of Commercial Farming

On commercial farms, production is largely market-oriented. Only a small part of the total production is used for subsistence. Purchased inputs constitute a major share, and family labour a gradually decreasing part, of the farmer's production resources. Substantial increases in the level of output usually occur in response to favourable price-cost relationships. Given the fact that in commercial countries the demand for farm products is inelastic both with respect to price and income, sooner or later prices will be markedly reduced. Output tends to be maintained under unfavourable prices and costs;

¹ This paper expresses the personal views of the writers. It does not necessarily represent the views of the Agricultural Research Service or the U.S. Department of Agriculture.

in fact, it often continues to increase even then. The resulting depressed incomes of farmers for prolonged periods become major problems of public concern.

Commercial agriculture is organized into two main types of production unit—family farms and large-scale farms. Family farms are those on which the operator and members of his family make most of the management decisions and are actually engaged in physical work on the farm. Large-scale farms may have several different forms of structural organization. In general, the management tends to be specialized and the work is performed largely by hired labour, or by workers who operate under a tenure agreement. Sometimes the latter arrangements involve semi-subsistence operations by tenants. But in general, the profit incentive is usually as strong or stronger than on family farms. Commercially operated co-operative farms, collectives, and State farms fall in a different class. Collective and State farms are organized as an integrated part of a national economy and pose different but important problems with respect to incentives for work, changes in organization, and supply responses.

Three characteristics of family-operated farms and privately operated large-scale farms are basic in explaining the peculiarities of agricultural supply under commercial farming conditions. First, increasing net money income is the primary consideration in changing production. Secondly, these farms are usually operated by farmers who are alert to changes that will increase incomes though they represent a wide range of attitudes toward examination of technological developments, evaluation of their economic effects, and willingness to act on the results of their investigations. Thirdly, non-farm inputs constitute a major share of the resources used by these farmers. In the United States, for example, approximately 55 per cent. of the inputs currently used in agriculture now come from non-farm sources.

Three effects of using these large proportions of non-farm inputs explain much of the supply behaviour of commercial farmers:

1. Use of non-farm inputs generally increases output per farm and in total. This is particularly true of shifting from animal to tractor power, and of the increasing use of fertilizers and pesticides. However, the tendency to increase product per acre and per unit of live-stock includes most types of non-farm inputs.

2. The characteristics of non-farm inputs make it difficult for commercial farmers to get in and out of production quickly. Many non-farm inputs represent capital investments for use over a period of years. In the United States the capital charges, depreciation and

repairs on farm buildings, power, and machinery account for more than half the annual use of non-farm inputs. To a large extent, 'fixed' labour resources are replaced by 'fixed' machinery and equipment investments. Thus, even large-scale farms are characterized by a relatively low proportion of inputs that can be classified as variable.

3. In general, use of non-farm inputs increases earnings of the individual farmer even in periods of low prices, as most non-farm inputs have a high marginal productivity per dollar of increased expenses.

Because of these three effects, there is a strong tendency toward upward expansion of total output on commercial farms. Operators respond to favourable price and income relationships by (a) increasing the use of non-farm variable inputs, such as fertilizers and pesticides, and (b) making new capital investments in order to increase intensity of operations for more efficient operation or to enlarge units. More capital-intensive uses of land are encouraged. If new land areas under low intensity of use are available, they are likely to be developed under such conditions. A prosperity environment results in bidding up the price of land and other resources as a part of the process of expanding output.

But many farmers are slow to adopt new technology even under favourable income conditions because of their inadequate knowledge of its effects, or because they cannot or will not obtain needed finances, take the added risks, or acquire the necessary technical and managerial skills.

Adoption of new technology means *reduced cost per unit of output* but, as indicated, this result is usually associated with an increase in *total output*. Most farmers respond to cost-reduction opportunities by adding inputs to their existing stock of resources. The increase in output brings more income to the individual farmer. That is, each farmer responds to a horizontal demand curve, usually without realizing the ultimate price-depressing effect of overall increased output that results from the widespread adoption of new techniques. But even if the consequences are foreseen, an individual operator who responds in this way maximizes his returns.

Once total output has expanded, it is unresponsive to less favourable price and cost relationships because the inputs added are highly productive as long as the farm continues in operation. Consequently, the supply curves on individual farms are not readily reversible in response to lower prices. Individual farmers cannot increase their net incomes by reducing output unless they discontinue their farming operations. This they will do only if the returns from alternative

employment, plus the returns from what they can salvage from investments in 'fixed resources', are above their expected returns from farming. If they attempt to liquidate machinery, livestock, and equipment in order to take non-farm employment, they will experience severe losses on their original investments. Consequently, most farmers try to carry on in the hope of more favourable future

TABLE I

Effects of Suggested Improvements in Farming on Expenses and Income of a Two-man Dairy Farm, South-eastern Michigan¹

Item	Present organization	Suggested organization	Increase over present organization	Percentage change
High prices ²				
	\$	\$	\$	
Total expenses . . .	11,675	13,761	2,086	18
Total gross income . .	15,024	20,519	5,495	37
Family labour income .	3,349	6,758	3,409	102
Medium prices ³				
Total expenses . . .	9,368	11,259	1,891	20
Total gross income . .	10,180	14,187	4,007	39
Family labour income .	812	2,928	2,116	260

¹ Total acreage in the farm is 320 acres, of which 290 are tillable. Major improvements in farming include more fertilization, more hay and pasture, reduction in small grains, increasing the number of cows from 30 to 60, and an associated additional investment in buildings and equipment.

