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THE INFLUENCE OF CONSUMPTION CHANGES ON THE USE OF RESOURCES AND ON TECHNICAL CHANGE IN AGRICULTURE

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MY title suggests a cause-and-effect relationship that many may wish to challenge.[1] To them it will seem that changes in production must precede changes in consumption, and that changes in resource use and technology occur independently of changes in consumption. Resources must be reshuffled before new products can be produced and the urge to shuffle comes from competition—not from consumer demand. Advances in technology originate in research but their adoption is inspired by the profit motive and competition. It may be held that it is the advertising and mass merchandising appeal technique of modern business that moulds the consumption pattern. Less frequently nowadays does one hear the claim that the consumer demands this or that. It is doubtful whether many things are demanded until a desire is created. The creation of desires has become an important function of producers and manufacturers.

The producer of farm products may have less influence on consumption than producers of industrial products, but the difference is one of degree only. The output of family farms and peasant holdings may be combined for marketing through large corporations or co-operative societies possessing sufficient capital and power to influence choice and consumption. The trade name 'Sunkist' may be as important the world over as the fruit it represents in moulding consumer desires and in shifting resources from the production of apples, bananas, mangosteen, and durian.

In many countries today the State, through marketing boards of one kind or another, combines, or permits the combination of, the products of agriculture and facilitates mass merchandising and salesmanship. The advertising efforts of various such bodies operating in the United Kingdom are cases in point.

[1] A number of persons with whom the writer corresponded in search of material for this paper questioned the causal sequence suggested by the title or mentioned exceptions to its general application. Among them were Herrell de Graff, Cornell University, J. H. Kirk, Ministry of Agriculture and Fisheries, London, and C. W. McLean, Food and Agriculture Organization, Rome.

In wartime the influence of production, or lack of it, has special significance. The nature and extent of consumption may be determined even more definitely by the State. Consumers in Europe did not demand *ersatz* coffee or paper suits during the last war; nor did farmers voluntarily choose to mix wood pulp with the ensilage and grain they fed to livestock. The consumers of many countries ate and wore what the State decided should be produced or brought from abroad, and production in exporting countries was moulded to that pattern. In Britain and elsewhere, consumption—and production too—is still affected by the policies of ten or fifteen years ago.

These examples may serve to indicate that the causal sequence suggested in my title is not above question. If the word 'influence' were changed to 'relationship', the suggestion of cause and effect would disappear and the result would be less contentious. But for the purposes of this discussion I accept the title as it is on the grounds that there are changes in consumption that do affect changes in the use of resources and technological advances.

First, let us attempt to relate production changes to consumption on a more or less global basis. Certain broad effects are discernible—more in the case of land than for other resources. I shall quote examples of relationships and shifts in particular fields of agriculture and refer briefly to the measurement of change. It should be noted perhaps that evidence of changes in the use of resources is more easily obtained in the case of land than for labour and other inputs. Though land is a diminishing factor in the total cost structure, it is the only one in many instances that can be, or has been, measured.

Time will not allow me to refer to the relation of elasticity to consumption and to resource use and technical change, important as it is.

Changes in Consumption

The changes in consumption that I shall relate to production may be grouped into three categories. The first is represented in the general shift from the plentiful and cheap starchy foods to the scarcer and more expensive proteins and protective foods. This change which has occurred in all the developed countries has been going on a long time. The second concerns specific products in more restricted settings. The third relates to the effect of urbanization and population density on consumption and production.

Concerning the first or general change, Lloyd, quoting McCulloch, notes that in 1837 income per head of the population in Britain was

about £17 per annum and food expenditure about £8.[1] A hundred years later real income per head had increased about fivefold and food expenditure threefold. Meanwhile 'tea and sugar had fallen by more than half in price and had increased fivefold in quantity per head; meat and fats had fallen in price and consumption per head had about doubled; the price of bread and flour was the same but consumption had nearly halved. . . .' The author goes on to note that the restrictions imposed since 1940 disturbed consumption trends but that in the case of milk, where subsidies have been effective, consumption has increased 60 per cent. Statistics provided by J. H. Kirk of the Ministry of Agriculture and Fisheries, London, indicate that since pre-war days the consumption of milk, margarine, potatoes, and fresh vegetables has increased. That of butter, other dairy products, meats, eggs, and fresh fruit has declined. The increases are mainly due to subsidies and price policy; the decreases to reduced imports associated in part at least with exchange restrictions.

A recent study of the United Nations Economic Commission for Europe points out that 'between 1910–13 and 1934–8 all of the countries in western and northern Europe had reached a point where a decline (in wheat consumption and rye consumption) sets in. In Germany, France, Belgium, and the Netherlands consumption fell by 20 per cent.'[2] In eleven countries of Europe the *per caput* consumption of cereals was less in 1950–2 than in the period 1934–8.[3] In Sweden the *per caput* calorie consumption of meat, bacon, and eggs has increased from 190 to 460 a day since the period 1876–85; dairy products from 360 to 800; margarine from 10 (1886–95) to 280; while cereals, pulses, sugar, and potatoes have declined from 1,990 (1906–13) to 1,630. The report from which these data were obtained states that 'the substitution of animal for vegetable products may be observed in most other western European countries'.[4]

In the United States since 1909 the annual *per caput* consumption of flour and cereal products has declined from 295 to 163 lb.[5] and of vegetables and fruits, other than the leafy green and citrus types, from 248 to 220 lb. Potato consumption has dropped from 202 to 103 lb.

[1] E. M. H. Lloyd, 'Food and Money: Some Reflections on Changes in Food Consumption and Farm Prices', *Journal of Proceedings of the Agricultural Economics Society*, Feb. 1953.

[2] Ingvor Svennilson, *Growth and Stagnation in the European Economy*, United Nations Economic Commission for Europe, Geneva, 1954.

[3] United Nations Economic Commission for Europe and Food and Agriculture Organization, *European Agriculture: A Statement of Problems*, Geneva, 1954. See also M. K. Bennett, *The World's Food*, chapters 11 and 15, Harper and Brothers, 1954.

[4] Ibid.

[5] United States Department of Agriculture, *Agricultural Statistics 1953*, p. 716.

There has been no net change in meats, fish, and poultry. All other groupings of food indicate increases—some very substantial. The milk equivalent of dairy products, other than butter, has increased from 192 to 249 quarts. The consumption of eggs went from 280 to 395; fats and oils from 59 to 67 lb. despite a decline in butter; citrus fruit and tomatoes from 59 to 110 lb.; leafy green and yellow vegetables from 63 to 103 lb.; sugars and syrups from 84 to 107 lb. The retail weight equivalent of all foods declined from 1,612 to 1,530 lb. *per caput*.

