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THE INTERACTION BETWEEN TECHNICAL CHANGE ON THE FARM AND TECHNICAL CHANGE IN MARKETING AND DISTRIBUTION

(*a*) FARM CROPS

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THROUGHOUT the world we are now in the midst of a technological revolution in farming of unprecedented scope. This development has been continuous in the West since the Industrial Revolution. Probably at no time has the *tempo* been so fast as during the post-World War II period. In other parts of the world technological change promises to lend a dynamic character to economies which have been almost static for centuries. Our problem is to discover and interpret the place of the industrialized farm in the larger context of the total economic and social structure of the economies concerned.

In order to describe the farm organization which has adjusted to technological change and in which has developed a rational programme of production for the market, I propose to use the term 'industrialized farm' for lack of a better one. By market I mean the organized facilities available to the industrialized farm in which goods and services may be bought or sold for a price. Included are the markets for labour, supplies, custom services, and products. Too often economists as well as others have made a direct approach to farm industrialization only to discover the limitations imposed by the stage of industrialization of the non-agricultural segment of the economy.

Perhaps it will be in order to review rapidly and, necessarily superficially, the historical progress of the Industrial Revolution in the West as it relates to agriculture. Trade was, in general, a precondition of the evolution of an industrial economy. In western Europe this was confined in the main to accessible coastal areas. It resulted in early product differentiation and specialization which, in turn, made necessary a market organization to implement profitable exchange. Invention and application of invention to industrial processes came along and manufacturing increased. Trade grew with

supporting areas from which raw materials were drawn. As interior communication and transport developed, these changes penetrated into the back country.

Agriculture in England during the period 1730 to 1914 profited from the rise of the industrial power of the State in many ways.[1] Of great significance was the availability to agriculture of the scientific and technological advances made in industry. British agriculture produced many leaders in the field of scientific change, from Jethro Tull and Lord Townshend in the early eighteenth century to Lawes and Gilbert and the Rothamsted Experiment Station in the nineteenth century, but the rise of native industry was essential to the production of those tools and other requirements necessary for general technological change in agriculture. It may be seriously doubted whether scientific progress in agriculture and its industrialization in England could have been achieved without the development and continued presence of British industry. Conversely, British industry was much indebted to the agricultural sector. British agriculture was a constant source of labour for new and expanding industries.

In modern Germany scientific farming came only after the Zollverein (Customs Union) made possible the rise of industry and the knitting together of the total national economy by railroad. Technological changes in agriculture came only with the increased production of industry.

The important historical lesson is that the industrialization of agriculture followed rather than preceded industrialization of non-farm production. In large measure agricultural technology has been borrowed from the cities where the early applications were made. Tractors, pumps, electrical devices, refrigeration, buildings, chemicals, fertilizers, insecticides, and antibiotics were developed in most instances from products originally manufactured for industrial or consumer use. The recent rapid growth of nitrogen fertilizer production is a case in point. The original research and development was for war purposes. The developments in the application of atomic energy seem destined to follow a similar pattern. Also, the agricultural experiment stations have been most productive where they quickly found an agricultural application for fundamental research, devices, products, or techniques developed or used elsewhere.

Most of us have a strong agricultural bias. In the United States 'agricultural fundamentalism' has penetrated deeply into the thinking

[1] For assistance in this historical analysis, I am indebted to M. L. Flaningham, Professor of Economic History at Purdue University.

and policies of persons responsible for technical assistance to agriculture. It is often accepted as axiomatic that in agrarian economies the place to start raising standards of living is with the food supply. Once this premise is accepted then it is logical to conclude that the way to increase the food supply is by mechanization, new techniques, better practices, better seeds, animals, sanitation, fertilization, and the like. This, however, is exceedingly difficult to accomplish within the traditional framework of the agrarian economy. The several parts of an industrial society give mutual support to one another. The whole evolves together, but the urban segment is generally in the vanguard.

The rate of capital formation in agriculture is slow. In new areas in the West where farm industrialization is far advanced the rate is more rapid, especially in times of inflation. However, in older static agrarian economies the annual savings which can be squeezed out of agriculture in good years are likely to be dissipated in years of adversity. In such economies there are four possible sources of capital funds: (1) accumulation in the hands of a few wealthy families; (2) borrowings from abroad; (3) accumulation by the State through taxation or confiscation; and (4) accumulated small savings in the hands of operating farmers. Capital once acquired may be used to finance either urban or agricultural industrialization. In economies which have a promising industrial potential there is little doubt that most progress can be accomplished by applying capital expenditures primarily in urban industry. In economies without promise of competitive industrial development industrialization of agriculture can proceed in the long run only on a basis of trade which creates the purchasing power to finance it.

In this situation, agricultural industrialization is likely to have either or both of two expressions: (1) technological applications to the typical small self-sufficient farm for which capital requirements may not be large if carefully planned. The farms emerge as more efficient units from which limited surpluses are available to market. (2) Technological applications to large highly industrialized farming operations primarily concerned with production for export.

Industrialized agriculture results in production surplus to the immediate needs of farm families. Product specialization is a necessary phase of this development. Industrialized farming results in mass production which in turn requires mass distribution and mass supply of the requisites of the mechanized farm.

Agrarian economies, with the possible exception of new settlements, have excess labour once mechanization begins and this will remain a major problem unless there are alternative employments,

while static agrarian economies have excess population and underemployment.

If in such circumstances there is first a development of urban industry, the agricultural labour force can be reduced considerably without any appreciable reduction in farm output. The net amount of product available for the market may actually increase.

One of the difficulties in effecting a programme of industrialization of farming arises through the traditional immobility. The causes of labour immobility include lack of communication transportation, and informational inertia resulting from family and property consideration, race, religion, and unwillingness to discard a poor but sure position for the promise of a better but less certain one. A difference in economic opportunity must exist to provide incentive for movement. This means that the income from labour must be less in agriculture than in industry, for comparable skills.

In 1921, in a study of the movement of farm population, I derived a formula from the data for 3,649 persons on or from farms in New York State.[1] The formula, $M=K^F/D^2$, in which M is the movement of population, F is the intensity of attraction from another community, and D is the distance from the farm of origin. After formulation it turned out I had rediscovered the law of universal gravitation. Recently, I have reviewed these studies with my engineering associates at Purdue University. We believe the flow of population conforms to the same laws which express flow relationships in the physical world. The elements are Impedance, Difference in Potential, and Distance. Total Impedance is the sum of the various interferences to population movement, including transportation and communication interference, cultural and institutional inertia, and geographical and institutional factors related to family, religion, race, and property. Total Impedance then becomes (K) in the preceding formula.

The Difference in Potential is the pressure engendered by the difference in force exerted on the labourer by the local farm employment market, and the labour market in the area to which the person might be expected to move. Such factors as wage differentials, security, size, and character of the communities, opportunities for education, entertainment, and the like, as well as the nature of the alternative employments with regard to interest and skills, determine the Difference in Potential. Difference in Potential then becomes (F) in the preceding formula.

[1] E. C. Young, 'Movement of Farm Population', *Cornell University Experiment Station Bulletin* 426, 1924, pp. 28–29.

There are two theoretical variants of these patterns which I wish to present for your consideration.[1]

1. Population flows in a straight line. This condition is approached when a valley is the only practical outlet, the valley being agricultural with a city at the valley mouth. Ordinary circuit theory suggests that the flow of population varies directly with the Difference in Potential and inversely with Distance.

2. Population flows in a plane. This condition is approached in the United States and in other areas where communication and transport are available and equally costly in all directions. In this case the movement of population varies directly with the Difference in Potential and inversely with the square of the Distance. So far as I know, there is no statistical proof for my first hypothesis, but there is adequate statistical evidence to support my second.

I would like to carry this analysis one step farther and suggest that the flow of technology and the penetration of urban influence into agriculture conform to the same laws.

Evidence supporting this thesis is presented in a brief summary of analysis by B. R. Bookhout and T. W. Schultz.

In 1942 B. R. Bookhout compared labour and equipment utilization in two central Indiana counties. White County was an agricultural county without much urban influence. Madison County is the centre of a substantial industrial development. His conclusions are summarized, as follows:[2]

Madison County was more industrialized than White County. As a result of the influence of industry, the farms in Madison County revealed:

(*a*) Less total family labour.
(*b*) Less work done by the operator's wife and children of school age.
(*c*) Fewer sons working full time at home.
(*d*) More regular hired labour coming from distant areas.
(*e*) Greater use of part-time farmers for special labour.
(*f*) Earlier adoption and greater use of tractor power and equipment.
(*g*) Closer adjustment of labour requirements to labour force.
(*h*) A greater amount of outside work of a non-farm nature.