² Ratio of prices received for farm products sold to prices paid for items for use in production at 115 (1910-14 = 100).

³ Ratio of prices received for farm products sold to prices paid for items for use in production at 84 (1910-14 = 100).

Source: C. R. Hoglund, *Economy of Improved Production Practices on Specialized Dairy Farms in Southeastern Michigan*, Agr. Econ. Report 491, April 1952 (Co-operative study, U.S.D.A. and Michigan State College).

developments. Those who decide to liquidate will sell out to others who will acquire the resources at lower costs; and in the short run the new owners are likely to use them at the same level of intensity.

Meanwhile, those who were not among the early adopters of the new improvements have added to their knowledge. Most important, they usually find that the marginal productivity of *additional capital*, even at lower product prices, is still high enough to yield a net return on the use of more non-farm inputs. An example of this is shown in Table 1. Gross incomes can be increased more than \$5,000 by an increase in expenses of approximately \$2,000 under high

prices. Under lower prices, gross incomes would still go up \$4,000 with an increase in annual expenses of slightly less than \$2,000. The resulting effects of these improvements would mean that under high prices labour income would be increased more than \$3,000, or doubled. Under lower prices, labour income would be increased about \$2,000, or 260 per cent.

The fact that the resulting income may not be high enough to yield a market rate of return on his *total resources* is not the deciding factor to a farmer who is committed to farming. If he is convinced that additional investment in output-increasing technology will increase the net income of his 'going concern', he is likely to make the change, unless he is unable to finance the reorganization or is unwilling to assume the greater risk involved in a larger investment and higher cash outlay.

Total output would be increased by more than a third in the reorganized farming system suggested in Table 1 without adding to the acreage of the farm. To the extent that such opportunities are utilized, technological advances provide a 'built-in expansion factor' on individual farms. And because the total supply curve is the cumulative sum of individual supply curves, it follows that total supply is not readily reversible in response to lower prices. Total output therefore tends to be maintained under declining prices and net incomes over a considerable range. In fact, under some conditions, output tends actually to increase.

This illustration provides at least a partial explanation for the recent expansion of farm output in the United States. Farm prices declined about 20 per cent. from the 1951 peak associated with the Korean crisis, to 1957. During the same period, prices paid by farmers increased nearly 5 per cent. Therefore, the drop in the price-cost ratio was even greater than the decline in price. Despite a large reduction in number of farms, the net income per farm declined about 14 per cent. Farm programmes designed to decrease production were inaugurated. Yet total farm output rose nearly 10 per cent. during these years. The annual rate of increase in output was only a little less rapid than it was from 1940 to 1951, when World War II and rehabilitation demands absorbed all the farm products that could be produced.

This recent experience in the United States may serve as an illustration of maintenance and expansion of output in the face of declining prices. It is not a unique experience, at least not in the United States. In the 1920's, when both prices and costs were unfavourable, farm output rose. But an element of uniqueness is the

increase of 24 per cent. in farmland values from 1951 to 1957, despite declining prices and incomes.

Some of the reasons for maintaining output when prices and incomes decline are fairly well supported. But the extent to which output and land values continue to rise is puzzling to many people. Does the fact that prices and incomes are declining have no effect on supply? Is the recent upward trend in output in the United States attributable to other factors? What are some of the reasons for the recent supply responses?

First, farming was profitable during World War II and the rehabilitation years, or from 1940 to 1951. In those years, large investments were made to increase output. Special emphasis was placed on wheat for rehabilitation needs and, after the Korean crisis, on cotton. Semi-arid grazing lands were broken and increased the acreage of wheat by 58 per cent. from the low point in 1942 to the record in 1949. Investments were made in new irrigation development and other facilities to grow more cotton. These two crops are in the chronic surplus category. The land and other capital resources that were invested in them have value primarily for their continued production.

Training programmes for war veterans gave on-the-farm training to 700,000 ex-servicemen of World War II. With their capital committed to farming and with growing families many of these veteran farmers find it difficult to shift into other occupations.

Those farmers who were able to build up financial reserves in the high-income years can adopt new cost-reducing techniques that increase output even though additional investments are involved. In this way, they would be able to maintain their net incomes, or at least increase them over what they would otherwise be.

Most important, perhaps, technological advances that involve greater use of those non-farm inputs that do not require large investments offer hope for income improvement even under relatively low prices. For example, farmers have discovered that high marginal returns can be obtained from greater use of commercial fertilizers. Recent studies indicate that net returns can be increased, even at present prices, by nearly \$3 for each dollar of additional expenditure for fertilizer on corn in the Corn Belt. The results on cotton in the south east are even a little higher, despite long experience in the use of fertilizers.¹ Other examples of non-farm inputs

¹ Estimates derived from D. B. Ibach, *Substituting Fertilizer for Land in Growing Corn*, Farm Economics Research Division, U.S. Department of Agriculture, Agr. Res. Serv. ARS 43-63, Nov. 1957; and unpublished data in Farm Economics Research Division.

that yield large marginal returns, require relatively small investments, and increase output per acre and per animal, are the new pesticides to control weeds, insects, and diseases; also the new livestock feed additives—antibiotics, hormones, and vitamins.