Patterns of food consumption in Canada indicate similar changes. Since the 1935–9 period annual cereal consumption *per caput* has declined about 18 per cent. and potatoes 11 per cent. Consumption of meats as a group is up by about 10 per cent.; poultry about 60 per cent.; milk and cheese 25 per cent.; citrus fruits, fresh, 50 per cent. and canned 1,500 per cent. Other fresh fruits have increased 60 per cent. and canned fruits 100 per cent. Butter consumption has declined by a quarter, and margarine, which was not consumed at all until 1949, now sells to the extent of 7 lb. *per caput*.[1]

These data reveal a long-run gradual improvement in the real income of the masses. In North America this has been particularly true of the past twenty years. The recovery from depression, the advent of wars and cold wars, the conversion of economies to peace-time production, the development and adoption of new machinery and new techniques, and finally the filling of back logs of consumer demand have led to unprecedented development of resources, industrial activity, and employment. In most sectors wages and income have risen more rapidly than prices, and since hours of labour have not declined proportionately both 'take-home pay' and real income have mounted. Despite taxes and the competition of home-building, furnishings, new cars, refrigerators, television, and a multiplicity of gadgets, there has still been more money for food. The consumption of dairy products (other than butter), meats and poultry, eggs and fruits has increased accordingly.

Global Shifts in Land Use

If these changes are widespread and significant, as it would seem they are, they should have had some discernible over-all effect on the use of resources, particularly land.

The area planted to the major grain crops throughout the world increased by 30 million ha. or 7 per cent. between the mid-thirties and 1952 (Table I).

[1] *Canada Yearbook*, 1954.

In the major grain crops of the developed countries (wheat, oats, barley ,rye, and maize) the increase was but 4 per cent. to 1953. Meanwhile the world population according to F.A.O. increased 15 per cent., that of the world exclusive of U.S.S.R., Asia, and Africa

TABLE I

*World Summary of Major Crops**

(*1,000,000 ha.*)

	1934–8‡	*1952*†	*1953*†
Wheat	128·1	137·4	137·0
Rye	16·0	15·1	13·8
Barley	35·7	40·7	41·6
Oats	38·1	37·0	36·2
Maize	83·9	85·1	86·4
Millet and sorghum	69·6	77·4‡	..
Rice paddy	85·8	94·9	99·9
Total grains	457·2	487·6	..
Potatoes	13·5	12·5	12·7
Sweet potatoes and yams	6·6	8·0	8·0
Total pulses	33·6	35·2‡	..
Total oil-seeds	68·5	80·8‡	..
Cotton	31·0	32·3	31·5
Sugar beets	2·1	3·0	3·0
Tobacco	2·8	3·2	3·3

* Excluding U.S.S.R.

† F.A.O. *Monthly Bulletin of Agricultural Economics and Statistics.*

‡ Food and Agriculture Organization, *Yearbook of Food and Agricultural Statistics*, vol. vii, part 1, 1953.

17 per cent.,[1] and livestock units, despite fewer horses and mules, by roughly 9 per cent. (Table II). There are indications that wartime losses of cereal grains have been replaced and that a period of relative stability or slowly declining acreage of the cereals common to the developed countries may ensue. The most consistent loser in the last twenty years has been the continent of Europe exclusive of the U.S.S.R. There reductions have occurred in all major grain crops except barley; also in potatoes (Table III). In North America the trend has been mixed. Wheat acreage, shown as being up in 1953 compared with earlier years, has actually declined since then. Substantial reductions have occurred in North America in maize and potatoes. The most significant expansion in acreage has occurred in Asia where increases in wheat, rice, millet and sorghums have ranged from 8 to 15 per cent. since 1934–8.

[1] Food and Agriculture Organization, *Yearbook of Food and Agricultural Statistics*, vol. vii, part 1, 1953.

TABLE II

Livestock Units

Cattle, Buffaloes, Equines, Camels, Pigs, Sheep, and Goats

Continent and world	*Pre-war*	*1949–50*	*1950–1*	*1951–2*
	millions			
Europe	137·8	131·5	132·9	134·6
North and Central America	122·1	131·7	133·0	134·6
South America	127·3	156·3	159·8	162·2
Asia	331·6	315·7	339·3	344·1
Africa	97·6	111·2	111·3	116·3
Oceania	30·8	32·1	33·4	32·9
World exclusive of U.S.S.R.	847·2	878·5	909·7	924·7

Source: Food and Agriculture Organization, *Yearbook of Food and Agricultural Statistics*, vol. vii, part 1, 1953.

TABLE III

*Regional and World Acreage of Major Grain Crops**

(1,000 ha.)

		Europe	*North and Central America*	*South America*	*Asia*	*Africa*	*Oceania*	*World*
Wheat	1934–8	29,930	33,070	8,560	45,620	5,580	5,340	128,100
	1952	28,380	39,920	8,120	49,970	6,420	4,180	137,100
Rye	1934–8	13,500	1,640	470	360	50	5	16,000
	1952	12,040	1,070	1,360	640	..	41	15,200
Barley	1934–8	9,380	5,710	890	15,310	4,180	240	35,700
	1952	9,680	7,000	1,350	16,250	5,680	570	40,500
Oats	1934–8	14,610	19,590	1,000	1,780	420	660	38,100
	1952	12,440	20,110	1,080	1,750	450	1,140	37,000
Maize	1934–8	11,700	41,900	10,000	13,500	6,700	130	83,900
	1952	11,000	38,700	9,100	17,300	8,300	70	84,500
Millet and sorghum	1934–8	270	1,700	110	48,210	19,290	2	69,600
	1952	150	2,250	360	55,620	18,980	86	77,400
Rice, paddy	1934–8	220	540	1,190	82,000	1,900	10	85,800
	1952	350	1,810	2,590	88,400	2,800	30	95,400
Potatoes	1934–8	10,030	1,540	630	1,150	110	60	13,500
	1952	9,200	740	840	1,460	160	60	12,500

Source: Yearbook of Food and Agricultural Statistics, vol. vii, part 1, 1953.
* Exclusive of U.S.S.R.

These reductions relating to population growth, in spite of a 17 per cent. increase in output in 1952 (Table IV), have resulted in reduced supplies of grain, potatoes, and other root crops in many countries when grain consumed by livestock is taken into account.[1]

[1] Based upon Calculations of Net Food Supply made by F.A.O. and appearing in the *Yearbook of Food and Agricultural Statistics*, vol. vii, part 1, 1953, Table 78.

In Europe, North America, and to some extent elsewhere, these reductions are associated with the improvement of diet referred to earlier. In Asia generally and in some other countries this is probably not the case.