[1] For assistance in this analysis I am indebted to P. F. Chenea, Professor of Engineering Sciences at Purdue University.

[2] B. R. Bookhout, 'An Economic Study of Farm Labor in Indiana', *Purdue University Agricultural Experiment Station Bulletin* 478, 1942, p. 2.

T. W. Scultz stated the relationship in a series of hypotheses:[1]

1. Economic development occurs in a specific location matrix; there may be one or more such matrices in a particular economy.
2. These Location Matrices are primarily industrial-urban in composition.
3. The existing economic organization works best at or near the centre of a particular matrix of economic development and in those parts of agriculture which are situated favourably in relation to such a centre.

Perhaps the greatest incentive for farm mechanization comes about when alternative opportunities for labour result in agricultural labour shortages and increased wages through competition from the urban-industrial segment.

I wish now to proceed to the analysis of recent technological progress in farming in the United States and from this to a more detailed analysis of the interdependence of agriculture and the industrial community.[2]

Technological progress offers opportunities for farmers to reduce costs, which opportunities have been only partially realized because of the lag in applications resulting from ignorance, conservatism, lack of capital, or lack of imagination. Yet, the first to make practical use of these new opportunities for cost reduction reap a golden harvest because the period before the new technique is generally adopted is one in which prices result from competition based on the old input schedule.

The increased control which the farmer now has over production allows him to proceed with increased confidence that results will come about according to plan. On the other hand, farms which have not or cannot make use of the new technologies are destined to lose out in the competitive struggle. Some will be absorbed into efficient operating units. Others will sink to a greater degree of self-sufficiency.

Improved technology has made it possible (1) to produce according to a predetermined schedule, (2) to achieve greater grade uniformity, and (3) to produce according to a predetermined specification of grade and quality.

In order to carry through successfully a production programme

[1] T. W. Schultz, *The Economic Organization of Agriculture*, New York, McGraw-Hill, 1953, p. 147. See also 'A Framework for Land Economics—the Long View', *Journal of Farm Economics*, vol. xxxiii, May 1951, pp. 204–15.

[2] At this point I wish to acknowledge my indebtedness to my associates, R. L. Kohls and V. W. Ruttan, who assisted with the analysis. See also V. W. Ruttan, 'The Impact of Urban-Industrial Developments on Agriculture in the Tennessee Valley and the South-East', *Journal of Farm Economics*, vol. xxxvii, Feb. 1955.

wherein maximum use is made of these technologies, radical changes in farm organization are required. Greater use of specialized equipment and larger capital inputs generally lead to product specialization or to a much narrower range of diversification. Supplementary enterprises are retained only if they make use of by-products or other resources that would otherwise be unused.

The developments just described require many new and specialized services and functions on the farms or in the communities. They have resulted not only in substantial modifications in the organization of farms but have effected entire communities, since many services can best be supplied on a community basis.

There is developing in commercial farming areas in the United States an increased specialization of functions, a discussion of which may be useful.

A. *Management*

Until recently substantially all management decisions were made by the farm operator or the landlord. There is now a growing trend towards specialization in the management function. Farmers not under the supervision of professional managers are delegating or sharing the management function. The Extension Service in many States has gotten into management through co-operative accounting and farm planning associations. The Farm and Home Administration and the Soil Conservation Service of the United States Department of Agriculture have furnished specialized managers who direct or assist in the planning of co-operating farms. Marketing agencies provide management service and frequently dictate the production programme.

B. *Ownership*

At one time ownership tracts and operating tracts were likely to be identical. Now, real progress is being made in the formation of efficient operating units which may include tracts under more than one ownership. The basis of operating outlying tracts under separate ownership offers many unsolved problems but the economies are large. As a satisfactory basis for combining tracts for operation is developed, a degree of flexibility in the organization of agriculture is achieved which contributes greatly to the economy of production. In the dynamic situation in which we find ourselves no pattern of land use can continue long without modification. The existence of

numerous tracts of varying size and quality offer an opportunity for easy evolution in land use.[1]

C. *Operations*

1. *Labour*

Traditionally, farm labour has not been specialized, but with the developments indicated, there has been an increase in the demand for workers with specialized skills. These workers may not be associated with a single operating unity but may more often be found in a custom service organization.

2. *Custom services*

The use of custom services has grown rapidly with the spread of technology and the development of commercial agriculture. New methods often require large outlays of capital for equipment which for its most efficient use requires a volume in excess of that furnished by the typical farms of the community. Milling has been a farm custom service since the Middle Ages. From it has evolved the present-day grain, feed, seed, and supply service agency. Following is a partial list of important custom services in the corn belt.

(*a*) Crops—Combining, baling, ploughing, weed killing, fertilizing, liming, seed treatment, seed production, silo filling, irrigation, fruit and vegetable harvesting and processing, spraying, and dusting.

(*b*) Livestock—Feed processing, immunizing, disinfecting and spraying, artificial insemination, producing breeding stock, incubation, breeding, shearing, and castration.

(*c*) Maintenance—Construction, cement mixing, fence building, ditching, terracing, clearing-machine maintenance and repair, welding, blacksmithing, and painting.

3. *Soil management*

From technical advice and education through the Extension Service we rapidly passed to action programmes designed to bring soil management service to farms through soil conservation districts, drainage districts, and Federal Agricultural Conservation programmes. A substantial part of soil management seems destined to pass into other hands than those of the operating farmer.

[1] E. C. Young, 'The Social Implications of Economic Progress', *Proceedings of International Conference of Agricultural Economists*, 1938, pp. 97–102.

4. *Crop and livestock quality control*

Marketing agencies influence farm production through their development and administration of specifications for products to be marketed through the organizations or bearing the organizations' labels. These marketing agencies may provide an inspection service, and also some essential services, such as certification of seeds and breeding animals, processing, spraying, dusting, rouging, culling, disease control, grading, and packaging. Around a marketing agency organized to sell specialized products there is likely to grow up a whole array of special service agencies directly controlled by or closely related to the marketing agency.

Enough has been said to indicate the profound effect that these changes have on farm organizations. Some persons believe that the family farm cannot survive long in this environment. In the United States there is a little evidence to support this view. Commercial family farms have continued to increase in size but the labour force per farm and in total has actually decreased. In any event, there is freedom to organize large operations if and when they can meet the competition from the family farm.

Most of the services that I have discussed can be provided more cheaply on a community basis than on individual units. The reason is that the area that can be economically served varies so greatly among the services that no farm turns out to be the proper size for the most efficient use of all services. The continual evolution of technology also necessitates continual reorganization of the services. The community arrangement provides a degree of flexibility not present even on large farms. This interdependence is characteristic of American industry. One of the world's largest and most diversified manufacturing corporations reports that 51 per cent. of their sales dollar goes to 21,000 suppliers of goods and services.[1]

There must be radical changes in the methods of operation employed by many farmers. The increased capital requirements essential to the application of new technology and the increased use of custom services make the traditional methods of renting difficult to administer. Capital invested in new facilities should, under ordinary circumstances, yield a high rate of return. Too often, improvements that would aid the economy of farm operation are postponed because the benefits do not accrue to the proper party under the terms of the lease.

As farming in the United States becomes more completely in-

[1] Statement by Harlow H. Curtice, President of General Motors, before the U.S. Senate Committee on Banking and Currency, 18 Mar. 1955.

dustrialized, the interdependence within the industrial community becomes clearer. Neither an industrialized farm nor a factory can live by itself. On the one side is a highly organized system of supply of raw materials, equipment, and services which take an ever-increasing fraction of the production dollar. On the other side are found fully integrated services in marketing and distribution of farm products.

Changes in consumption have accompanied revolutionary changes in farm production. Freezing has reduced the perishability of products which sell in competition with fresh products. Frozen products can be held for a longer time and be produced farther from market. These developments have already led to important shifts in production areas. It has permitted greater regional specialization and encouraged the growth of larger, more completely industrialized farms.

The chain of integrated agencies and services in the frozen food industry extends from the special production services available to the farmer through farm production, processing and freezing on the farm or at nearby plants, packer warehousing, sales, transportation to distributing centres by refrigerated railway cars or trucks, terminal or distributor cold storage warehousing, local distribution by insulated trucks to retail food stores equipped with cold rooms and refrigerated self-service counters, and finally to the consumer's refrigerator or home freezer. Included among the food-store customers are farmers who buy to stock their own deep freeze units with mass-produced fruits, vegetables, and meats. Home butchering, home canning, and the home garden and orchard have declined rapidly as the industrialized farm has emerged as a specialized commercial unit.