Farmers bought new equipment in the prosperous years, and with the larger high-speed tractors, they can operate more land than their original units contained. With excess labour and equipment capacity, they find that *when additional land is added to their present units* it yields a relatively high marginal return over cost, on either a purchase or a rental basis. Consequently, farmers' bidding for land to add to present holdings in an attempt to maintain incomes was one of the factors behind the rising land market.¹ Public and private investments in land improvements for irrigation, drainage, watershed protection, and other conservation measures have contributed both to higher land values and to added output.

Although the estimates show a reduction in farm population of about 15 per cent. from 1951 to 1957 and a decrease in number of farms of about 10 per cent., the effects of these reductions in labour input on farm output appear to have been fully offset by a recombination of farm units and changes in technology. In some instances at least, farm consolidation and use of improved techniques by new operators resulted in higher output per acre of land.

The net result of all these forces has been a 10 per cent. increase in total output from 1951 to 1956 on a 4 per cent. smaller acreage of cropland with 9 per cent. less labour. More non-farm inputs were used and as a result, total measurable inputs increased about 1 per cent., but *output per unit of input* was about 9 per cent. higher in 1956 than in 1951.

This analysis of recent experience in the United States indicates that the momentum of commitments for increased output in a period of prosperity carries over into years of adversity. Low prices are not likely to result in reduced output for several years, unless they fall so low that returns do not cover the marginal costs. In a dynamic economy, total output may continue to increase for some time despite considerably lower prices and reduced incomes. The technical horizon may be high enough to permit continued expansion over a considerable period of time.

Low prices, however, are likely to retard the rate of increase in

¹ Other forces also have pushed farmland values upward. Urbanization of the countryside has injected not only new competition for land, but a speculative element as well. Non-farmer buyers of land for farming also have constituted a small but stimulating segment of the market.

output, and in the long run there may be some actual shrinkage in total output. If other employment is readily available, there will be fewer new farmers. Very low prices and incomes may also induce some farmers to discontinue operations. The land may then be shifted to less intensive uses by the operators who take it over. In fact, some abandonment of land may occur. Once production has expanded, however, unaided contraction by individual farmers is a slow and painful process.

*Agricultural Supply Conditions of
Semi-commercial and Subsistence Farming*

In many areas formerly devoted almost entirely to subsistence farming, there is now ferment and striving for reorganization of agriculture in order to increase total output and output per man-hour. In some areas, considerable progress has been made in mechanization, other technological advances, and greater commercialization. Farm output tends to increase as improved technology and greater commercialization are achieved, mainly because of better practices and the release of cropland used for producing feed for work animals.

Most of the farmers of the world, however, still operate very small farms mainly by hand labour with the assistance of simple tools and perhaps one or two draught animals. On these farms, the supply of agricultural products is subject to three unique conditions.

First, land and labour constitute the large bulk of the inputs. Only a small part of the production resources is purchased. In Greece, for example, purchased inputs account for less than 10 per cent. of the product, whereas in the United States and some other highly commercial countries, more than 50 per cent. of the product is represented by purchased inputs. The associated low levels of earnings provide little margin for improvement in production. With little other employment available, there is strong pressure to continue farming, and these land and labour resources are retained in agriculture when farm prices decline. Production is likely to continue at the same pace so long as returns provide subsistence and cover the cash costs.

Second, on most of these farms a major part of the production is for the use of the family. In general, production plans are not oriented to market demand but to family needs and also to the labour and land of the operator who has little money for purchased inputs. Because his first aim is to meet the subsistence needs of himself and his family, the quantity he markets varies substantially with yields. Usually, the market for small quantities sold by individual producers

is not organized for wide distribution of output. Frequently, therefore, when production is in excess of the usual needs of the local area, gluts are encountered, and the products clear the market at low prices despite unsatisfied needs in other areas within the same country. Because of the nature of individual production plans and the uncertainty as to price, there is little response to either upward or downward movements in farm prices and costs.

Finally, traditional tenure institutions also play a significant role in impeding changes in agricultural supply, and particularly in increasing the supply of farm products. Where large landed estates are prevalent, traditional modes of farming are continued because they are simple to prescribe, require little knowledge or attention on the part of the landlord, and the problem of sharing expenses is uncomplicated. Sometimes also, there is lack of confidence in the peasant's ability to carry out such improvements.