TABLE IV

World

*Summary of Major Crops**

(*1,000,000 metric tons*)

	1934–8‡	*1952*†	*1953*†
Wheat	129·3	164·2	163·9
Rye	21·0	20·2	18·7
Barley	41·3	52·4	55·1
Oats	45·1	49·9	45·5
Maize	110·3	138·3	144·5
Millet and sorghum	49·5	51·0‡	..
Rice paddy	151·2	159·3†	170·8
Total Grains	547·7	635·3	..
Potatoes	158·9	154·9	160·4
Sweet potatoes and yams	46·0	69·0	69·0
Total pulses	21·5	21·8‡	..
Total oil-seeds	41·2	51·6‡	..
Cotton	5·8	7·1	7·4
Sugar beets	..	69·8	82·9
Sugar centrifugal; raw	22·6	30·9‡	..
Sugar non-centrifugal, case	5·0	6·0‡	..
Tobacco	2·7	3·2	3·3

* Excluding U.S.S.R.

† Food and Agriculture Organization, *Monthly Bulletin of Agricultural Economics and Statistics.*

‡ Food and Agriculture Organization, *Yearbook of Food and Agricultural Statistics*, vol. vii, part 1, 1953.

In many countries still in the process of settlement new land is generally planted to cereals. The area of this new land may represent a substantial part of the increase in total area planted to grain. In other words there has been a net loss in grain acreage in established farming areas of some countries whose total acreage has increased or remained constant. National statistics have masked the internal changes that have been taking place. In Canada, for instance, the area seeded to wheat, oats, and barley in the Maritime Provinces has declined from 525,000 acres in the late thirties to 330,000 in 1954, while the total acreage for the country as a whole has remained the same. In Alberta the area seeded to wheat has declined by from 15 to 20 per

cent. in spite of considerable new land development.[1] Some of this land has reverted to an unimproved condition but much of it has gone into other crops.

What has become of the land that might have gone into grains and potatoes throughout the world? The picture, if we had it, for different countries, would vary, but looking at the world as a whole

TABLE V

Average Annual Fruit Production in Principal Countries
(Thousand Tons)

	All countries		*Europe*		*United States*	
	1934–8	*1949–53*	*1934–8*	*1949–53*	*1934–8*	*1949–53*
Deciduous						
Apples—table	6,240	8,550	2,559	4,375	2,586	2,376
,, —cider	4,630	4,580	4,584	4,486	..	..
Pears—table	2,020	2,700	1,031	1,598	627	672
,, —perry	590	770	579	764	..	..
Plums	2,600	2,890	1,667	2,087	697	501
Peaches	1,780	2,310	401	616	1,143	1,330
Cherries	910	1,130	725	847	125	207
Apricots	530	630	141	200	205	181
Total	19,300	23,560	11,687	14,973	5,383	5,267
Citrus						
Oranges	6,560	10,210	1,267	1,678	2,249	4,630
Grapefruit	1,100	1,620	..	..	1,001	1,465
Lemons	770	1,020	400	369	316	466
Total	8,430	12,850	1,667	2,047	3,566	6,561

Source: Commonwealth Economic Committee, *Fruit Review*, 1954.

it is clear that much land has gone into oil-seed crops, pulses, sugar beets, sweet potatoes, and tobacco—about 16 million additional hectares since 1934–8 (Table I). Acreages of fruits and vegetables are not available, but records of production indicate marked increases. The output of the major deciduous fruits has increased by 22 per cent. and citrus fruits by almost 50 per cent. (Table V). With an increase of 9 per cent. in livestock numbers other than poultry and a tendency to shift to grass-land farming, it is probable that considerable land has been diverted to pasture and to the production of hay and ensilage. The global picture does seem to indicate that widespread changes in consumption habits are affecting the use of land resources, particularly in the so-called developed countries. That other resources and technical developments have also been affected seems self-evident.

[1] *The Current Review of Agricultural Conditions in Canada*, Nov. 1954.

Resource Adjustment in Particular Products

I shall refer here to changes that have occurred in the consumption and production of a variety of products in different parts of the world.

Apples versus citrus fruits. One of these changes is that relating to tree fruits, particularly apples, and citrus fruits. Production of apples in the principal countries has increased from 10·9 million tons in 1934–8 to 12·6 million in 1953. Most of this occurred in Europe, including the United Kingdom where production has doubled.

The production of oranges in the principal countries has risen from 6·6 million tons in 1934–8 to 11 million in 1953; grapefruit from 1·1 million tons to 1·9 million. Thus it would seem that the consumption of citrus fruits has increased considerably more than that of apples.

In the United States annual *per caput* consumption of fresh apples declined from 61 lb. in 1909 to 21 lb. in 1952 while that of citrus fresh fruits increased from 16 to 44 lb. and with a high point of 67 lb. in 1947.

In Canada *per caput* consumption of fresh citrus products has increased by 50 per cent. since 1935–9, while that of apples has shown a 10 per cent. increase.[1]

Reflecting these changes in world production and consumption, the production of apples in the United States is down 20 per cent. from the production in the 1934–8 period and 30 per cent. since 1949. Canadian output has declined 10 per cent. from the pre-war level and 20 per cent. from the 1946–50 period.

Apple-acreage statistics are not available for the United States but the decline in total tree numbers from 100 million pre-war to 50·6 million in 1950 indicates a drastic cut in acreage. In Canada the decline was from 6·5 to 5·4 million trees.

The real casualty in Canada was Nova Scotia where the loss of the British market in World War II combined with changing consumption to bring about a serious situation. Tree numbers were reduced by 50 per cent. from 1·8 million in 1941 to 0·9 million in 1951. What happened in the reallocation of resources is significant to this discussion. It illustrates how an industry can meet a difficult situation—can pull itself up by other boot straps, so to speak.

Adjustment of sales to the domestic market and diversion of pro-

[1] Statistics on apples in Canada in this section are from: D. W. Ware, *Trends in Fruit and Vegetable Production and Consumption*, Unpublished data, Economics Division, Marketing Service, Canada Department of Agriculture, 1955.

duct, capital, and labour into apple processing were among the early efforts used to meet the situation. This was followed later by the removal of trees, largely varieties no longer in demand, and by conversion of acreage to other crops. In this the Federal and Provincial governments gave assistance. The major adjustments, however, were made by the industry. Acreage was diverted to small fruits and vegetables and to grass and pasture. In the Province as a whole expenditure on lime and fertilizers, sprays and pesticides greatly increased; poultry numbers mounted from 1·1 to 2·6 million head; buildings were converted, and expensive new plant and equipment installed. The production of silage from grass, reflecting the shift to grass-land farming, moved from 2,000 tons in 35 silos in 1949 to 70,000 tons in 700 silos in 1953.[1] Not all of the gains indicated are the result of adjustments in the apple industry, nor have all the gains been maintained, but the fact is that the orchard area of the Annapolis Valley has led in major readjustments in resource use and in technical changes in agriculture.

