SECOND SCIENTIFIC MEETING—SECOND ENGLISH MEETING

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE,
FEBRUARY 28TH, 1942

FOOD PRODUCTION AND DISTRIBUTION IN RELATION TO NUTRITIONAL NEEDS

Morning Session: Chairman, SIR WILSON JAMESON

In opening the proceedings, Sir Wilson Jameson (Chief Medical Officer, Ministry of Health) said that it was the Government's policy that the Ministry of Food should be advised by the Minister of Health. His (Sir Wilson's) duty was to watch for any deterioration in the nation's health. There was no evidence so far of anything serious. During his recent visit to America he had been greatly impressed by the interest in nutrition shown by official bodies in the United States and especially by the way in which a representative of the Department of Agriculture took part in all discussions. He was struck by the Toronto experiments (Ebbs, Tisdall and Scott, 1941), which showed what profound influence the prenatal diet had on the health of mother and child, and thought that it was imperative to draw from these experiments the necessary practical conclusions.

The Agricultural Implications of a Food Policy Based on Nutritional Needs

Sir John Orr (Rowett Research Institute, Bucksburn, Aberdeen)

(*Summarized Report*)

The field of nutrition is wide and the object of the Society is to bring the workers on different aspects of nutrition into contact with one another. It is necessary for the workers to realize the full implication of the science of nutrition. For example, the psychological effect of diet is one of the important problems of the future. It has been found at the Mayo Clinic that deficiency of vitamin B_1 in women has a depressing effect on their mental state (Williams and Mason, 1941). A wide gap exists between disease and perfect health. Those engaged in medicine might find much to learn from agricultural research on the subject of infant mortality. Much work has been done, for example, on the effect of diet on the viability of the chick. The infant mortality rates in New Zealand are considerably lower than in England and Scotland. Expectation of life in New Zealand is 9 years longer than in Scotland and 8 years longer than in England. In the 19th century there was no actual starvation. People had plenty of calories and protein. In the 20th century the need for other factors was discovered with consequent improvement in health. By 1934 dietary standards could be set up. This constituted a great advance. The National Nutrition Conference for Defense convened by President Roosevelt in 1941 set up similar standards. In this country 10 years ago one-half of the population fell below such standards, but

by 1937 considerable improvement had taken place and only about one-third of the population was undernourished, also deficiencies which were in existence were much less marked. In the U.S.A. a vast amount of work has been done in assessing the nutritional status of the population and similar results have been obtained. If sufficient protective foods were to be supplied to enable the population to obtain a satisfactory diet, the United States estimated that butter production would have to be increased by 15 per cent., milk by 20 per cent., eggs by 35 per cent., tomatoes and citrus fruits by 70 per cent. and the production of green vegetables and fruits by 100 per cent. (Stiebeling, 1939). In this country also all protective foods must be greatly increased. In Ceylon in peace time, one half of the population did not have enough calories. There is an appalling shortage of food in many countries at the present time. The United States of America are prepared to go ahead with a world wide food policy based on nutritional needs as a basis for post-war reconstruction. What is to be done with agriculture? We must obtain the maximum amount of food from every acre. More crops must be grown which can be used directly as human food. Direct consumption of grass as human food has been tried thousands of years ago under royal patronage, but it did not catch on. One man's work in Canada produces more wheat than the equivalent of labour in this country. Nations should co-operate to see that easily transported foodstuffs are grown in the regions where production is most economical. The foods which should be produced in Britain are vegetables, milk, eggs and pork. Agriculture will have to make this change-over. Certain countries like Malaya may have to change from cash crops like rubber to food crops. In Canada strains of wheat rich in vitamin B_1 have been produced and agricultural research may be able to increase the vitamin and mineral contents of various foodstuffs. These changes should be of enormous and incalculable benefit to the human race.

REFERENCES

Ebbs, J. H., Tisdall, F. F. and Scott, W. A. (1941). *J. Nutrit.* **22**, 515.
Stiebeling, H. K. (1939). *Yearb. U.S. Dep. Agric.* p. 380.
Williams, R. D. and Mason, H. L. (1941). *Proc. Mayo Clin.* **16**, 433.