In some countries with high proportions of subsistence farms, co-operative farming is emphasized as a means of improving agricultural production. The advantages claimed include the economies that accrue from larger scale operation and more effective use of scarce resources in land, technical knowledge, and available capital. Also, production and processing can be more closely integrated. These organizations vary from purely voluntary co-operatives to collective and State-operated farms. They vary also in the degree of overhead supervision, the incentives provided, and the extent to which freedom of decision is permitted. The writers do not have sufficient evidence from which to judge the eventual success or failure of these structural organizations. But much may depend upon the incentive developed for good husbandry and effective use of resources.¹

Despite conditions which discourage changes by individual farmers, progress is being made. Significant increases in the supply of agricultural products are being obtained in several subsistence farming areas. Governmental policies that encourage adoption of new technology and increased output have stimulated and aided these changes.

Countries characterized by subsistence farming frequently experience food shortages because of the narrow margin between the minimum needs of the population and actual scarcity. Unfavourable growing conditions can eliminate the small surplus above the minimum needs. Developments of this kind leave the non-farm population in a precarious position unless additional imports can be obtained.

¹ See *The Indian Journal of Agricultural Economics*, vol. xiii, No. 1, Jan.-Mar. 1958, for a section devoted to the experience of co-operative farming in India.

Protection against the threat of food deficits, together with the desire to improve present levels of food consumption, leads to concern about increasing farm output.

Some countries, however, need to recognize more clearly that the threat of food deficits cannot be eliminated by expanding the supply of agricultural products without accompanying improvements in technology and in the organization of agriculture. In fact, expanding agricultural production by a *proportionate increase* in workers on the land may eventually accentuate the threat of food deficits because a larger population in agriculture may find it hard to maintain even present levels of output per acre and per worker. In most countries in which a high proportion of the population is in agriculture, the agricultural population has increased since World War I. This positive relation between increased total output and more farm workers is in contrast to the even more rapid increase in output along with substantial reduction in agricultural population in countries where commercial farming predominates.¹ Sustained improvement in levels of living can be obtained only by increasing production per farm worker and thus widening the margin of output above the minimum needs of the farm population. This will involve adopting new technology and changing the economic organization of production and distribution of farm products. Such changes frequently are considered under the general term 'technological advance'.

Subsistence farmers can advance technologically by increasing output on their present units through use of better seed, commercial fertilizer, and improved cultural practices. These changes involve more intensive use of both labour and capital on present acreages. The first fruits of such improvement redounds to the farm families themselves. They have more products available for direct consumption and a little more surplus for sale. Frequently, even these small changes are difficult to carry out because of the lack of knowledge, skills, and funds necessary for financing the change.

Eventually, however, more complex changes are needed if productivity is to continue to rise significantly. The process of increasing total farm output and output per worker also will require new systems of production, increased mechanization and larger farm units. Available evidence suggests that, with appropriate changes in technology and systems of farming, there are many instances in

¹ Study of Table 5A, *Food and Agriculture Statistics*, vol. x, part 1, 1956, for countries with populations of half a million or more, shows farm population increasing between inter-war period and recent years in at least 17 of 19 countries with more than 40 per cent. of the population engaged in agriculture. In at least 18 of the 21 countries with 40 per cent. or less of their population engaged in agriculture, farm population declined.

subsistence farming areas where additional production might be obtained at relatively low cost in relation to returns. However, greater income possibilities from additional production does not lead most subsistence farmers to produce more. This paradox deserves further consideration. How do we explain the persistence of this generally accepted gap between potential costs and returns of additional production on these farms?

Part of the answer may lie in what subsistence farmers attempt to maximize. Brewster and Parsons have emphasized the importance of the 'frame of mind' in determining farmers' production responses.¹ We raise the question as to whether the subsistence farmer is dominated by a frame of mind which leads him to work hard carrying out the job of farming, but in which he visualizes the job as largely within the limits of the resources he owns or controls and the farming systems commonly in use. As a consequence, he uses his labour, land, tools, and limited funds as effectively as possible in following the accepted farming system, hoping that with divine assistance a satisfactory product will result. The level of output attained, however, may be considerably below the level attainable with improved technology and a new combination of inputs.

To consider using borrowed funds to establish complex new combinations of factors and systems of production probably requires a frame of mind that differs from one which is content to continue the present farming system. Even among commercial farmers many do not readily consider changes of this type. The required shift in frame of mind may represent more of a change than is appreciated by persons with a commercial farming background. Furthermore, the concept of equating added costs with added value of sales is not meaningful to subsistence farmers who produce primarily for home use and have experienced sharp changes in the prices of their residual products for sale.

Any change that involves increased output requires, first, awareness of possibilities, then motivation to initiate it, a favourable institutional environment for its development, availability of finance, and the managerial and technical skills needed to carry it out. Motivation for change is lacking if the improvement appears to be impossible of achievement. Because of the meagre incomes and low levels of living in subsistence farming, there is a high propensity for direct consumption of any increase in output and income. Unfilled

¹ John M. Brewster, and Howard L. Parsons, 'Can Prices Allocate Resources in American Agriculture?', *Journal of Farm Economics*, vol. xxviii, No. 4, Nov. 1946, pp. 938-60.

wants for food, clothing, and other items of consumption limit the funds available for investment in technological improvements represented by capital goods. Consequently, for many farmers the problems of capital accumulation present a formidable barrier to achieving desirable changes. Frequently, also, loanable funds are scarce, and even if credit is available, the terms are likely to be burdensome. Existing land tenure arrangements also may prevent a farmer from making improvements or from sharing equitably in their benefits.