Similarly, but less spectacularly, all crops, including the grains, fall into a similar pattern.[1]

These developments are not possible without a complete network of communication and transport. Almost every commercial farm in Indiana has wide access to markets on improved roads.

There are in the United States 3 million miles of improved roads occupying over 17 million acres of land and built at a cost of 55 billion dollars. (Replacement cost would probably be three times this amount.) This constitutes an investment (at present prices) of $1,000 *per caput* on about $\frac{1}{8}$ acre of land. The present rate of expenditure on rural highways in the United States is at the annual rate of about 4 billion dollars, about half of which is for maintenance.[2]

[1] For a detailed description of these developments, see U.S.D.A., *Technology of Food Marketing*, Agricultural Monograph 14, Oct. 1952.

[2] For these estimates I am indebted to K. B. Woods, Professor of Highway Engineering at Purdue University.

Large capital outlays are needed to effect farm industrialization. Farm-capital expenditures for buildings, drains, fences, and machinery may far exceed the value of the bare land. In addition, community-capital investments in roads, utilities, transportation, and farm services are very large but difficult to calculate, since they serve the whole community.

Food distributors have been quick to take advantage of the improved products as they become available. Long before farmers had made much progress in product specialization or in standardizing quality, distributors had learned how to lower costs by mass distribution of products standardized by processing. As new production techniques made possible more uniform products, these low cost methods of distribution were extended to fresh perishables—fruits, vegetables, potatoes, nuts, dairy products, and meats. As a general rule, whenever a product can be offered to the consumer in uniform grade and individual packages, the distribution cost can be reduced. These developments in marketing have increased the opportunities for commercial farmers to increase their output of uniform products designed for specialized markets which demand large quantities.

In order to accomplish an economic organization such as I have outlined, a one-class mass market must develop. Only in this way can the economic potential of an industrialized agriculture be realized. According to H. P. Whidden, western Europe is well on its way towards the development of such a market. The speed and extent to which this can be realized in the 'open' economies of western Europe have yet to be tested.[1] The one-class mass market assumes both a demand for rural labour in other industries and a strong economic demand for the products of agriculture. Without these two elements industrialization in agriculture will lag, even with the existence of urban 'islands'.

In conclusion, I would like to stress that in farming and industry methods, techniques, machines, and processes, as well as institutions, must adjust quickly to changing technical conditions in order to maximize the returns from research and development. If a country cannot meet this requirement, then it must be content to fall behind in the competitive struggle for markets. It must then accept a lower living standard for its people than is possible if opportunity is taken to exploit to the full the products of its laboratories.

[1] *C.R. du congrès de Brest de la confédération nationale de la mutualité de la coopération et du crédit agricoles*, 1954; and Jules Milhau, *Rapport au congrès de Nice de la confédération nationale de la mutualité de la coopération et du crédit agricoles*, 1955.

(*b*) MILK

J. L. DAVIES

Milk Marketing Board of England and Wales

IT is not my purpose in this paper to discuss the theoretical basis of this theme, but I shall listen with the greatest interest to the observations and conclusions of the economists. Their thoughts will be followed with the closest attention by persons who, like myself, are engaged in the field of organization of marketing of farm products. We are established, perhaps in a unique position, to promote, to influence, sometimes to catalyse, always to observe this interaction of technical changes on the farm and in the market. We have the difficult task of trying to serve two masters, the producer and the consumer, and sometimes the Government is close enough to make the number three.

There is a growing band of people, taking the world as a whole, who are concerned like myself with the supervision and organization in varying degrees of the marketing of farm products. It is not necessary here to describe the various types of marketing organization; it is sufficient to say that whether these are sponsored and organized by governments or by the producers themselves their problems are similar and the direction in which their functions become effective is much the same. The great voluntary producer co-operative movement in many countries is one example, although this is by no means homogeneous in scope and effort; the variety of marketing organizations mainly sponsored by governments is another. In our own particular organization we have tried to borrow from both and we hope that we have taken only the best.

The operation of a constant interaction of technical changes is certainly affected by these organizations and it is further much influenced by the policies and planning efforts of governments in the fields of agriculture and food, and indeed in the wider fields of national and international trading. We are already far away from the simple concept of the farmer and his market.

There have been many examples of national and some international policies in recent years which have been designed to bring about planned results in milk and milk product markets. Politics, economics, and sociology are variously emphasized in the design and pattern of these efforts, and I refer to them at this stage in order to show that the relatively simple economic analysis of interaction between farm

and market no longer obtains. Marshall, commenting on Ricardo's theory of diminishing returns, wrote that Ricardo did not allow enough for the increase of strength that comes from organization. 'In fact', he said, 'every farmer is aided by the presence of neighbours whether agriculturists or townspeople.' How true this is of the mid-twentieth century. The instrument of market price in its effect on the farm and market has of course not disappeared but it is much modified. And in the policies of full employment pursued in most countries the cushion generally provided for farming makes it difficult to analyse and separate the economic factors. Personally, I do not regret the passing of the purely economic discipline of the market in milk and agriculture generally. Its action and interaction often created hardship and I doubt whether in the long term it brought the benefits which the economist argues that it should. Even if it did, the cost in human effort and misery of farmers and land workers in the world was considerable and I believe it is fair to say that the doctrine of *laissez faire* can expect no respect and regard from farming communities. Of course, these new influences do not affect milk alone—they obviously apply to other products—but they are very important and their effects should be studied.

It is important also to know the industry in which they operate. Milk-producing farms in most countries have certain common features and so have milk markets. The outstanding feature, however, is that milk is produced mainly on small farms, or farms which are smaller than average. I believe this to be true even of the United States and Canada. The description small obviously varies in the different countries and a twenty-cow small herd in the United States may be regarded as a fine big one in European countries. In our own country where the farms are not generally regarded as small, the milk side is a very prominent part of our farm enterprises. One in every two farmers sells milk and the output of milk accounts for a third of the total output measured in money terms. The average size of the milking herd is about sixteen cows, and 40 per cent. of the milk is produced from herds with fewer than twenty cows. This fact of smallness in the milk-producing farm units has a most important bearing on our subject.

Economists may argue that a great effort should be made to amalgamate these holdings into large and efficient units for milk production. There are some of these, and politicians in some countries dream of many more. But I do not foresee a great revolution in this queer mass of small farms in our own country and in Europe in this century—and that is looking far enough ahead for our

purposes. There is no doubt in my mind that the larger units in milk production are more efficient measured in economic terms, perhaps much more efficient if the real human effort on small farms could be measured properly and evaluated. The large number of small units are a main cause of the wide variation in costs of production of milk on individual farms. The range must be very wide where the units are so many and vary so much in size. Their degree of response to technical changes probably shows a similar variety, tending to make the average response slow and the organization rigid. The shortage of capital which is inevitable in the small unit, in conjunction with the very much greater capital requirement in relation to output on the small units, necessarily retards the interaction of which we speak in this session.

Another feature of our milk farms which also has an influence on our topic is that they are the family farms *par excellence*. They are the holdings also where the family works seven days of the week—a most unusual event in these technically efficient days. This family unit is almost unique in that it is still prepared to work the seven-day week and the milk business exploits most fully and effectively the potentialities of the labour of the whole family. A high proportion of the milk produced in the world still comes from this very large number of small family farms, and without their efforts we should all be seriously short of milk and dairy products. It is also a well-known fact that the input of labour in milk production remains high under most conditions. The small unit and the work of the family probably tend to restrict the speed of mechanization on milk farms, but the nature of the operation in most countries requires and will continue to require a relatively high labour input.

The returns from the markets for milk, however, are comparatively certain and stable and it is probably true to say that the risks in this part of agriculture are less than in most. This undoubtedly has quite an influence in making milk production the province of the small family farmer.

A third feature which applies to dairy farming in the United Kingdom and a number of other countries is the growing degree of specialization. This no doubt is due to economic factors: the rising standard of living of the community, the trends towards guaranteeing markets by organizations, the cheapness of transport. The general use of the internal combustion engine in road haulage has given countless farmers their opportunities to sell milk. This was followed by the development of tank transport for milk for liquid consumption and now we are on the edge of another great improvement in the

application of the tank principle to the handling of milk on farms. When the engineers and scientists perfected the technique of pasteurization of milk they solved many problems of perishability in milk and this had the widest influence on the problems of supplying milk to large city communities.