Butter and margarine. In much of the Western world margarine has displaced butter. In dairy farming everywhere adjustments are being made. Often these have intensified the shift to production for fluid consumption, leading to more intensive land use, new labour-saving equipment and buildings, improved sanitation, more forage crops for winter storage, and more labour.

In some countries the shift has been away from dairying. In Sweden, for instance, Åstrand reports that in 1950 butter prices were adjusted in favour of vegetable and meat production.[2] The result was less milk, reduced butter surpluses, and rural depopulation. The rural labour force, also encouraged by an urban trade boom, has declined by between 30 and 35 per cent. since 1939.

Livestock production. Changes are taking place in North America in the production of cattle and pigs. These are related to consumer preference for meat and, in the case of pigs, to a declining market for fat for the production of such products as soaps and shortening. As for beef, the demand is for smaller cuts with less fat. With pork it is for leaner meat. These preferences have been expressed in price changes. For the fifteen-year period 1905–19, wholesale prices of fat cuts of pork on the Chicago market averaged $15·57 per 100 lb. The price of lean cuts was $13·83. During the period 1938–52, the average price of fat cuts was $20·48 or 32 per cent. higher than for

[1] *Report of the Department of Agriculture and Marketing*, Nova Scotia, 1954.

[2] Letter to speaker from Halvdan Åstrand, Agricultural Economics Research Institute, Stockholm.

similar cuts in the earlier period. In contrast, lean cuts had increased to $28·92, an increase of 109 per cent. In 1952 the wholesale price of lean cuts was 40·0 cents a pound; that for fat cuts 23·9 cents. Forty years ago fat cuts averaged 18 per cent. more than lean cuts.[1]

This demand for leaner pork is affecting pig production in the United States. For some years experimental work at various institutions has been focused on the development of meat-type pigs. Livestock associations, extension workers, and farmers are now taking up the campaign for increased attention to this type of pig. Stressing one of its advantages, the secretary of the Iowa Swine Growers points out that the true meat-type pig is a good rustler and makes good use of legume pasture in summer and of grass silage and high quality hay in winter.[2]

The effect of this on technological change in agriculture may also be inferred from a similar statement made by D. Howard Doane. He urges less attention to rapid maturity and high daily gains based on the feeding of corn and concentrates and more emphasis on pasture and hay. It requires only about 700 calories to produce 1 lb. of lean meat gain at weights of from 180 to 200 lb. compared with 4,000 calories of fat gain.[3] Thus a general shift to the production of meat-type hogs in the United States would have a significant effect on resource use in the corn belt of the mid west.

The change that is now under way in the United States took place in Canada during the 1920's. In a few years Canada changed from a fat- to a bacon-type pig. The change was made to meet consumer preference on the U.K. market, but Canadian consumers also liked the result. Also during that time, Canadian bacon was gaining popularity in sections of the United States. Since then, well-trimmed back bacon, 'Canadian Style', most of it produced in the United States from leaner-type pigs, has sold in substantial volume.

Referring to beef, Baker, in the same reference, states that consumers prefer the lighter younger steer and heifer beef, and that desirable carcass weights have declined from the old-time three-year-old steer with its 650 or 700 lb. carcass to younger animals that will dress out at 400 or 450 lb. He quoted heavy Red Brand carcasses (top quality) at Winnipeg selling for less than light-weight Blue

[1] F. A. Pearson, W. I. Myers, and E. E. Vial, *Interrelationships among Consumers' Supplies, Demands and Prices for Beef*, Department of Agricultural Economics, Cornell University, U.S.A., July 1953.

[2] Wilbur Plager, 'A Muscle Program is Our Best Hog Tonic', *American Hampshire Herdsman*, Sept. 1951.

[3] F. M. Baker, 'Livestock Production and Market', *Agricultural Institute Review*, Jan.–Feb. 1953.

Brand (second quality) carcasses. The same trend in consumer demand is evident in other countries.

These changes will affect the market for grain and concentrates. They will affect the volume of meat produced per acre. Shifts in land use and in technology will occur. More pasture, hay, and silage will be produced and less grain. Less concentrated feeding should mean less building investment and less labour. More capital may be put into growing cattle and less into feed-lot operations. Reflecting this change, pasture-improvement by fertilization and the almost phenomenal production per acre of beef from irrigated pasture are attracting much attention among Canadian stockmen.

Natural and synthetic fibres. Consumer interest in synthetic fibres is having an apparent effect on the production of certain natural fibres. Statistics on a world basis for synthetic fibres are not at hand, but data for the United States may be indicative of what is happening in other Western countries. In the period 1939–52 the annual *per caput* use of cotton in the United States has varied from 25 to 41 lb. but there has been almost no net change. Wool consumption has varied from 3 to 5 lb. *per caput* but with no perceptible trend. In the case of rayon, acetate, and other synthetic fibres the secular trend has been rapidly upward from 3·5 to 9·2 lb. *per caput.*

In the 1934–8 to 1952 period world sheep numbers exclusive of U.S.S.R. have increased from 665 to 692 million or 4 per cent. against a population increase of 15 per cent. North American totals have declined from 54 to 33 million. The world wool clip, exclusive of U.S.S.R., was up by 7 per cent.

In the same period world cotton acreage, exclusive of U.S.S.R., gained 4 per cent. and production 20 per cent., flax fibre production on the relatively small acreage outside U.S.S.R., was up 90 per cent. and output 60 per cent.

It seems apparent that interest in the production of sheep has failed to keep pace with the demand for fibres. This is particularly noticeable of North America where sheep numbers have declined nearly 40 per cent. The acreage of cotton has lagged behind population growth, particularly in the United States where a net loss of about 10 per cent. has occurred since the mid-thirties. But here the gain in output, due to greatly increased yields in the United States, has more than kept abreast of world population growth. Some will probably relate this to price supports and acreage allotments, but it may also reflect technological advances in an industry faced with increasing evidence of consumer interest in competing products.

Rubber. Beginning with World War II and throughout the inter-

vening years synthetic rubber has made heavy inroads into the consumption of natural rubber. It now represents one-third of all rubber used. Consumers have found the synthetic article suitable for many purposes and its uses are increasing. Its competition poses a real threat to the agriculture of Malaya, Indonesia, and other countries and to their national economies.