Therefore, technological advances designed to increase output per worker involve much more than purely technical improvements. They require a combination of technical, economic, and institutional changes, and above all competent local leadership. In most countries, vast improvements in research and especially in education are needed if rapid technological advances are to be sustained. Technical assistance and supervision may need to be provided to teach the technical and management skills required for successful adoption of the new methods. Concurrent changes in credit and tenure institutions may be necessary also; and a central government that can offer security, encourage progress, and provide a stable currency is essential to sustained advances.

Development of new land areas can be a means of increasing output per worker and advancing the national welfare. But if this goal is to be reached, land development will need to be combined with adoption of new techniques, larger units, and more equipment per worker, as essential elements in the process of increasing output per worker. In recent years, large-scale land improvement projects have been undertaken under government auspices in many countries. They involve clearing, drainage, irrigation, and other improvements that require large capital outlays. Considerable time elapses from the initiation of such projects to their completion and use for agricultural production. Usually, the goal is to establish farms with emphasis on commercial farming. But the transition is difficult both for the government that undertakes it and for the settlers on the new project. New technical and management skills must be learned. Credit is needed for land improvement, for equipment, and for the larger volume of production. Local markets and transport to consuming centres must be established. For these reasons, emphasis on programmes to increase output on present units may yield greater returns than will development of new land in the earlier phases of an agricultural development programme.

A high percentage of the population engaged in subsistence

farming usually indicates either a lack of resources for industrial and commercial production or that such development has been retarded. If non-farm resources are available for development, growth in these sectors can offer employment for workers who are not needed in an advancing agriculture. Large-scale improvement in incomes and in the welfare of people on subsistence farms may come only with concurrent development in industry and commerce. Available evidence supports the conclusion that incomes of farm people in any area are not likely to rise much above the incomes of the non-farm population.¹

Unless agricultural improvement that increases output is part of a development and growth process in the entire economy, there is danger that the fruits of such improvement may be absorbed by an increased population without any lasting effects on the standard of living and the general welfare of the people. But improvement of agriculture can assist materially the development of industry, both by providing food for the non-farm population at reasonable prices and by providing a basis for the development of food- and fibre-processing industries. Therefore, the importance of concurrent agricultural, industrial, and commercial development cannot be overemphasized.

Development of both industry and commerce is needed to provide employment for the surplus farm population, for improved transportation and processing, for more adequate production supplies, and for expanded markets. But giant strides in development of non-farm enterprises are required in order to absorb the surplus population of an advancing agriculture in countries where from 50 to 75 per cent. of the people are now engaged in agriculture. If industrial development is decentralized, greater opportunity will be provided for transition from full-time subsistence farming to part-time farming, with non-farm work providing part of the family income.

If the shift to a more commercial agriculture with increased productivity per person can be accomplished in a developing non-farm economy, there will be large potentialities for filling unsatisfied needs. The population in undeveloped areas usually has a relatively high income elasticity for consumption of farm products. Therefore, improvement in incomes will result in increased demand. Demand may even outrun the increase in farm output with inflationary results. Once the volume of farm output has increased, however, there is no road back to lower output levels. Production increases can be slowed down or halted, but contraction of output is difficult. Shifts

¹ J. R. Bellerby, *Agriculture and Industry: Relative Income*. Macmillan & Company, London, 1956. See especially pp. 3, 303, and 304.

in production to products with more favourable markets are sometimes feasible, but contraction of total output is perhaps even more painful on semi-commercial and subsistence farms than on commercial farms.

Conclusions

Available evidence indicates that the factors affecting the supply of farm products differ between the commercial and the semi-commercial and subsistence farms. But once an increase in total output has been achieved, it is not readily reversible. Because of the low price elasticity of farm products, maintenance or increase of output in the face of slackening demands may result in sharp declines in farm prices and incomes. These effects will have relatively greater impacts on commercial farms because of the high percentage of cash costs and the greater proportion of the output represented by sales.

In the less fully developed countries which are experiencing rapid growth in their entire economy, the higher income elasticity for farm products is likely to lead to improved technology and greater commercialization, resulting in increased farm output at prices and incomes that are relatively favourable to producers. Under these conditions it is desirable to strive for an expanded farm output in order to reduce the food deficit and to provide food insurance for the entire social group. It becomes very important, however, to achieve the higher output by means that will result in greater production per worker.

In many subsistence farming areas economic progress is impeded unless incentives for change are provided, and financial and institutional obstacles are removed. Even when these conditions are met, the benefits may be absorbed eventually by a larger farm population unless a growing economy offers non-farm employment.

The national economy gains from increases in *physical efficiency* in the agricultural sector. The effect of gains in physical efficiency on *economic efficiency* needs to be traced through the individual firm and over time to the group and aggregative effects.

Because of the characteristics of agricultural supply in response to changes in prices and costs, ways need to be worked out by which all farm people can share in the benefits of efficiency and progress. This need is apparent in the countries now characterized by commercial farming as well as in those in the semi-commercial and subsistence categories which are striving for more commercialization.