Discussion

Squadron Leader T. F. Macrae, R.A.F.V.R. (R.A.F. Institute of Pathology and Tropical Medicine), opener: In the past we have imported large amounts of food from countries with ill nourished populations; to reduce these imports we ought to grow more food suitable for direct human consumption. Consumption of bread, from a flour of about 85 per cent. extraction (national wheatmeal), milk and milk products and a good variety of vegetables in liberal amounts would ensure adequate nutrition. Such a diet would be lacking in flavour and therefore those foodstuffs which we find particularly palatable, such as meat, eggs, bacon and fish, are highly desirable; even though these foodstuffs are among the most nutritious, it is their menu value rather than their nutritive value which is the more important.

Importation of all the wheat used for bread would appear desirable, since, to ensure a nutritious loaf, acceptable to the people and made from a flour of high extraction, good quality wheat must be used; English wheat is of poor quality.

Further encouragement of allotments would improve the supply of fresh vegetables. The present method of distribution of vegetables is unsatisfactory since now they contain only a fraction of their original food value when they reach the public. The onion or other tasty vegetable has its value just as the more nutritious potato, greenstuff or carrot.

Professor E. J. Bigwood (Belgian Commission for the Study of Post-War Problems, 115 Eaton Square, London, S.W.1): Sir John Orr stated that post-war agricultural planning had to be considered on a world wide basis if it was to be efficient. An indication might, therefore, be given in a few words of what the position is in a country like Belgium, not only because its position in agriculture is in many respects similar to that of Britain but also because there are indications of what the Nazis' agricultural policy is in occupied Belgium and probably in all occupied countries. Although the country was chiefly engaged in industrial activity, nearly two-thirds of its surface area was used for agricultural purposes before the war, and yet Belgium depended very markedly on imports for its food requirements. In terms of cost the deficit was of the order of 25 to 30 per cent.; in terms of calories it was as high as 50 per cent. and even higher, when the large imports of food for domestic animals necessary for home produced food of animal origin are taken into consideration. Of Belgium's agricultural land 50 per cent. was pasture. When the area of fodder crops is also taken into account, about 75 per cent. of our agricultural domain was used for the rearing and breeding of domestic animals. Less than 10 per cent. of it was used for wheat crops; bread was made almost exclusively of wheat flour.

The more the agricultural policy of a country is limited to the production of meat and dairy products, the more the country depends on its imports in order to cover the calorie requirements of its population. Per unit surface area of agricultural land the yield in calories is on an average at least ten times greater for crops than for the production of food of animal origin. Germany's policy in occupied countries is to change from pasture and fodder crops to cultivation of cereals, potatoes and sugar beet on a scale large enough to render the country as self sufficient as possible as far as calorie requirements are concerned. It brings back Belgium's position to what it was a century ago, and tends to throw the diet of the population entirely out of balance by exaggerating the deficiency in consumption of protective foods. The influence of such a policy on the nutrition of the population will be precisely the opposite of what should take place. If such a policy is general in all occupied countries it will tend to create the paradoxical situation in which European countries will produce more and more at home of the least perishable foods of which there are large world surpluses, and will depend more and more on shipment from overseas of the most perishable types of foods which properly should, as far as possible, be consumed where they are produced.

Mr. A. L. Bacharach (Glaxo Laboratories, Ltd., Greenford, Middlesex): The difference between optimum health and average or "normal" health has been less stressed in this country than in the United States. This difference, like that between frank deficiency and average health, may be regarded as a qualitative rather than a quantitative difference, even though the three states are bridged by a series of small quantitative

changes. It is difficult to produce a permanent advance in nutritional status from frank deficiency to average health and probably as difficult to raise the average to the optimal. To replace frank deficiency by optimal nutrition is at least doubly difficult, and may be even impossible of achievement in the span of an individual life. It is thus an eminently practical issue to prevent any lowering of the standards of health to a level that could no longer be considered even adequate. For this reason, surveys, such as those being carried out at Oxford and Cambridge, are of the greatest importance, quite apart from their theoretical interest, and the utmost vigilance should be maintained for signs of sub-clinical deficiencies, with a view to their immediate alleviation, before permanent harm is done.