In Malaya, one of the largest producers of natural rubber, various governmental policies have affected the situation, but within the industry itself and with government assistance to a degree, changes in land use and technology have been adopted. New varieties of high-yielding materials—budding clones and clonal seeds—have been developed by plant breeders, and extensive experimental work has been carried on. Land is being cleared of low-yielding trees at an average cost of from $250 to $300 per acre and replanted to new varieties and under improved cultural practices. The cost of clearing and replanting, combined with a waiting period of six to seven years for a new planting to come into production, has retarded necessary adjustments, particularly among smallholders. To meet this problem subsidies are paid to them, the funds for which are derived by a tax on the product of the industry itself. The competition of synthetic rubber and the development and acceptance of new products have brought improvements in processing and marketing. New impetus is being given to the search for new uses.

Adjustments involving other crops are also being made. Land in rubber is being diverted to coffee, coconuts, paddy, pineapple, and other products. These involve not only new techniques of production but new investments in processing machinery and in facilities for marketing. To encourage this development subsidies may be paid on much the same basis per acre, as for replanting of rubber.

The Effect of Urbanization and Population Density

A third type of consumption change that is significant in the context of this paper is associated with changes in the concentration of population. Apart altogether from the change common to the population as a whole, the changes in total consumption that occur in a particular area have pronounced effects on resource use and techniques of production. Lattimer, in a study of markets for farm products in the province of Quebec, found that in the forty years, 1901 to 1941, the population in four counties increased 227 per cent.[1] These counties, containing large urban centres, had the highest *per*

[1] J. E. Lattimer, *Shifting Markets for Farm Products*, Technical Bulletin No. 18, Macdonald College, Ontario, 1946.

caput income. In twenty-four other counties the population increased but 36 per cent. Referring to the effect of this concentration of population on dairy farming he notes that such centres provide enlarged markets for fluid milk. The average price paid to farmers in 1940 was $1·40 per cwt. compared with 98 cents in distant counties where milk was used for manufacturing purposes. Cows produced 5,669 lb. per head annually compared with 4,045 lb. Land values per acre were $81 and $55 respectively. The farms nearer large cities were smaller and more intensively worked. Many produced vegetables and fruits. Twelve per cent. had trucks compared with 2 per cent. in the remote areas.

In short, the growth of consuming centres intensifies production in nearby areas. Production of milk for fluid use replaces production for manufacturing purposes. Farms become smaller. More feed is purchased and less grown. Intensive fruit and vegetable production replaces extensive grain and pasture. More fertilizers are used and more land is irrigated, more labour per acre is employed. Immigrant labour replaces some native population. For a time at least fewer cars and more trucks are in evidence. Land, labour, and capital are all used more intensively.

Resource and Technological Change in Existing Production Patterns

What more should be said of the effect of consumption changes on existing industries as contrasted with developments in new fields? Has the decline in consumption of potatoes and cereals stimulated more intensive use of resources and technological aids by growers of these products? The answer is in the affirmative. With added investment in machinery, with insecticides, fungicides, and herbicides, and the substitution of fertilizers for land, efforts are being made to meet competition. In commercial potato-producing areas the use of 1,000 lb. of fertilizer per acre is fairly common and 2,000 lb. or more not unusual. In New Brunswick, Canada, where probably 75 per cent. of the fertilizer bought is used on potatoes, farmers in 1953 purchased almost double the tonnage of fertilizer for about the same acreage as in 1940, and the plant food value of the product now purchased is probably 60 per cent. higher than that of 1940. Certified seed and the newest technique to control insects and disease are in general use. Yield per acre has increased by a third or more.

Much the same may be said of wheat production. While acreage has declined in areas where alternative crops are feasible, the commercial producer in the major surplus producing countries has gone

'all out' to protect his interests. Nowhere, perhaps, has so much been spent on machinery. The use of fertilizer is increasing. The state of Kansas, a great wheat-producing area, uses 200,000 tons annually compared with 12,000 in the 1935–9 period. Nowhere is the latest discovery of the chemist, botanist, and field husbandman more eagerly sought and adopted. Improved cultural practices and the most efficient techniques for control of weeds, insects, and disease are in general use.

What has been said of wheat and potatoes is true of cotton, butter, rice, and other products. Though production will ultimately decline when consumption is permanently reduced, the impulse is to meet competition with new combinations of resources and technological improvements.

In the economies with which most of us are familiar, price and income (reflecting consumption) play an important role in adjusting production. Many have asked if price support policies now in general use have prevented or delayed necessary and desirable resource and technological adjustments; whether the resistance to adjustment in wheat, cotton, rice, butter, and other products should be encouraged; whether it might not be in the interests of agriculture to free prices and facilitate adjustment. Some say 'Yes',[1] and at least one strong voice has questioned the claim that all the effects of price support are negative in the matter of resource adjustment.[2] As between conflicting arguments on this issue there is room for the view that a flexible and moderate support policy may help in easing agricultural adjustment and in stabilizing national economies through a prolonged period of transition from war and cold war to peace.

The Measurement of Change

If we accept the proposition that changes in consumption influence resource use and technological advances, some further examination of global use of resources and at least national advances in technological change may be of interest.

Changes in land use have been suggested already both globally and in national and industrial settings. Shifts in labour are mainly out of agriculture. Seldom, in the Western world at least, has agriculture as a whole or any segment experienced a net gain in labour supply. Two factors of production that have become relatively cheaper owing to technological advances in the urban sectors have

[1] The Farm Foundation, *Turning the Searchlight on Farm Policy*, Chicago, 1952.

[2] J. K. Galbraeth, 'Economic Preconceptions and the Farm Policy', *The American Economic Review*, Mar. 1954.

been used more abundantly in farming. These are fertilizers and machinery. World statistical summaries provided by F.A.O. indicate that in 1952–3 4·7 million metric tons of commercial nitrogenous fertilizers (N) were used compared with 2·4 million in 1938. Comparable data for phosphoric acid (P_2O_5) were 6·1 million in 1950 and 3·5 million in 1938; for potash (K_2O) 4·6 and 2·5 million—increases of 96, 75, and 84 per cent. respectively.

In 1952 there were 6·3 million tractors in use throughout the world exclusive of the U.S.S.R. This is an increase from 5·4 million in 1950. No pre-war data are available. In 1953 there were 4·4 million tractors and 2·5 million trucks on farms in the United States compared with 1·4 and 1·0 million in 1939. In Canada annual sales of farm machinery since 1948, adjusted to 1935–9 prices, have consistently run four to five times those of the base period.