This is the pattern, and it provides a service of milk and milk products in many countries which has reached a very high standard of economy in the fuller sense of that term. It must be admitted, however, that the small specialized dairy units tend to give a degree of natural rigidity to the industry, and it can be argued whether the modern marketing organizations and State intervention improve or retard flexibility and change on the farms. The economists, no doubt, will tell us whether technical changes in the milk industry have been greater or less than in some other branches of food production, whether they have been insufficient, and what the causes are. The question is whether changes have occurred with sufficient rapidity to promote that measure of efficiency in this branch of farming which would be expected under prevailing economic and other conditions.

To endeavour to answer this point I turn first to the marketing and distributing aspects of the industry. Do the technical changes which should arise from the general progress of scientific methods in industry take place as rapidly in the milk industry as they do in other branches of economic effort? I see no good reason why they should not. In our own country certainly the milk industry seems to be fully abreast of other branches of industry and trade as far as technical efficiency is concerned. Once the milk has been taken away from the farm, transported, and then bulked in large quantities, modern large-scale methods involving heavy capital investment apply to milk as they apply to beer or to oil. These three liquids have many similar problems in handling and processing and in fact the engineering methods used are very similar and much of the equipment for these purposes is made by the same manufacturers. The passage of market information, the interpretation of consumer demand through the price mechanism, are in no way exceptional in the milk industry. In Great Britain we have today a service of bottled liquid milk delivery to all households every day. This is a business with high labour input also and gives rise to problems under conditions of full employment. The distributive side, however, has been subject to considerable rationalization and compared with conditions twenty years ago it is highly efficient.

It is at the farm end, however, that most difficulties arise in the milk industry. In England and Wales all milk sold off farms must be

sold through the agency of the producers' Board. All milk offered by producers has to be accepted, and in these days there is, with government help, a guarantee of price. The Board, which is the channel through which all milk is sold and all milk producers paid, is controlled by the producers. Whilst the Board in the early stages confined its efforts to the marketing side, it was even then able by price adjustments and inducements to influence technical changes on the farms. In more recent times the Board has been active in assisting producers in other directions. It has reorganized the whole of milk transport from the farms and taken the responsibility for haulage, with substantial consequent savings and improvement in the service. When the technique of artificial insemination of cows became practicable the Board organized a service to all producers of milk, investing more than a million pounds sterling in the enterprise. This year one-half of the dairy cows are subject to artificial breeding.

I will not labour this point but it is an example of the value of a marketing organization in promoting technical changes on farms. Such an organization can do much in my view to offset the basic weaknesses of small farm units and I hope that organizations such as ours will be widening still further their field of endeavour. The key, however, is capital. Small producers individually have very little, and they suffer accordingly, not only by producing at high labour costs but by persisting in low standards of living. Collectively they have a great deal of capital, and more credit, and it is this fact that our own marketing organization has tried to exploit to the advantage of the host of individual producers.

The edicts of governments concerning conditions on dairy farms may be less obvious but they have also an impact on technique. The regulations of the health authorities in the United States, for example, regarding milk supplied in liquid form to towns and cities always interest me because of their influence on the economy of farms which do not comply with the standard conditions.

Although the liquid milk business in most countries is isolated within national boundaries, it is affected by international trading in dairy produce, particularly butter and cheese. Dairy products contain milk in a form that allows for storage and transport over long distances and it is here that markets change quickly and have their most rapid and violent reactions on dairy farms. By comparison, for example, the task of supplying liquid milk to an industrial community like the United Kingdom is a relatively stable one. At the present time there are a number of other most important market influences at work. In the United States, for example, skim milk powder is

available in attractive packages and at a relatively cheap price to tempt the consumer of liquid milk. Consumption of cheese has also been increasing there while the demand for butter has fallen heavily. There are many other movements in markets and, in current conditions of full employment and demand, we cannot see how they will reveal themselves under other conditions. Above them all are the uncertainties of the demand for and supply of milk products in the next few years, particularly in the Asiatic countries.

Mention has been made of the increasing degree of specialization on milk-producing farms and its possible effect, in the prevailing pattern of small family farms, on the rigidity of the farming system. Organization and State intervention may be both the cause and the outcome of specialization, but the next logical step appears to be specialization and organization on an international scale. As I said earlier, marketing organizations are growing strongly in many countries and it should not be long before it is possible to have much more combined action by them. We are already doing simple things with organizations similar to our own, which have a great interest in British markets for dairy produce. It will be a comparatively short step to a closer link and a more co-operative effort between milk-producer organizations in Europe, with the object not merely to talk but to act together. Organization on such a scale cannot fail to affect techniques.

Having said this, I must add that I do not minimize the possible benefits of government action on a national and international basis. The great need is for new capital investment on hosts of small farms producing milk for sale—to replace fixed capital which was invested to a large extent very many years ago, but which the low earnings of producers have not enabled to be renewed in the usual way. Here is a big industry with some millions of farmers dependent upon it, which provides a most important food service. It is an industry which seems to me to require a great deal in the way of marketing organization and government assistance to enable it continuously to keep in step with technical changes in the worlds of industry and trade. Up to now only the first steps have been taken towards this goal—but even these show clearly that benefits accrue to producers of milk everywhere. Our own experience shows also that there is tremendous support from producers for organization on these lines which takes away their individual freedom to market their produce. Confidence in the market should be the reward for organization and this is a first requirement before technical changes occur in an industry consisting of small family units. Successful organization in many

countries will make the way for international efforts. And as I see them the world problems in our own milk industry give to these countries infinite scope in the next decades.

(*c*) LIVESTOCK

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ALTHOUGH there may be considerable causal connexion between technical changes in production and in the distribution and marketing of field crops and milk, in the case of livestock the relationship implied in the title of this paper has little meaning and, in fact, may well be considered non-existent.

The great impetus to industrial production was given by the development of steam power. Similarly, the great impetus to agricultural production was given by the introduction of power to the individual farm and later by technological advances. As one prominent agriculturalist in the United States has pointed out, however, the cattle producer is at the bottom of the list as an effective user of power and technology.[1]

The main types of change in livestock production which have taken place in recent years may be divided arbitrarily into three sections: development from the standpoint of feeds, development in breeding and nutrition, and development in the control of diseases and pests.

With regard to the first, one of the most striking has been the increased utilization of pastures in Australia and New Zealand, due particularly in the latter country to an extensive use of aerial top dressing, as a result of which livestock have been carried farther up on the hills so that the emphasis is no longer principally on sheep and pigs but includes the production of beef.

There has generally been a spectacular rise in meat production during the last twenty-five years, due in large part to increases in the production of feed grains and forage crops. Hybrid corn, increased use of fertilizers, and mechanization of farming have added to the supply of feedstuffs. Pearson and Myers point out that associated with the added efficiencies with which these have been utilized, there has been a 'spectacular decrease in the "real cost" of producing live-

[1] *Canadian Cattlemen*, July 1955.

stock and livestock products' which, passed on in the form of price concessions, has contributed to an increased consumption.[1]

In so far as breeding is concerned, technical change in livestock production has lagged far behind similar improvements in plants. E. W. Stringan, Chairman of the Department of Animal Science of the University of Manitoba, attributes this to three main causes:[2]

1. The biological nature of the material. The cycle from birth of one animal to birth of the succeeding generation is largely a chronological one and cannot be markedly changed. True, some animals can produce two or more sets of progeny a year and thus stagger the generations but this is only a partial improvement.

2. In animals you are dealing with a more complex individual where a greater number of phenomena, even psychological ones, come into play. In economical production, the fact that market animals are often dependent upon their parents *in utero* or as sucklers for the larger part of their lives (beginning with conception) complicates the problem.

3. The propagation of the seed stock is dependent on a large number of breeders who can have a greater effect on the strains than the originators. Once established with a breed or strain it is difficult to get them to adopt improved strains at a later date.

Although livestock improvement has been slow, it has been definite; the experiments in cross-breeding which have developed the Santa Gertrudis and Brangus breeds are examples of successful breeding for special environments. Developments in artificial insemination have been spectacular. So far as meat animals are concerned, its use has been somewhat restricted but its potentialities are well known. Through the use of artificial rearing and consequent early weaning, the number of litters of pigs per year has been increased and the use of growth stimulators and antibiotics has also hastened efficient development for market.

With respect to the third type of change, an outstanding one has been the reduction of rabbits in Australia through the spread of myxomatosis, which it is estimated has raised average fleece weight by nearly 2 lb. in two years, in addition to increasing pasture carrying capacity.

All the foregoing are either direct technical changes in farm livestock production or are technical developments having a direct bearing on such production. They are not the result of any technical change in marketing or distribution and have taken place or been developed

[1] F. A. Pearson and W. I. Myers, 'Distribution of Housewives' Food Dollars Between Farmers and Middlemen', *Farm Economics*, Cornell University, Mar. 1955, p. 5266.