Professor H. P. Himsworth (University College Hospital Medical School, London, W.C.1): In considering the advisability of raising the amount of any accessory factor in the national diet account should be taken of the psychology of feeding. There are two ways of supplementing a diet. One is to issue separately concentrates of the particular factor, as is being done with cod liver oil and fruit juice; the other is to ensure that the basic foodstuffs contain the increased amounts of the desired factor by either producing richer foodstuffs or incorporating the factor into the food. The latter method is the only one which guarantees that the object will be achieved. Under war time restrictions the population can relatively easily be persuaded to take foods and concentrates rich in accessory factors, but after the war there will be a rush for the palatable diets of peace time, and if nutrition is to be maintained it would appear important to ensure that the basic foods, which are consumed both in peace and war, contain all and sufficient of the necessary food factors.

Dr. S. W. Swindells (1 and 2 Albion Terrace, Cartergate, Grimsby): Adequate supplies of vegetables are being grown, yet, although these are eaten, clinical evidence shows the existence of vitamin C shortage. Methods of cooking in canteens are such that most of the vitamin C must be destroyed. This is particularly true of methods planned for school feeding when vegetables are cooked early in the day and kept hot until after morning school. This problem should be tackled by the Ministry of Health.

Sir Wilson Jameson: Difficulties are due to shortage of equipment.

Professor J. R. Marrack (Haymeads Emergency Hospital, Bishop's Stortford, Herts.): The destruction of vitamin C of food in communal feeding centres is not excessive. Nevertheless, judging from actual analyses of food as served, people are not getting at present enough vitamin C and supplies of vitamin A also are inadequate.

Miss M. C. Broatch (Room 443, County Hall, Westminster Bridge, London, S.E.1): The general standard of cooking and menu planning is low because it is often in the hands of inexperienced people. Although extra rations are allowed for school children they are not made use of to the fullest advantage because those in charge of school canteens do not understand the importance of supplying children with extra food and because the children themselves do not understand why they should eat vegetables. The importance of simple teaching of nutrition in the schools as it is done in the U.S.A. ought to be stressed.

Dr. E. Kodicek (Dunn Nutritional Laboratory, Cambridge): In connexion with the problem of white bread and wholemeal bread, attention should be drawn to a deficiency in the diet which has been regarded as non-existent in this country, that is the deficiency in nicotinic acid. The daily requirement for nicotinic acid has been suggested by Elvehjem first to be 25 mg. This figure is too high. The latest estimate of the Committee on Food and Nutrition of the U.S.A. National Research Council (1941) of 15 mg. seems to be nearer the truth. I have calculated the amount of nicotinic acid present in a pre-war middle class diet, as described by Drummond and Wilbraham; the value is about 12 mg. in the daily ration. As there have been no signs of an endemic occurrence of pellagra in Great Britain, this diet was sufficient to prevent the disease. Certain vegetarian diets, although low in nicotinic acid, may have just sufficient of the vitamin to prevent pellagra, although they may cause partial deficiencies; the daily ration of such a diet, according to my calculations, contains about 8 mg. of nicotinic acid. On the other hand, deficient diets used by Wheeler, Tanner and others to produce human pellagra supply about 2 to 6 mg. of nicotinic acid daily.

War time diet in the United Kingdom contains about 12 mg. of nicotinic acid, if wholemeal bread is being consumed. When, however, white bread is taken instead, the daily intake of nicotinic acid falls to the low level of 9 mg. Such a small amount of the vitamin in the diet may perhaps not cause an outbreak of pellagra, but may induce a state of partial deficiency.

REFERENCES

U.S.A. National Research Council. Committee on Food and Nutrition (1941). *J. Amer. med. Ass.* **116**, 2601.