National statistics on farm costs in Canada indicate that total inputs for 1954 in 1935–9 dollars were 44 per cent. higher than in 1926. Labour was down 45 per cent. and interest 43 per cent. Feed and seed were up 200 per cent. and fertilizer 500 per cent. Truck and tractor costs were up five to tenfold.[1] These data clearly indicate the shift in resource use. Inputs of labour and capital in real terms have been reduced by nearly one-half; mechanical power has been greatly increased. Fertilizers have replaced land in the expansion programme. Much more feed and much higher priced feed has been fed to livestock. The gains from the additional inputs are significant. In the United States farm output per man-hour in 1953 had increased almost 200 per cent. over 1910.[2] Brewster calculated that output per worker in 1953 had risen 341 per cent. since 1870.[3] In the United Kingdom net output per man-hour in 1952–3 based on 1951–2 prices was 58 per cent. above the 1937–9 level. This was achieved with the aid of an increase of 168 per cent. in farm machinery and increases of from 111 to 258 per cent. in various types of lime and fertilizer used.[4]

In Canada an index of physical volume of output per man-year in agriculture suggests a gain of 140 per cent. between 1935 and 1952. The increase since 1946 is shown as 80 per cent. The author of this

[1] W. McKenzie, Unpublished data based upon *Reference Paper 25*, University of Alberta, Dominion Bureau of Statistics, Ottawa.

[2] Agricultural Research Service, *Changes in Farm Production and Efficiency*, U.S.D.A., June 1954.

[3] John M. Brewster, 'Farm Technological Advances and Total Population Growth', *Journal of Farm Economics*, Feb. 1955.

[4] H. T. Williams, *Changes in the Productivity of Labour in British Agriculture*, A paper read at the British Agricultural Economics Society Meeting, July 1953.

calculation attributes about 35 per cent. of the gain to favourable weather.[1]

To what shall we attribute these gains? To express them in terms of labour is like crediting jet propulsion to the man that operates the controls. Consumption changes have provided an impetus. The movement of resources to more productive channels and new combinations of use in the same channels have contributed. But technology is also an important factor. Schultz and his associates at Chicago, using Bureau of Agriculture Economics data with adjustments of their own, have come out with some results.[2] They conclude that on the basis of 1946–8 input prices 14 per cent. more inputs were employed in U.S. agriculture in 1950 than in 1910. This gave an output 75 per cent. larger, or a gain of 54 per cent. on each new unit of input. Using 1910–14 prices the gain per unit of input was 32 per cent. These advances they ascribe to improvements in production techniques. Looking ahead to 1975 John D. Black, in his statement for the Paley Commission Report, concluded that an increase of 85 per cent. in U.S. farm output is technically possible but that an increase of about one-third per acre on the basis of the gain in technology between 1925 and 1950 is more likely.[3] Applying a similar analysis to Canadian agricultural statistics, Anderson has measured the increase in input and output and attributed the difference in the rate of increase to technological progress.[4] Using input-output ratios based on 1935–9 prices and comparing the four years 1926–9 with the seven years 1947–53 he gets a rate of increase equal to 24 per cent. Since the gain in output without reference to factor cost was 36 per cent., he concludes that two-thirds of this was due to advances in technology.

While it may seem that these authorities have failed to recognize sufficiently the gains from shifting resources, from inherent improvements in resources (quite apart from changes in input costs), and from improved weather conditions, for purposes of this discussion these may be disregarded. It is apparent that changes in resource use and in the application of technological advances contribute to significant increases in output. In stimulating these advances consumption changes play an important role.

I have pointed out that the causal sequence suggested by the title

[1] H. C. Pentland, *The Economic Journal*, June 1954.

[2] T. W. Schultz, *The Economic Organization of Agriculture*, McGraw-Hill, 1953.

[3] *A Report to the President by the President's Materials Policy Commission*, June 1952.

[4] W. J. Anderson, *The Effect of Technological Progress on Input-Output Ratios in Agriculture*, Paper read at the annual meeting, Canadian Political Science Association, Toronto, June 1955.

may not meet with general acceptance. The influence of production on choice and consumption may be more important than is implied.

Information on consumption trends in various countries of the Western world suggests a long-run shift from the starchy and relatively cheap cereals and potatoes to the more expensive high protein foods and to fruits and vegetables. This, I have suggested, has led to a shift in land use throughout the countries of the Western world. More detailed examination of representative commodities indicates significant changes in consumption and in resource use. Changes in population density have had the same effect.

The effects of changes in consumption are not confined to the shifting of resources from product to product. They also produce new combinations within existing segments of agriculture; and greater application of technical improvements.

The study of input-output ratios and production data for various periods indicates very significant advances which may be related to progressively more efficient use of resources and to technological improvements. This development, I suggest, has been influenced by changing patterns of consumption.

D. R. Bergmann, *Institut National Agronomique, Paris, France*

The evolution which Dr. Booth spoke of should be given a name. If you will allow me, I shall call it the 'westernization of diet'. The speaker has shown the nature of this transformation very clearly. He might also have mentioned the work of F.A.O. on food schedules, and made analyses such as those given by Mr. Cépède and Mr. Langellé in their recent book on world food economy. But is this westernization of diet always possible? Can all countries have a diet containing more protein, fruit, and vegetables? For different reasons many countries may be prevented from following such a trend.

If a country is to improve its diet in this way, its rate of increase in population must not be too rapid in relation to the rate of agricultural progress. Furthermore, average incomes must increase and inequalities in incomes must be reduced. Finally, there must be no government measure or sociological obstacle to prevent the change.

Evolution in food consumption in the sense described by Dr. Booth is therefore a luxury. It is a luxury which some countries cannot allow themselves, either because of circumstances which limit their resources, or because the population and the level of incomes in these countries permanently prevents them from improving their diets.

Historically, it was not consumption which governed production,

but the reverse. At the self-sufficient stage production depended on the opportunities of the district, and the products were consumed during the year by the farmer's family. Consumption habits thus depended on natural possibilities. Even in a country such as France, this 'geography of consumption' is found even now. There are, for example, regions where the principal fat is olive oil, others where butter is mainly used, and yet others where lard is the chief fat. This geography of consumption applies also to drinks.

But if certain countries have been able to improve diets because of technical and economic developments, the possibility must not be excluded of movements in the opposite direction. An example of this is to be found in Algeria, where it would be logical (which is not to say that it will happen) to give up the cultivation of certain crops such as vines, which are luxury products, in order to increase the production of goods necessary for the feeding of a population which is increasing rapidly. Similarly, if there were a world-wide shift from a profit economy to a more generous distributive economy, the rich countries would have to be content with less protein in their diet; and in all probability resources would have to be transferred from meat to plant production. I think that nutrition experts should be called in to develop diets which would be adequate for human nourishment, and which would also take into account the natural resources of the countries concerned. It would also be useful if the teaching of ecology were included in the training of agricultural economists.

In the second place, will the desires of the consumer always be fulfilled by the producer? In the United States or Canada one has the impression that many farmers modify their activities to suit the trend of consumption. Naturally, in liberal régimes, the price mechanism induces producers to decrease one crop or to increase another. Changes in price relationships tend to bring about the transformations in the use of resources which have been so clearly described by Dr. Booth. But in many cases this machinery works badly. Why?