[2] E. W. Stringan, *Canadian Grain Journal*, Apr. 1955, p. 16.

independently of such, in an endeavour to produce more cheaply or to utilize factors of production to a better extent than formerly.

Let us then look at the changes which have taken place in marketing and distribution to see if there is any direct connexion between them and farm production. There are two main types—organizational and structural changes, and scientific technical developments. Under the former heading might be classed the development of producer marketing boards, such as the Fatstock Marketing Corporation in the United Kingdom, the New Zealand Meat Producers' Board, and the development of State trading or State-controlled trading in some countries, such as Argentina. Technical changes might include such matters as grading for wholesale and retail sale, canning, refrigeration for transporation as well as for retail distribution and, allied with the latter, the development of quick freezing.

It would appear that if there is any interaction between technical change in production and technical change in marketing and distribution, the impetus would come from a change in marketing, as it is in this sphere that the more obvious changes have taken place.

Originally, the extent of livestock production was limited by the distances which animals could travel on foot as they were taken by drovers to slaughtering points near the centres of consumption. The first major change in this process occurred with the development of rail transportation, which facilitated both the movement of animals and of the resultant product. Special cars were designed particularly for range cattle, but they had their limitations; and in North America the location of processing centres was determined by the limits within which livestock could be moved profitably by rail. Hence the growth of the packing industry of the middle western States, halfway between producer and consumer.

The first refrigerator railway car was designed in the United States around 1885. This enabled the packer to ship meat instead of livestock to eastern markets. The modern insulated car was developed some twenty-five years later, enabling shipments to be made in extremes of cold as well as in extremes of heat. Refrigeration meant that processing plants could be located nearer to the centres of production and thus led to a wider dispersal of the packing industry. Meat could now be shipped long distances, even overseas, a development which opened up the world as a market for producers in remote areas—a market limited only by government regulations.

Along the chain from producer to consumer, a number of intermediaries have operated in various countries. Many farmers could not follow their stock to market and turned them over to commis-

sion agents to sell at the collecting points by private treaty or by auction. Stockyards, often described as 'hotels for livestock',[1] built first as stopping-places for watering and feeding, became centres at which buyers and sellers could trade.

Later, the trend in North America towards a more stable form of mixed farming with a greater proportion of the livestock produced in smaller numbers on smaller farms created a transportation problem. By 1930 nearly 50 per cent. of all railway livestock cars loaded in Canada carried an assortment of cattle, calves, pigs, or sheep—a situation which was neither satisfactory nor economic. This difficulty would not be likely to arise in a country such as Denmark where farms are all relatively close to strategically located slaughter-houses. The motor-truck solved the problem in North America and either brought the buyer closer to the farm or enabled the smaller farmer to ship directly to the processor or stockyard without having to make up carload lots for rail transportation. In many cases drovers, stockyards, and commission men were by-passed and by 1948 over half the livestock marketed in Canada was sold direct to the processor.

Although the changes in transportation have been far reaching, it is questionable if any of them have had any direct responsibility for technical changes in methods of production. It is true that technical advances in refrigerated shipping, for example, opened up the British market to chilled beef from South America, Australia, and New Zealand and brought about an expansion of the livestock industries in these countries, but I would be interested in hearing from the representatives from those countries whether or not such expansion brought about any comparable change in livestock production.

Between the time of production and its marketing in a processed form, livestock obviously differs fundamentally from either grain or milk. The storage life of the end-product, meat, is less than that of grain, or perhaps even of certain products derived from milk. At all times it is perishable and whilst milk may be used to produce a variety of products, livestock, within the terms of this paper, produces only meat. Stock cannot be held for sale without deterioration and therefore differs drastically from grain in that respect. Therefore, at the point where livestock differs most from grain and milk a situation has developed, in North America at least, where the livestock processor or packer will clear the market at all times and will, at a price, take everything the producer wants to sell, regardless of type, weight, or quality or whether the processor wants or needs

[1] M. Rachlis, *The Structure and Operation of the Canadian Livestock Marketing System* (reprint), Economics Division, Canadian Department of Agriculture.

it or not. This, I believe, is one of the main reasons why there is no direct connexion between technical changes in production and technical changes in distribution and marketing of livestock.

With modern methods of retailing, the consumer is offered an ever-widening choice, especially of livestock products, and variety of services. These developments should enable the consumer's preference to be reflected through to the producer and thereby direct his use of technological advances. Ideally, the consumer would indicate to the retailer his preference by his purchase. The retailer, in turn, would indicate to the wholesaler or the processing plant, and they would attempt to indicate to the producers what was in demand and what was not. The fact that the processor clears the market, however, blunts this evidence of the consumer's reaction.

The most important change in distribution has been in the field of retailing, where self-service and pre-packaging have become the normal method of presentation to the consumer in many countries. It is generally thought that this might have a bearing on livestock production. However, one of the largest chains of super-markets in North America advises that:

> As a general statement from our own experience and our observation of other self-service and prepackaging operations, the two developments have had *no* material effect on livestock production or marketing. We have been operating self-service meat sections and stocking prepackaged meats for several years on a steadily increasing scale. We have made practically no change in our specifications for carcasses or cuts of beef, veal, lamb, and pork which can be attributed to the effect of either self-service or prepackaging.
>
> For several years in the U.S., and to a large degree also in Canada, consumer, and in turn, retailer demand, has been moving to lighter cuts——therefore lighter carcasses of beef, veal, lamb, and pork. This development started in the late thirties or early forties *before* self-service and prepackaging, and I believe has been due more to the price level factor than anything else. Large cuts from large carcasses at price levels during and since World War II have meant a fairly high price tag, and have met with consumer resistance and a demand for smaller cuts. To a somewhat lesser degree, the institutional demand (hotels, restaurants, &c.) have moved to smaller cuts, and for the same reason. There are undoubtedly other factors involved, but I believe the price level has been the most important.
>
> There is a definite move in the U.S. to produce more meat type hogs as opposed to the lard type in an effort to increase the realization of meat cuts, the return to the producer, and have more satisfactory cuts for the consumer; however, we do not consider self-service and prepacking responsible for this development.[1]

[1] Westwood Distributors, Oakland, California, U.S.A. *in lit.*

The move towards the production of a meat-type hog is being made by producers not as the result of any technical change in marketing or distribution, but in order to increase the profitability of their operations. As a matter of interest, it is indicated that these new forms of retailing are increasing the sales of prepared meats, such as sausage and luncheon meats, which are made from lower grade animals. This only strengthens the incentive (sometimes called the obligation) of the packer to clear the market by providing a ready outlet for the lower grade animals. Meat packaging at the packer level has already progressed to a great degree in North America with items such as bacon, frankfurters, sausages, and sliced cold cuts. Not very long ago this was considered impossible, but the time is now visualized as not being far distant when the packer will cut, trim, and pre-package most of the fresh meat for sale by retailers. This may relay consumer demand more effectively to the producer, but that is doubtful.

Since the late thirties, a demand in North America for lighter cuts of meat from smaller animals has had some influence on the earlier marketing of cattle and generated a demand for a smaller, compact animal. Although producers have tried to meet this demand, they have found it uneconomical and within the last year or two, as one said, 'We have come to the end of the line on shoved-up cattle'.[1] The expression 'weight for age' is now being used by auctioneers as bigger cattle are more profitable for the commercial man and the trend in production is opposed to consumer demand.

The exception to this in North America has been the development in the marketing and production of poultry within the last decade, which has been spark-plugged by the broiler industry. Introduced into Canada from Pennsylvania in 1945, the practice of sub-scalding and the sale of eviscerated chicken packed in cracked ice, either as whole birds or cut up, has revolutionized the poultry industry. From one store selling ice-packed cut-up chicken, the method of sale spread rapidly to other centres and across the country. This stimulated a heavy demand for a 3½-lb. bird and led to drastic changes in production, which were reflected in the production of other types as well.

This new technique of marketing and distribution resulted in the packing plants searching for poultry as well as developing contracts directly between retailers and producers. Production had to be stepped up and new methods developed to meet the growing demand. No longer a Sunday-only visitor to the dinner table, chicken became one of the cheapest of meats, and the consequent year-round marketing demand has developed year-round production. The industry has

[1] *Canadian Cattlemen*, op. cit.

shifted from a housewife's backyard pin-money basis to large commercial enterprises with fifteen to thirty thousand, or even up to forty thousand, birds per man. One plant reports that only 20 seconds of labour is required per pound of meat marketed. Consumption in Canada has increased from 198 million lb. in 1939 to 435 million lb. in 1954. Poultry would therefore appear to be the exception in showing a direct relationship between a technical change in marketing and technical changes in production.