For full references to earlier work, *cf.* Kodicek, E. (1942). *Lancet*, **242**, 380.

Dr. J. D. King (National Institute for Medical Research, Millhill, London, N.W.7): It is true that pellagra is not prevalent in Britain, but there is a condition which, in my experience, is associated with deficiency of one or more components of the vitamin B_2 complex, the so called trench mouth or ulcerative gingivo-stomatitis. In the army and, more recently in some children in London, I have found that this condition responds well when local treatment is supplemented by nicotinic acid or food yeast. The clinical appearance of these lesions is not similar to that in scurvy.

Rival Claims of Animals and Man for Food

Dr. N. C. Wright (Hannah Dairy Research Institute, Kirkhill, Ayr)

It is not often realized how important a part the livestock industry plays in the country's total agricultural production. The number of livestock almost equals the total of the human population, roughly 40 millions against 46 millions, while in addition there are some 80 million poultry. On a weight basis the livestock greatly exceeds the human population, the comparative figures being about 5 million tons for stock and 2 million tons for man. Moreover, the rate of live weight increase, the rate of reproduction, and the secretion of animal products such as milk and eggs make exceptionally heavy demands on the productive capacity of domestic animals. Within a life span of, say, 10 years,

a dairy cow will, for instance, have reached a liveweight of 1000 lb., produced 6 calves, each weighing 60 to 80 lb., and secreted some 20 tons of milk. The total dry matter contained in the resulting tissues and secretions will amount to over 5000 lb. During the same period of time a human child will only have attained a weight of about 70 lb., corresponding to 20 lb. of dry matter. Or, to make another comparison, a year after birth a human infant will have roughly trebled its weight; a pig, the fastest growing of the domestic animals, will in the same period have increased its weight over fiftyfold.

In these circumstances it is not surprising that before the war the total food consumption of the British livestock population was many times greater than that of the human population, and that much of the produce of our agricultural industry, as well as a large proportion of our food imports, consisted of feeding stuffs as distinct from human food crops. It will be instructive to examine briefly the pre-war figures. Agricultural production may be measured in terms of acreage or tonnage. As regards acreage, statistics show that, while roughly equal areas were devoted to the roots and green crops required for animals and man, the area producing cereals for live stock was nearly twice that producing cereals for direct human consumption. In addition, livestock utilized a vast acreage of grassland for grazing and for the production of hay. Summarizing the total figures it is apparent that, while only 3 million acres were devoted to human food crops, over 27 million acres were allocated to the maintenance of the country's livestock. These differences were roughly paralleled in the tonnage of the crops and in their contained nutrients. In terms of dry matter, livestock consumed nearly 10 times the quantity of home produced food consumed by the human population; in terms of energy they consumed 8 times as much and in terms of protein over 14 times as much. To these figures there must be added the nutrients contained in imported foods and feeding stuffs. Here again, however, the peace time claims of animals considerably exceeded those of man; over two-thirds of the total imports were destined for stock, the protein and energy contents being roughly in the same proportion. Thus, taken as a whole, the livestock population consumed about 10 times the crop nutrients normally consumed by the human population.

What is the justification of this very disproportionate division of crop nutrients between animals and man? The answer lies partly in the special role played by livestock products in the nutrition of the human population, and partly in the important contribution made by livestock to the country's soil fertility. Dietary surveys show that animal protein supplies practically half the total peace time protein intake of the human population, while nine-tenths of our intake of fat is also derived from livestock products. The value of both these classes of nutrients is, too, greatly enhanced by passage through the animal. The protein is not only improved in quality by virtue of its higher content of essential amino-acids, but is present in animal products in far higher concentration than in the corresponding plant form. Thus, while the protein content of the dry matter of grass, cereals and roots varies from 10 to 20 per cent., that of milk, cheese, eggs and meat varies from 30 to as high as 50 per cent. Again, while the percentage fat content of the dry matter of plant tissues seldom exceeds 5, that of dried milk is over 30, of dried eggs over

40, of cheese over 50, and of fat meat over 80. Thus the animal performs the valuable function of concentrating the available nutrients into a form more suited to the digestive systems of man, providing products of both minimum bulk and minimum fibre content. Moreover this process of concentration also applies to the mineral elements and vitamins, thus conferring on many animal products an exceptionally high value as protective foods. It would not be out of place to stress, too, the importance of such products in ensuring variety and palatability to what would otherwise be a monotonous and insipid starchy diet.