Firstly, there are farmers who are ignorant of market trends because they sell very little. Consequently, price relationships do not influence them. Others are insensitive to these monetary influences because of sociological factors which may be classed as tradition. There are farmers also who do not wish to alter their production patterns because it would entail changes in their methods of management. For example, on the large farms in the Paris region which employ hired labour, changes in consumption pattern would justify an increase in milk production, but the farmers refuse to go in for

dairy cows which bring many labour problems, especially on Sundays. In other cases institutional factors prevent the necessary changes. For example, in south-western France, there are some share-cropping farms (*métayage*). To change their major product from cereals to animal products or vegetables would lead to difficulties of supervision. Such a change would be resisted by the owners. Further, the preferences of the consumer are translated to the producer by a commercial system. We all know the defects of this system. In the case of France, while the change in consumption pattern would encourage farmers to produce more meat, certain farmers forgo this change because they see that the markets for store and fat cattle are so badly organized that they cannot obtain reasonable prices.

In France all these factors have played a part and we have many farms which have not followed the evolutionary process mentioned by Dr. Booth. They have not changed their systems of farming. For this reason the most fashionable word at the moment in French agricultural literature is 'reconversion'. 'Replacement crops' are also much spoken of. Naturally, this reconversion is extremely complex. It would require a better knowledge of the resources of each region and of each farm, together with an analysis of demand, and an economic model such as that set up in the United States by J. D. Black and R. Mighell. It would also require a policy ensuring the complete economic development of the under-developed regions of our country.

E. F. Nash, *University of Wales, Aberystwyth, Wales*

I agree that the wording of the title which has been assigned for this session of the discussion calls for a little comment. It seems to me that the effect of changes in consumption on the fortunes of farmers and on the use of resources in agriculture is one subject, and the question whether these changes in consumption are the cause or the effect of technical progress in agriculture is another. In my opinion, it is only in a limited and partial sense that changes in consumption cause technical progress in production. Dr. Booth has given examples of this when he instances the influence of the growth of towns and urban communities on the agriculture of the surrounding areas. Instances of this kind of influence are familiar of course in many different periods of economic history, and they are the basis of Adam Smith's well-known contention, that 'the commerce and manufacture of cities, instead of being the effect, have been the cause and occasion of the improvement and cultivation of the country'. But Adam Smith would have been the first to remind us, I think, that

increases in the aggregate of consumption are rendered possible only by increases in the aggregate of production, and to those latter increases in production, of course, agriculture and all other branches of productive activity contribute. The question whether or not changes in consumption are the cause of technical progress is one which I propose to dodge. The growth of real income is made possible by technical progress, whatever its cause, and the use mankind is likely to wish to make of that increase in its real income, and the effects of its choice in that matter on the fortunes of agriculture, and on the uses of resources in agriculture, seem to me to be the questions to which we can most usefully give our attention. What I have to say is mainly devoted to the first of those questions, namely, the use mankind is likely to wish to make of any such increased income.

As Dr. Booth has reminded us, we know the answer to that question, in a certain sense, and up to a certain point. We know something about the kind of changes that occur in consumers' preferences as their incomes rise. Two general principles have been established, to which we may refer for brevity, as the Engel Law on the one hand, and the Giffen Law on the other. The Engel Law states that as income rises a smaller proportion of income tends to be spent on food and other necessaries; and the Giffen Law is to the effect that when a certain level of quantitative adequacy in the diet has been reached, consumers tend to try to improve its quality by rejecting the cheaper sources of energy, such as cereals and potatoes, and by increasing their consumption of livestock products, fruits, and vegetables. In modern jargon, the first of these tendencies means, of course, that the income elasticity of demand for food is less than unity, and the second means that this elasticity for some commodities is very low, or even negative. On the other hand, for those commodities of which the consumer tends to increase his consumption as his income rises, elasticity is relatively high. In Great Britain these principles can be illustrated by the findings of recent analyses of pre-war expenditure. The total income elasticity of demand for food of all kinds has been put at about one-half. Small, zero, or negative elasticities have been given for such foods as flour, bread, condensed milk, margarine, sugar, and tea, but elasticities considerably greater than the average have been assigned to such expensive foods as fish, cakes, fruit, and green vegetables. Round about the average level of income elasticity we have such foods as milk, meat, and eggs.

But to suggest that we have in these fairly well-established tendencies a complete analysis of the reaction of consumers' demand for food to changing economic circumstances, is of course an over-

simplification. Some light has been thrown on the complications in Great Britain, by the National Food Survey, an investigation of food expenditure and consumption which was started by the Ministry of Food during the war, and is being carried on by its successor ministry, the Ministry of Agriculture, Fisheries, and Food. One point which comes out is that if you try to estimate the elasticity of consumers' demand from the expenditure only, without reference to the quantity of consumption, you may get the answer wrong, because families at higher income-levels pay higher prices, as well as consuming, very often, larger quantities. The reason for their higher price is frequently a difference in the quality of the food they buy. Also again, it is partly explained by a difference in the quantity of other services, which are, so to speak, wrapped up in the food parcel which the housewife buys. This fact was referred to by Dean Young this morning. But there are some interesting exceptions to this tendency. For example, analyses of consumers' budgets in Great Britain show that the expenditure on commodities like fresh vegetables or eggs does not always rise so rapidly, as you go up the income scale, as might be expected. Here, the explanation is that families of higher income and in higher social classes provide more of these commodities, such as garden produce, for themselves. Another exception to the general tendency for more services to be bought with food as income rises is provided by that commodity known as fish and chips which consists of fried fish and fried potatoes. It is very commonly bought by working-class housewives as a ready prepared meal, but it is relatively little used by families of higher income-levels. Of course, housing and other matters connected with housing also exert an important influence in these respects. The food storage available to the housewife, whether or not she has a refrigerator, and other circumstances of that kind, also influence these differences in consumption. Again, the type of work done by the members of the household has an influence which is clearly visible in the survey figures. Generally speaking, among families at the lower income-levels, the wage-earners are more likely to be engaged in manual work, and this partly explains their greater consumption of energy foods. Then again, there are regional differences in food consumption, some of which may originally be due to differences in the kind of produce which local resources can make available, but they give rise to food habits which sometimes tend to persist, even after the original reason for these peculiarities may have disappeared. It is natural to expect, for example, that fish will not be consumed in such large quantities by families living at a distance from the sea as by those on the sea-coast.