Generally speaking then, technical changes on the farm, in North America at least, are directed solely at increased returns. They fit into the existing market structure rather than create corresponding technical changes in marketing.

Similarly, technical marketing changes are not normally reflected back to production. The impact of such changes is rather wider: the development of refrigeration, canning, freezing, &c., has had the effect of diminishing much of the seasonality of supply of livestock products. Supplies at the seasonal peak are stored and can be shipped long distances to make good seasonal deficiencies on consumer markets. With technical marketing facilities available, the producer, utilizing advances in agricultural science and farm practice, can direct his efforts to producing a product in constant demand, knowing that the marketing chain can look after the technical problems of distribution.

Market developments which I have summarized have increasingly required quality standards that are easily definable and designed to suit large scale operations as economically as possible, as marketing costs and services take an increasing share of consumer expenditure. As Pearson and Myers have pointed out, 'The modern housewives no longer buy farm produce, but buy processed food with built-in maid service.'[1] The need for definite qualities can be translated back to the farm through the price mechanism operating in favour, for instance, of small beef animals or No. 1 bacon. This, however, from North American experience, is not as effective as the development of advances in agricultural techniques which themselves provide a basis for developing and maintaining standards of quality by providing the producer with higher returns.

Technical changes in production have as their basic objective the increase of agricultural output and an increase of the consequent return to the farmer. With changes in production continuing, we may well expect that the competition for markets will increase both domestically and abroad. The probability is that the marketing

[1] Pearson and Myers, op. cit., p. 5268.

and allied distribution problems which will therefore arise will not be solved in any particular instance by technical developments but rather by large-scale selling operations, such as the imminent Australian advertising campaign in the United Kingdom and the widespread consumer education campaigns undertaken by both the Canadian and American Meat Institutes.

I would suggest that the relationship between changes in production and changes in distribution and marketing of livestock are generally not of a technical nature and that the implication contained in the title of this paper is invalid.

F. G. STURROCK, *University of Cambridge, England*

Dean Young defined market as 'the organized facilities available to the industrialized farm in which goods and services may be bought and sold for a price. Included are the markets for labour, supplies, custom services and products.' This interpretation is a very liberal one and in fact covers the whole environment of the farm and the whole range of technical progress. There is no time for me to cover this wide field and indeed it is my task to comment particularly on the marketing of crops.

In general, the interaction of marketing and technical change can take two forms: the effect of technical changes in marketing and distribution on farming; and the effect of technical changes in farming on marketing and distribution.

The fundamental fact in crop production is that crops are grown and harvested at one season and must be marketed over as long a period as possible. The purpose of marketing is thus to spread these products over space (transport) and time (storage). If the product is not perishable, storage is a simple matter. If, however, it is perishable, improved methods of storage can have a profound effect on the economics of production. As an example, we can take fruit and vegetables. If storage is not possible, the price structure during the harvest period has a characteristic hook shape. Prices are high at the beginning of the season when supplies are scarce and the product is a novelty to the consumer. Later, the price falls as supplies become more plentiful. Finally there is a slight rise in price at the end of the season as supplies decline.

The shape of this price curve can, however, be altered by storage. The older methods were bottling and drying which have now been largely superseded by tinning (canning). These are only a partial substitute for the fresh product, however, and tend to form a separate market. Newer methods, particularly freezing (whether carried

out by the manufacturer or the housewife), provide a product which is a closer approach to the fresh product. In so far as the stored product can compete with the fresh, it will tend to change the price curve. Out-of-season produce sold fresh is less of a novelty and will fail to command as high a premium. Many growers may therefore turn to production for the freezing or canning merchant, and the variety grown and the date of harvesting will become geared to his requirements rather than to those of the fresh market.

A second form of technical change in distribution which can affect the farmer is the emergence of the large retail store—in particular the self-service super market. Such shops must have a standardized product which can be readily packaged. In this way labour costs in selling can be reduced and, as Dean Young has pointed out, a one-class mass market may develop for standardized produce.

While this development has advantages where labour costs are high, it may not be a pure gain. In particular, its success presupposes a standardized consumer. He (or more probably she) may exist in America, but certainly not in Europe. Within each country there exists a wide variety of markets divided by region and social class and their requirements vary greatly. Indeed, speaking as a European, I hope that standardization will not go too far.

I can recall, for example, buying packages of apples in a super market in the United States—beautifully packed in cellophane, uniformly bright in colour, uniformly hygienic, and uniformly tasteless. In Italy I have eaten a delicious local cheese called Bel Paese. Once I saw a cheese of the same name in Boston, factory made in the United States, but any resemblance to the Italian original was purely coincidental. Let me hasten to add that similar examples could be quoted elsewhere. Some of the so-called Port Salut cheese in Scandinavia is uniform, hygienic, and standardized but it lacks the flavour of the French original. For that matter our standard wartime cheese ration in Britain (christened 'mouse-trap' by the housewife) fell far short of the farmhouse Cheddar whose name it bore. I also sincerely hope that French vine growers will never try to produce a standardized product for it is variety that gives their wines their attraction.

Let us now consider the other side of the picture—the effect of technical changes in farming practice on the distributor. Many instances could be given, but one that is topical in Europe at the moment is the harvesting of grain crops. Under the old system, grain was stored unthreshed and supplies moved gradually to the market as the crop was threshed. Indeed, the number of threshing

machines available limited the volume of supplies. Now, combine harvesters are becoming common and this has released a flood of grain at harvest time. The problem is: where is this grain to be stored and dried? In Britain the problem is far from solved. On the large farm the tendency is to erect large bins which can be ventilated with warm air when the moisture content is too high for safe storage. On small farms driers are being installed which dry the grain in sacks and these sacks are also used for storage. The Government has also encouraged farm storage by arranging an increase in the seasonal price from autumn to spring. Much grain is also stored by the merchants but they still lack the system of local and central grain silos such as are found in North America.

Transport has an equally important part to play. Essentially, the function of transport is to allow the growing of foodstuffs in one area and its consumption by human beings in another. Indeed an efficient form of food transport is a prerequisite to the development of urban populations.

Many explanations have been offered for the decline of the Mayan civilization in Central America. It is revealing, however, that one of these explains the abandonment of their towns in terms of lack of transport. To judge by their architecture, they had a sophisticated civilization but they had no draught animals and no wheeled carts. Food had to be carried on human backs to the towns and agriculture was thus limited to a small radius. When fertility dropped in this area, it became impossible to feed the town populations and migration was forced on them. Whether or not this theory is correct, other examples of the impact of transport on farm production can easily be given. The building of railways which opened up the western part of North America had a profound effect on European farming. The flood of wheat which began to arrive helped to bring on an agricultural depression in Britain and eventually led to a change in emphasis from crop to livestock production. Something of the same kind also occurred in Denmark. Within countries the process has now been carried much farther by improvements in road transport. In particular, it has permitted local specialization, for example in fruit or vegetable production.

The second effect of transport is to allow fodder crops to be grown in one area and fed to livestock in another. The production of grain in the Middle West for feeding to broilers in New England is an obvious example.

The benefits to be derived from specialization are obvious in a large country such as the United States. Unfortunately, in smaller

countries, the benefits of improved transport are often negatived by customs barriers. It is worth speculating perhaps on the shape of European agriculture if there were no such barriers. Eastern Europe might have become our 'Mid-West' supplying bread grains and fodder for livestock kept in western Europe.

It is unfortunate that as dependent territories achieve independence their first action is often to strive to attain self-sufficiency. The reasons are obvious. Too harsh a challenge to national agriculture by imports may cause distress to farming communities. From the strategic points of view, such countries are nervous lest supplies of food be cut off during war-time.

Dean Young's account of progress in the United States is a success story. Unfortunately there are considerable difficulties, both economic and political, which hinder similar advances being made elsewhere. In spite of these, there is no doubt that technical progress will help to lower the costs of distribution in course of time. It does not necessarily follow, however, that in Europe we should attempt to copy American methods in detail. If North America with its high labour costs concentrates on supplying the mass market, it may pay us in Europe to use our assets of skilled labour and lower wage costs to concentrate on high quality and variety.

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Mr. Davies's paper clearly reflects the experience gained from his unique position in milk marketing where, in the course of time, he is continually involved in decisions relating to the introduction of technical advances which are in the public interest and which also benefit the dairy farmer. His suggested approach to the international aspects of marketing dairy products through producer organizations is to be commended, but I shall forgo comment or criticism of this matter in order to consider other points in his paper and to state a few of my own views relating to the interaction of technical changes on the farm and in the market, particularly with respect to fluid milk.