The problems associated with variations in agricultural supply require the joint efforts of economists, other social scientists, natural

scientists, and engineers, to work out ways in which science can serve all farm people as well as the entire economy. We do not know of any country that has analysed adequately the aggregative effects of individual farm adjustments to changes in prices and costs, and has solved the problem of retaining an equitable share of the benefits of technological advance for farm people during periods when the growth in output exceeds the expansion in market demands.

Special attention will need to be given to present and potential income levels of farm labourers, tenants, and small farmers. Increased education and training may be prerequisites to the development of the income potentials of these farm people. Under-developed human resources in agriculture, as in other sectors of the economy, are wasted resources.

We need also to bear in mind, however, that achievement of equality of economic opportunity for farm people will provide satisfactory living conditions only in an environment of economic progress and improved incomes in the entire economy.

A. GONZALES SANTOS, *Consortio del Seguro Agrícola Integral y Ganadero, Mexico*

The authors of this paper have given us a complete account and explanation of phenomena at the farm level relating to the favourable and unfavourable effects that technical characteristics of farming have on the peculiarities of supply, and also of the relationships of these characteristics to the cultural status of farmers and their level of living. They stress the need for technical advance in farming and increased production per worker as conditions for raising the level of living of the farm population; but they assert that such changes, to be effective, should be accompanied by development of non-farm activities. This is the only way they see of attaining balanced economic development, equilibrium between farm and non-farm-activities and, it is supposed, stability of agriculture's terms of trade.

It seems that these ideas are right.

But Dr. Johnson and Dr. Bachman are not very much concerned with the problem of the deterioration of agriculture's terms of trade. They devote a good part of their paper to showing that technical advance in farming in the United States permits a rise of income through increased output, in spite of declining prices of farm products. However, they also recognize that subsistence farming is different, because of the difficulty of achieving technical advance and of becoming semi-commercial or commercial. We must conclude that the undeniable tendency of agricultural production to over-

supply and the consequent deterioration of the terms of trade are of great importance. This is especially true of under-developed countries, which account for most of the world's population, and whose agriculture is mainly of subsistence type.

In these countries economic development has to be based to a large extent on agriculture. Farm output has to be increased sufficiently to meet the unfilled needs of the farm population and, in addition, to pay for the imports of capital goods required for the development of both agriculture and industry.

Growth of agricultural supply must be simultaneous with, if not previous to, industrial development, as a means of financing this development, but always with the net result of over-supplying the national and international markets for export crops.

If this is correct, balanced development is a goal—a desirable condition—frequently out of reach of countries which are in the first stages of development. As Dr. Johnson states, gigantic strides in the development of non-farm enterprises are required in order to absorb the surplus farm population and expand national markets for agricultural output.

Industrial production can be expanded almost without limit, at least when the increase is justified by economic circumstances, since it is easily absorbed by a rapidly increasing demand. The problems of industrial over-supply are usually of a temporary nature, and the terms of trade of industrial products remain favourable. By contrast, increased consumption of most agricultural products is slow, practically equivalent to population growth, while there is an urgent need for expansion of agricultural output to make the acquisition of non-farm domestic goods possible and to pay for foreign loans and direct imports of capital goods for agricultural and industrial development. Given the known peculiarities of agricultural supply, which is rigid, irreversible, variable, unpredictable, seasonal, substitutable; and which has a low price and income elasticity; the tendency of over-supply and deterioration of the terms of trade seems inevitable.

Some economists believe that economic development leaves agriculture in a relatively disadvantageous position.¹ Others reply that there is no *a priori* reason for agriculture's disadvantage and that everything depends on the particular circumstances of each country and on the period of observation.² The international trade of England over more than a century has had long periods of alternatively favourable and unfavourable terms of trade of agricultural imports

¹ E. M. Ojala, *Agriculture and Economic Progress*, London, 1952.

² Ercole Calcaterra, *L'agricoltura nello sviluppo delle economie arretrate*, Roma, 1954.

and industrial exports. Such periods have been so long that the fluctuations are matters of great concern, and there is every justification for assigning great importance to the problem of the international terms of trade of agricultural products.

O. ARESVIK, *College of Agriculture, Vollebekk, Norway*

Dr. Johnson and Dr. Bachman have broadened the subject significantly. They have treated principally the normal supply function which expresses the producer's reaction when planning production. The quantity offered will then be a function of all the factor prices and of the product price. On the whole, I am in agreement with most of what they have said and with all their main conclusions.

I agree that the analysis is sharpened by considering the commercial farms and the subsistence farms separately, though a greater distinction could have been drawn perhaps between commercial family farms and other commercial farms.

They say that to increase net money income is the primary consideration in changing production on family-operated farms. That is true. But on these farms there is an intimate connexion between the family, the household, and the firm. Agriculture is here not only a form of production but also a way of life with certain cultural and social values which, together with money income, determine the total welfare.

That the use of non-farm inputs generally increases output may be questioned in the form in which it is given. The use of these inputs may also represent a substitution of production factors. Where we have a surplus of agricultural products such cost-reducing substitution is very important and should perhaps be stressed more by extension workers.