We find in Great Britain that fresh green vegetables are not consumed in such large quantities north of the Scottish border as south of it. This difference is no doubt climatic in origin. There are other differences, even within a country which is so comparatively homogeneous as Great Britain, and of course there are much greater differences when you come to make international comparisons, for which differences no very obvious explanation may suggest itself. We find in some parts of Great Britain, for example, that it is a common practice to make bread in the homes, whereas in other parts it is unknown. During the war the Ministry of Food made special efforts to see that miners had a relatively large supply of cheese because we were told that miners liked to take cheese down the pits with them—and this was greatly appreciated, I am glad to say, by the miners in South Wales. But we had letters of complaint from the miners on the north-east coast of England, who asked why we were giving them all this cheese; they said that if you worked doubled up all day long as they did, you would find that cheese only gave you a stomach-ache. Then there are differences due to composition of the family, which it is sometimes difficult to disentangle from differences in income.

Moreover, even if you have established a fairly clear picture of the pattern of consumption at a particular time, the pattern may change over time, and this point comes out when we compare recent data with pre-war data. The biggest change in the British diet since the war, as Dr. Booth remarked, is the very large increase in the consumption of liquid milk. A recent study of the elasticity of demand shows that the income elasticity of demand for milk is now very much lower than it was before the war. This, of course, may be partly due to the fact that the consumption has approached a satiation level, but it is undoubtedly due in part to the special measures which the Government have taken in encouraging the consumption of liquid milk by subsidies and by providing cheap supplies for mothers and children. This is a reminder that changes in demand may often depend to some extent on government policy as well as on the spontaneous reactions of consumers to changes in income and prices. Generally speaking, the present-day figures for diet in different income groups in Great Britain show, as one would expect, a considerable levelling out of the differences since before the war. This is partly due to the continuance of rationing which we have only fairly recently got rid of in Great Britain; and the full effects of a return to a free market are not yet able to be studied in the survey data. It is therefore not yet possible to say, with any confidence, what has happened to the elasticity of demand for food in general, because the

latest data on the subject are still affected by the continuance of rationing.

Those are some points which emerge from the study of consumption within one country and of course, when we try to study it on a world-wide basis, the complications are multiplied many times. In order to make any estimate of the future of the world demand for products like cereals, for example, it is necessary to estimate where on the scale of consumption in relation to income different countries stand, and also to estimate what is likely to happen to their income-levels; and only when all these different estimates have been put together can they be translated into anything like a prediction of the future of the world's demand for the product. I suggest that a study of these tendencies on a world-wide basis would be most valuable and instructive. We have some approach to such a study in some of the work done by the F.A.O. For example, there is a most instructive chart published in the *State of Food and Agriculture in 1954*, which shows the relation in a number of different countries between the average income-level and the consumption per head of cereals and potatoes on the one hand, and also of animal protein foods on the other. The cereal chart shows a curve which rises to a maximum consumption reached at an income-level of I think about two hundred dollars a head; but the animal protein chart shows an apparently linear relation between the logarithms of consumption and income, suggesting that the income elasticity is approximately constant, and is about three-quarters.

It is on the basis of data of this kind that the question of the future of the world demand for these groups of products will have to be studied. The nearest approach which the F.A.O. have made I think to such studies is in their 1960 nutritional targets which are contained in the second edition of the *World Food Survey*. But these are not quite the same thing as a prediction because they are targets; they represent desirable levels of consumption, rather than levels of consumption which appear to be actually likely to be attained. Those targets cover more than sixty countries, and in the majority of them the experts who drew up these targets considered that an increased consumption of cereals was desirable. And in fact, on balance, the total world demand for cereals, when all the different estimates for different countries are added up, and if the targets were reached, would be 20 per cent. greater in 1960 than it was in 1950. That demand includes the world's need for cereals for animal feed as well as for direct consumption.

In the case of animal protein foods, the targets suggest that an

increase of 30 per cent. in meat consumption ought to take place in 1960 compared with 1949–50. But the question then arises how likely is it that an increase will occur? Can such an increase in supply be obtained, and is the demand for the foods in question likely to increase correspondingly? Those questions have not been fully examined. So far as demand is concerned, we can make some sort of guess at the rate of increase in consumption which is postulated in the target by using the relation I have just referred to, given in the F.A.O. diagram. From that it would appear that the average increase in the income per head of many countries where animal protein consumption is low would have to amount to 20 per cent., and in some cases considerably more than that, in order to give rise to the increase in demand necessary to reach the targets. I do not know whether such an increase in income is likely to occur, nor can I answer the question whether or not the increase in world supply necessary to satisfy such an increased demand would be forthcoming. But I would like, if it is not too presumptuous on my part, to end with the suggestion that more work on those lines should be done. For, valuable as the targets are as a guide to food policy, prediction also has its uses.

A. HANAU, *University of Gottingen, Germany*

The speakers have referred mainly to conditions in the more highly developed countries. Unfortunately we do not know enough about consumption trends in the under-developed world. In particular, we do not know the income and price elasticities of demand for food in these areas. Such data, however, are needed if we are to estimate the conditions of absorption of an increasing rice production. We hope that F.A.O. will supply these figures in the near future. With reference to demand for food in the developed countries I would like to draw your attention to the following facts. In the last 150 years the industrial revolution has caused great changes in consumption patterns, such as the proportionate increase in consumption of animal products, vegetables, and fruit. While these trends continue, the rate of increase is decreasing in those countries which have already reached a high level of real income. Here we can observe another striking development: an increasing demand for services which are combined with the sale of food. This new development is a consequence of the urgent desire to diminish kitchen work. This trend is well established in the United States of America and in countries which enjoy a similar high standard of living. To save labour in the household is an increasing problem in other countries also, especially in western Europe. More prepared and processed

food is required; and more services are demanded, particularly from the retail trades. This demand must tend to increase retailers' margins. Moreover, increasing wages and salaries, induced by industries with rapidly increasing productivity, cannot be absorbed by retail food trades without a further increase in margins. These tendencies towards increasing retail margins do not favour agricultural producers.

ERIC ENGLUND, *Embassy of the United States of America, London*

I would like to call attention to one point, which has been referred to only on the fringe of this discussion. Reference has been made to the effect of different levels and distribution of income upon patterns of consumption, including that pattern which is represented by a shift from the high calory foods, such as potatoes and bread grains, to fruit, vegetables, and meats. There is one technological aspect on which I think one day we shall have more facts for our analysis, and that is the effect of technological change—and may I add mechanical change—upon the physiological requirements for food.

In the more advanced countries, which we have cited many times from the standpoint of income analysis, we also have great additions to mechanical aids to work. We also have the phenomenon of shorter working hours and therefore more leisure. This reduces food requirements as measured in terms of calories, for less physical exertion is required of the masses of the population. Patterns of food consumption tend to be correspondingly altered. This might play a larger role in our analysis when statistical data on these and similar matters have been assembled. I believe we shall have to rely very heavily on the physiologists in the first instance. At any rate, we shall need their help.