I agree that a close look at the statistics of the dairy industry brings out those features mentioned by Mr. Davies, namely, that milk is produced mainly on small farms or farms that are smaller than average; that they are mainly family farms where output is dependent on the labour of the whole family; and that there is a growing degree of specialization in the economy.

Mr. Davies also points out that in his country the producer-controlled Milk Marketing Board has been an important influence in

assisting dairy farmers to adopt technical changes on the farm and in improving the hauling of milk to market. I am sure that his counterpart in other countries, leaders of dairy co-operatives, have a similar record of achievement. Additional credit will be required either from the marketing organization, from banks and other credit institutions, or from the government, if technical changes on the family-size farms are to keep pace with those taking place in the distribution business.

The statistical data and research studies that I have used are limited to work done in the United States, but it is the object of this conference to foster exchange of views and information, so I shall welcome references to additional research from other countries.

The dairy industry has a long record of progress attained by applying new results of research that involve technical change both on the farm and in the dairy plants and continues to be a leader in the current technical revolution in agriculture. This modern miracle of production and distribution efficiency growing out of application of results of scientific research has occurred at an accelerated rate during the 1940's and the first half of the present decade. It is a result of favourable farm prices; of increased demands by labour for higher wages, shorter hours, and more fringe benefits; and of a continuing heavy demand for labour in practically all segments of industry.

Of the many technical developments in the field of farm management that have an important influence on more efficient production of milk, I should like to mention three: artificial breeding, forage handling equipment, and grass silage. Artificial breeding started to be used extensively after careful research under controlled conditions had been tested with commercial herds. Programmes of artificial breeding are in general use in many important dairy countries. Both governments and farmer-owned co-operatives have played important roles in getting this new practice adopted and in time it will result in offspring capable of increased production per cow. The revolution in forage handling equipment continues at a rapid rate in the United States but it involves substantial capital expenditure. However, its use enables a dairy farmer to cut hay at the proper stage of maturity and to obtain more milk by feeding higher quality hay. The equipment is better suited to the larger farms with good sized relatively level fields, but small farmers can share its advantages by having the work done on a custom basis or by exchanging labour for using the equipment. Grass silage is on the increase in most countries as a result of adopting research findings. Fortunately it can be made on small as well as large dairy farms and it too results in greater production of milk per cow.

Milking machines, while not new, continue to increase in number with a result that more cows can be milked per man. The most recent addition to the handling of milk at the farm is the bulk tank which is growing in popularity and in future is likely to be the predominant method in many milk markets throughout the United States though it will not of itself necessarily result in the saving of labour in milking. When bulk tanks are combined with pipe-line milkers there are considerable opportunities for saving in time. However a pipe-line milker is more advantageous for a large farm than a small one and may be particularly so where labour is hired. There is a real incentive for plants that adopt bulk receiving of milk to shift over completely to this type of operation. It is estimated that receiving costs could be cut by about two-thirds when bulk is compared to cans. Larger producers will benefit the most, and the change will hasten the trend to larger herds.

Thus the technical changes taking place on the dairy farms of the United States will result in some increase in size of farms, greater milk production per cow, more efficient use of labour and, with the improved methods of cooling and storing, in better quality milk.

On the marketing and distribution side there are several developments in the United States where technical change is widely adopted. Among them are the downward trend in the number of distributors, particularly producer dealers; increased sales through food stores; adoption of every-other-day delivery to homes; widespread use of paper containers; the extensive adoption of homogenization; increased inter-market competition in distribution and important shifts in consumer demand for various dairy products. In addition to technical change, the distribution of milk has been influenced by economic factors, particularly increased labour costs which have undoubtedly accelerated the application of new techniques. Over the years there has been a downward trend in the number of milk distributors. This has been particularly true of producer dealers. In recent years there has been a trend towards consolidation of dairy plant facilities and milk distribution outlets. Dairy farmers are affected by these changes especially when they involve changes in market outlets.

Throughout the country, but particularly in the larger metropolitan markets where wages are high, traffic is heavy, and people live close together, there have been important changes in the distribution of milk. There has been an increase in the size of load on wholesale routes with increases in sales of milk through food stores, particularly in super markets. Prior to World War II less than

one-half of the milk for home consumption in the New York metropolitan marketing area was sold through stores but by 1955 it had increased to nearly three-quarters. However, many smaller markets have maintained home delivery of milk but on an every-other-day basis or even on only three of the seven days in the week. This is one economy introduced during the war that has been retained rather universally in the years that followed.

Homogenization has been generally accepted in small as well as large markets. For example, in ten years homogenized milk increased from 11 to 54 per cent. of all fluid milk sold in the Rochester, New York, market. In 1943 only 5 per cent. of the milk sold in the New York metropolitan market was homogenized but nearly ten years later it had increased to 73 per cent. The most recent survey in the New York market area for 1955 showed that 91 per cent. of the milk was homogenized. Increased use of paper containers which limit the visibility of the cream line have undoubtedly contributed to this trend for which there is a sound technical basis. Studies show that homogenized milk will keep longer than regular milk without developing a noticeable oxidized flavour. The fact that when it is in glass it is much more subject to adverse affects from sunlight is being offset by the increased use of paper containers. In the New York marketing area prior to World War II only 20 per cent. of all fluid milk was sold in paper containers. By 1951 nearly half and, in the recent survey for 1955, 62 per cent. was distributed in paper. This development has been stimulated by the increase in store sales in that area. In the suburbs of greater New York glass bottles are more widely used where over half of the milk is distributed on retail routes. Paper containers represented only 37 per cent. of the milk there.

In many of the smaller markets the distribution of fluid milk products is undergoing important changes. Factors in this development have been compulsory pasteurization of bottled milk, increased use of paper containers, and greater competition between markets. A study of milk distribution in Minnesota in 1952 indicated that three-fourths of the fluid milk plants in the smaller communities were distributing their products in outside markets, where approximately half of the total daily volume of fluid products bottled was distributed. Larger plants using paper packages were important factors causing this change. This trend toward outer market distribution is occurring elsewhere; but local health regulations as well as limitations imposed by milk marketing orders and milk control agencies may slow this trend in spite of the economies offered through this inter-market competition.

Another development in the central part of the United States is the continuing shift from the delivering of cream separated on the farm to the daily delivery of whole milk to dairy manufacturing plants. Together with the introduction of the bulk system of handling, this will tend to speed up the closing of small creameries in the mid-continent dairy area.

I would be derelict of my duty if I overlooked the consumer. The bulging beltlines of housewives, husbands, and high school teenagers is changing the type of foods consumed from high calorie fats to nutritionally valuable proteins. During 1953 consumers in forty-two federal order markets were using fluid skim milk, buttermilk, and flavoured milk drinks to the extent of 8 per cent. of the total fluid supply. In those federal order markets where 'half and half' (10–12 per cent. butterfat) is sold, about one-third of the butterfat sold as fluid cream was used in making this low fat product. This past year sherbet and ice milk containing less than 6 per cent. butterfat made up 16 per cent. of the total gallonage of frozen dairy products sold. Cottage cheese production was two-fifths of the total pounds of all kinds of cheese made last year.

The dairy industry has been hard hit by the loss of one-half of its pre-war butter market to the lower priced butterfat substitutes. Butterfat is losing out not only through the substitution of margarine for butter, but also through the use of vegetable fats and molecularly modified animal fats in imitation ice cream.

A result of the technical advances that have been put into practice by the dairy industry in recent years has been to maintain or improve the quality of milk which reaches the consumer in most cities throughout the United States. The bulk farm tank and the insulated tank truck have done much to maintain the original quality of milk. High temperature, short-time pasteurization with increased use of homogenization have been effective in further maintaining good quality. The availability of refrigeration in most homes and in stores where milk is sold has made it possible to keep milk over several days. The expanding use of refrigerated coin-operated vending machines for milk that have been installed indoors in manufacturing plants, schools, and public buildings make fresh cold milk available at all times to the consuming public. Even outdoor-type vending machines have added another convenient outlet for additional milk with which the food store and milk route must compete. Refrigerated bulk dispensers that help cut container costs are gaining in use in soda fountains, cafeterias, and restaurants.

To venture a prediction, I conclude by saying that in future years,

this good quality milk will be processed in fewer but larger and better equipped plants that use less labour per unit of output. The milk will come longer distances by bulk tank trucks from fewer but larger dairy farms that also use more labour-saving equipment and have higher producing cows than today. I trust that dairy farmers and milk distribution agencies will continue to make technical changes that are indicative of progress and profit.