Again, I would disagree that non-farm inputs are the decisive factor which prevents farmers from completely suspending production, as manufacturers would, when prices are low. Long-term investment can be still more marked in industry. Keeping the family labour occupied probably plays a more important role. Furthermore a farm is not like a factory, where the owner can shut the door and later begin production again with his machinery and plant intact. Much cultivated soil, if left to itself, would soon be overgrown with bushes and trees, and it would take considerable investment to put it into production again.

That the use of non-farm inputs generally increases the earnings of the individual farmer even in periods of low prices may also be a questionable statement. If non-farm inputs have a high marginal

productivity per unit of increased expenses even with a low price-cost ratio, the conditions of maximum return must be far from fulfilled, especially before the drop in the price-cost ratio. Table 1 seems to be based upon this assumption. It is here only a question of using old techniques. In the same connexion it is mentioned that technological advances provide a built-in expansion factor. In my opinion it will be clearer if we distinguish between new techniques and old techniques and include under new techniques only the main built-in expansion factor.

Regarding commodities produced on small farms, the quantity used by the family will have some effect on the market supply. If the commodity is not important for the producer's total income, it may have an ordinary declining demand curve. If, on the other hand, the sale of the commodity is important to the producer's income, so that changes in the price also affect his marginal utility of money, the effect can be that home consumption declines when prices fall below a certain level and rises again when prices rise.

A falling supply-curve in agriculture can result from the need for liquid assets and we get what we can call a forced supply curve. This was fairly common in the 1930's, when farmers had to get cash in order to keep their property. The forced supply curve has the form of a symmetrical hyperbola such that the product of price and quantity is a constant amount. If the price rises above a certain level, the normal supply curve is reintroduced.

It is also well known that when unstorable agricultural commodities reach the market, their supply curve will be nearly vertical, that is the whole supply will be sold at whatever price can be obtained.

From the experiences we have had in Norway, I would emphasize the importance of organizing and regulating market conditions for agricultural products. Our experience indicates that it is of little use to preach technological improvement before the economic conditions, especially those of marketing, permit it. If it could be arranged here in India that all farmers, both large and small and also those in remote locations, could have stable and reasonable price and market conditions, then the foundation for increased production would be laid. Agricultural marketing co-operatives were the principal means chosen to achieve this end in Norway. Their chief aims were to create market possibilities for all farmers, to rationalize the processing and marketing of their produce, and to carry out both geographical and seasonal regulation of supply so that a steady supply at reasonable prices could be maintained. By these means the uncertainty involved in agricultural production was reduced and the

foundation for increased production was laid. This had beneficial effects in previously backward areas also. Organization by the farmers themselves to solve their own problems on a voluntary basis has been much used in the other Scandinavian countries as well. Personally I have more faith in this method than in measures administered from above to help the farmers. The best way is certainly to help farmers to help themselves to the greatest possible extent. This can be done by applying co-operation in varying forms. It would also give the necessary basis for a change in the frame of mind which Dr. Johnson mentions.

P. K. RAY, *Food and Agriculture Organization of the United Nations, Rome, Italy*

While dealing with the unresponsiveness of agricultural output to declining prices the authors did not mention the effects of various support measures in retarding the reduction of supplies. I think that is important. We all know the inherent inelasticity of supply of agricultural products. It may vary in different countries, depending upon the various physical and economic factors that may be operating. But in the present world it becomes pertinent to find out to what extent this unresponsiveness of agricultural output is due to support measures, and to what extent it may be natural. Also in this connexion the paper mentions that farm prices in the United States declined about 20 per cent. from the 1951 peak. Do these prices include the costs of the support measures or are they independent of them?

S. SCHMIDT, *College of Agriculture, Cracow, Poland*

The points I should like to make may be illustrated from our experience of the supply of pork.

The prosperity of Polish agriculture in pre-war times depended to a considerable degree on exports of small grains (rye and barley), sugar, bacon, butter, and eggs. Of the world's export surplus of rye we supplied nearly 48 per cent., of barley 13 per cent., and of eggs 7 per cent. (1934-6), but one of our most characteristic features was a steady increase in pig production. It went along with the growing importance of small peasant subsistence holdings of from 7 to 12 acres. Although about 18 per cent. of the land remained in estates—'gentlemen' farms, run on a commercial basis—most of it was cultivated by small owner occupiers. For them, pigs, eggs, and butter were the most important cash products, pigs coming first.

Our hog cycle ran in periods of three or four years. But while the

ratio of prices of hogs to feed exerted a strong influence on market deliveries, subsistence farming seems to have been affected more by variations in crop yields, particularly potato yields.

According to a study made for the ten pre-war years, 1929 to 1938, total yearly yields of potatoes varied between 92 and 123 per cent. of the ten-year average. But after requirements for seed, for human consumption, for industrial purposes, and so on have been deducted, for all of which there is an approximately constant demand, the amounts left for feeding animals were much more variable than yields. Relating the quantities needed for feed to the quantities available, it was found that only 70 and 75 per cent. respectively of the supplies were needed in 1929 and 1937, while in other years there were shortages. In 1933, for example, requirements were 35 per cent. higher than supplies. In fact there were several years when they were fed at a loss. Nevertheless, by relating the cost of feeding pigs on potatoes to the costs of feeding them on rye, I have been able to show that during the same period it paid to feed pigs mainly on potatoes. Grain was used as a subsidiary food and as a substitute for potatoes in times of shortage.

After the war the situation changed. The small individual peasant remained the characteristic feature of Polish agriculture and the revolution did away with all landed property in excess of 120 acres. So the number of smallholders increased by more than 50 per cent.

Some of this increase may have been due to fictitious subdividing of land in inheritance cases. It is certainly striking that the number of farm units increased mainly in the old vojevodships, especially where custom tended to preserve farm units undivided. This was a result of the agricultural policy which prevailed up to October 1956 and which aimed at equalizing farmers' incomes and at limiting by indirect means the size of peasant farms. The farmers gradually lost interest in producing for the market, and hence too in the size of their holdings. Subdividing the land relieved them of high taxation, and they confined themselves more and more to subsistence farming, with a striking increase in pig production.

In October 1956 Gomulka, following Krushev in the U.S.S.R., introduced the new agricultural socialist planning. Compulsory deliveries with price fixing on the one hand and some black market selling on the other, make it difficult to follow the post-war development of the country as a whole. But if we look at the four vojevodships for which figures exist, we find that cyclical movements are now much less pronounced. Controls have largely succeeded. The price of pigs has been fixed at reasonably high levels with a result that they

maintain their purchasing power for feed. Prices of potatoes, rye, and barley remain low, rye suffering most. Owing to the system of price fixing it has become more profitable to feed rye than to sell it. In fact, potatoes as a feed have been displaced more and more by grain. Consumption of pork has doubled and we even have considerable quantities for export. But as the yields of crops have not increased correspondingly, the shift over to feeding grain has resulted in shortages, and we have suddenly become a grain importing country.

The U.S.S.R. and the U.S.A. are supplying us with grain, and if present trends were to continue we should be able easily to supply the whole world with pork.

V. M. DANDEKAR

Yesterday Professor Lewis made a distinction between developed and under-developed or developing economies by saying that the first suffered from food surpluses and the others from shortages. This implied that the terms of trade ought to be more favourable for agriculturists in under-developed or developing than in developed economies. I am not quite sure whether that is true. On the other hand it seems to me that the difference between the levels of living of an industrial worker and a corresponding agricultural worker is greater in under-developed than in developed economies. I was wondering how it could be demonstrated, and today's paper seems to provide some evidence. He states, for instance, that in developing economies there is an increasing use of non-farm inputs and this is because the non-farm inputs have a higher marginal productivity. I am not sure whether this is evidence that in these countries the agriculturists have more favourable terms of trade. If so, I would invite explanations from both Professor Lewis and Dr. Johnson. I am not sure either that we can say that subsistence farmers really have a different frame of mind. A subsistence farmer is not so by choice. He too tries to maximize his money income although he ends up with no more than subsistence. In India the history of fertilizers tells us that if they are available on favourable terms then farmers use them. I think their problems are their shortage of capital and their small margins which mean that they cannot easily experiment so as to improve their lot.

U. AZIZ, *University of Malaya, Singapore*

I think we should underline Professor Aresvik's stress on the need for market reform as a pre-requisite for technological progress.

Speaking particularly of the under-developed areas in South-east Asia, I feel that the analysis whereby we say that if you can move from subsistence farming to commercial farming then productivity and farm incomes will rise and so on, is all very fine if everything is functioning in a market that is more or less what the textbooks call competition, or even in an imperfect market. But, the truth is that the market is in another category altogether which, for want of a better term, I call exploitation. The people involved in the market—the merchants, the money-lenders, and also (in relation to the farmers) the landlords—do not have the classical attitude, that they want to make profits or interest or rents. Their primary aim is not these, but to acquire as much of the farmers' land and property as possible, and also their capital equipment. They do this to create monopsonistic situations and also, arising from their traditional business methods, to dominate the whole village economy. The result of these operations in the course of time is to redistribute the land and property in the village. They become more and more unequally distributed. The merchants also increase their power by controlling such processing equipment as mills or smoke houses. In a situation like that I think it is ridiculous to analyse the situation in terms of perfect competition or even imperfect competition. We require a different frame of mind not only on the part of the farmer but on the part of the economists and agricultural economists who are going to study this problem. Perhaps Dr. Johnson will enlighten us on this point.

SHERMAN E. JOHNSON (*in reply*)

A word about one or two of the questions that have been raised. First, the United States prices mentioned in our paper are the market prices, including government price supports. I realize that there are significant impediments to adjustment in many areas and I concede a lack of acquaintance with some of the special situations which Dr. Aziz mentioned. In the preparation of this paper we may have been guilty of some broad generalizations that do not fit specific situations.

I agree with Professor Aresvik that there is great need for the types of programme that he mentioned. We said in passing that we were not aware that any country had really solved the problem of equitably sharing the benefits of technological advances. What we should do is to concentrate research on problems of this type. Agricultural economists must realize, of course, that the actual policy decisions fall in other hands, but we can do a great deal to develop foundations for programme development.