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I regret that I do not agree with the generic approach nor with the very definite conclusion of Mr. Marshall. There are some aspects and problems that it seems to me cannot be generalized, and I believe he has not taken enough account of conditions that prevail in many other areas of the world. The United States of America, Canada, and a number of European countries have achieved outstanding technical and economical development in the various phases of livestock breeding and management as well as in processing and marketing activities. Therefore it may be that further noticeable progress cannot be expected in the near future. Consequently, it is extremely difficult to conduct an analysis based on actual conditions and then try to demonstrate whether or not such a relationship exists. Any unquestionable and representative conclusions have to be substantiated by a thorough study of the factors and particular conditions that have contributed to the present state of affairs.

In the so-called under-developed areas, to a certain extent, technical changes in animal husbandry determine corresponding technical changes in the processing and marketing fields. In other instances such a relationship may not exist. Let us indicate as a positive example the establishment of a progressive meat-packing plant in a distant cattle area. This will offer great possibilities and will stimulate, no doubt, the improvement of the herds, since cattle producers benefit as the efficiency of the plant increases as supplies become larger and better. Such a plant will justify the selection of breeders, the castration of the discarded bulls, the control of internal and external parasites, the adoption of good management of the pasture lands, and for feeding stock, &c. These improved livestock practices will in turn exert a corresponding demand for new devices for assuring transport and conservation of the product in the best possible way. It is then that refrigeration, canning, salting, and other forms of meat processing which unquestionably are technical improvements, come into the picture. It is only natural that livestock producers as well as all the intermediaries will try to obtain the

highest possible economic return. In every case economic factors determine the need of technical changes.

The nature and magnitude of consumers' demand exercise a great influence or, more properly, a definite pressure, on the quality of livestock products, determining necessary adjustments sooner or later. Likewise, livestock producers and processing plants can, to a certain extent, impose a specific product on consumers, notwithstanding their preferences, provided a shortage in the supply happens to be a dominant tendency in the market and that the demand is inelastic.

Let us refer to egg production for example which Dr. Marshall regards as one of the few exceptions to his rule. We all know that consumers generally favour special qualities such as size, colour, taste, &c. This specific demand reflects inevitably on the breeding of birds. The dairy industry also offers interesting examples. For instance, canning factories are compelled to turn out a product as uniform as possible and therefore demand that producers deliver clean milk of standard butterfat content, establishing a price range in accordance with the quality of the dairy produce. In Denmark, recently, we have had the opportunity of visiting a co-operative packing plant for swine meat. The manager informed us that only pigs of a very definite size and weight commanded the highest price and that larger or smaller stock were subject to severe price discounts and in some instances were even rejected. Therefore, farmers raising pigs have to adapt their breeding qualifications to the nature of the market demand.

Consumers' preference for fat or, on the contrary, for lean meat determines an inevitable readjustment of livestock breeding programmes. Great Britain gives special importance to fat beef, as against consumers of Peru who prefer lean meat, and it so happens that Argentina is the main source of supply for both countries. The tendency in a number of countries is towards light carcasses, but in others heavy carcasses of beef, veal, lamb, or pork are preferred. Meat-type hogs are replacing the lard type in some countries such as in Sweden.

A small volume of production may not justify the application of technological advances in a given farm, territory, or country. In Peru, for instance, the exceedingly high cost of transport from distant livestock districts in the mountains has prevented a considerable increase of cheese and butter manufacture. Very frequently, under such conditions no steps have been taken to make proper use of the milking capacity of the herds, but preference is given to

increasing the weight and yield of the carcasses. Mutton is processed and dried into a product called *chalona* for expanding its outlet. Likewise, other cattle farms more conveniently located, have changed the orientation of their enterprises from primarily milk to dual purpose exploitation of beef and milk, in order to meet market demands. To reduce cost of production, breeders strive to make the maximum use of precocity factors in the improved strains.

Aeroplane transport has made it feasible to locate processing plants in distant areas from the centres of consumption, where rail transport or travel on the hoof of range cattle is hardly possible. Grading of livestock products appears to be one of the more important characteristics of an improved distribution system, but in countries that have not yet achieved a high level of social and economic development, one cannot reasonably expect to impose control standards in order to establish market differences in final use. Commercial values of each category can only be reinforced when there is sufficient volume of produce delivered to the market to satisfy the demand. It is only when acute competition is the dominant feature of market transactions, that quality plays an important role in cattle breeding, in price determination, and in the marketing structure as a whole. In Peru there are no basic standards for the different cuts of beef. A change in the actual classification has been tried on a rather small scale, but with outstanding success, by a chain of supermarkets and sooner or later a better grading system will be acceptable no doubt, to consumers, distributors, and producers alike.

Finally, I do not agree that technical changes in production have as a sole objective the increase of agricultural output and economic return to the farmers. Many technical changes on the farm have had a compulsory origin, leaving the producers no alternative to adopting new techniques so as to comply with specific demand and to survive in the farm business. There is a positive relationship between technical changes in production and technical changes in processing and marketing.

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It is obvious that there is a mutual effect between technical change on the farm and technical change in marketing and distribution. On the whole this has led to a gradual transfer of processing, marketing, and distribution away from the farm. Once farming was an almost completely integrated undertaking and the majority of the population consisted of farmers. In Sweden about 80 per cent. of the population were farming in 1880, compared with 20 per cent.

today, and the volume of farm production has doubled. This means an 800 per cent. increase in productivity. This is partly due to technical development, but much of the work in processing, marketing, and distribution has been transferred to other sectors, so that the net development in farming is not so large as it seems.

For example, the grinding of cereals no longer takes place on Swedish farms. Even the farm population purchases 70 per cent. of its consumption of flour and similar products. About 30 per cent. of the milk is now used for direct consumption. Farmers' direct sales of fluid milk amount to only 8 per cent. of all such milk. The rest is delivered through dairies, almost all of which belong to farmers' co-operatives. In 1895 half of the 1,800 dairies consisted of farm dairies and only a third of them handled milk from other farms. Now the total number has fallen to 560 of which only some ten are farm dairies. Motor transport has helped to expand the district in reach of a dairy—some milk collections cover over 400 kilometres—and the transport function is almost completely taken over by the dairies. The tendency to centralize the industry is hastened by the demand for milk in sealed and dated packets which can only be provided where there is large and expensive equipment. Dairies also have taken over butter production. Farm butter has diminished by 93 per cent. since 1939. The same applies to cheese.

Dried milk requires large-scale manufacture and has never been farm produced. Dairies have to manufacture dried milk during the summer so as to meet the farmers' demand in autumn and winter for skim-milk for pig raising. This demand has arisen from the increasing seasonal variations which have accompanied the greater use of pasture and the better quality of pasture through fertilization and better botanical composition. These seasonal variations have also called for longer storage periods for butter. Consumers today demand a year-round supply of food of high hygienic standard and in forms that permit a minimum of household work. Farms are too small and have too little capital, and their labour requirements are too uneven, to allow them to go in for processing, storage, and distribution. The farmer seems to become more and more a producer of raw materials.

In spite of these developments, however, they have been able to keep control of processing and marketing through their co-operatives. At present Swedish co-operatives have assets of over 5,000 million Swedish crowns and own capital of about 400 million Swedish crowns, or about £100, per farmer. They handle 98·3 per cent. of all dairy milk, 77 per cent. of all slaughterings, and 65 per

cent. of egg marketing, bread cereals, fertilizers, and feeding-stuffs. Farm co-operatives own 1,700 retail shops though their turnover scarcely reaches 4 per cent. of all retail food marketing.

In the long run the small farmer will have to choose between increasing the volume of his production and going over to part-time farming. High employment in industry and good transport makes part-time farming easy and natural. It follows that milk will have to be produced in larger units, because it seems to be the only solution to the problem of fixed and limited working hours and regular holidays for the agricultural population.

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The papers we have heard seem to relate only to countries with super-developed agriculture and to side-step the problems of the less well-developed countries. The marketing structure of these countries has not kept pace with their technical changes in agriculture. In Colombia we have had a very substantial increase in production due not only to an increase in farm land but also very substantially to technological innovations. In spite of this, the marketing structure continues as unorganized now as it was, let us say, fifteen years ago. This lack of organization is noticed primarily in those food crops which are used for home consumption. The marketing of export crops, mainly coffee and bananas, is fairly well arranged, as is also the marketing of crops which undergo some form of processing, such as wheat, rice, and cotton. But the problem is aggravated by inadequate and costly transport, especially refrigerated transport, and by a totally inadequate system of market intelligence. The picture is rather cheerless, and there is little encouragement in such government measures as have been taken to alleviate the situation. They lack boldness and some of them have been ill-advised, even to the point of producing results opposite to what was intended.