Of almost equal value from the point of view of man's food supply is the function of livestock in improving soil fertility. Even in a self contained agriculture the important role which livestock play in converting crop nutrients into humus is well recognized, though the magnitude of the contribution thus made is not always appreciated. To the point is the following quotation from a current report from India (Burt, 1941), a country where, until recently, the poverty of the ryot has led him to cultivate cash crops to the exclusion of animal fodder: "Experiments have shown that by devoting one-third of the farm in rotation to the raising of fodder crops for milch animals and using the manure on the land, more wheat, cotton and sugar cane were obtained from the remaining area *than from the whole farm previously*, in addition to a substantial profit from the milk." Such is the advantage of mixed husbandry, where "up horn" also signifies "up corn".

In Great Britain a further stage has been reached, for, as a result of importing large quantities of animal feeding stuffs from overseas, it has been possible not merely to increase greatly the application of humus to the land, but to make a substantial contribution to the supply of specific soil nutrients. The magnitude of this contribution may be gauged by the fact that the manurial constituents derived from imported feeds have supplied to the land each year at least as much potash and phosphate, in addition to twice as much nitrogen, as have been furnished by direct application of artificial fertilizers. Thus British agriculture, with its very limited acreage, has been in a position to compete on more equal terms with the extensively farmed areas of the world's cereal belt. Moreover the British farmer, adopting the practice common to many other industries, has at the same time been able to supplement his uncertain livelihood as a primary producer by turning more and more to "processing" as a source of increased income. Thus, as long as peace reigned and imports remained unfettered, the needs of animals and man were complementary, not competitive, and their interests identical, not antagonistic.

This specialization on livestock production has, however, been rudely shaken by the outbreak of war and the resulting intensive blockade of the British Isles. The immediate effect has been twofold. In the first place imports of both human food crops and animal feeding stuffs have had to be drastically curtailed and, as between these two classes of nutrients, human food crops have had to be given priority. In the second place, in order to meet the resulting shortage in the supply of human food crops, home agricultural policy has had to be rapidly re-orientated to produce more of such crops, notably wheat and potatoes, at the expense of large areas of grassland. There is no doubt that in a time of national emergency

such a re-orientation in policy is fully justified. If competition does exist between animals and man, its intensity will clearly depend on the relation of the available supplies of food crops to the total human requirements. The first essential must always be to ensure a sufficiency of gross nutrients for the human population, that is, an adequate supply of energy and of total protein. The alleviation of *undernutrition* must always be accorded priority over the alleviation of *malnutrition*. The overall efficiency of conversion of feeding stuffs into animal products seldom exceeds, and generally falls well below, 25 per cent. The beneficial changes in the quality of the human nutrients resulting from this conversion can, therefore, only be achieved at a high cost in energy and protein. Such a conclusion is equally apparent from a study of the gross nutrients obtainable from equal acreages devoted to the production of crops and livestock, respectively. Thus an acre of land will yield as potatoes some 6 million Calories, as wheat about 3 millions, as milk 1 million, and as meat only one-fifth of a million. Again, in terms of crude protein, wheat and potatoes yield 200 lb. per acre, milk about 100 lb. and meat less than 50 lb. Where, as in a blockaded country, the risk of serious undernutrition, and even of starvation, is ever present, such a prodigal sacrifice of nutrients cannot be indefinitely continued. It was, I think, Sir Thomas More who, observing the transformation of England from an arable to a pastoral country, stated succinctly "Sheep are eating men." The plough policy of the present war has already, and in my view rightly, reversed this trend, though at the inevitable cost of a fall in the livestock population.

In what directions will this re-orientation of policy affect the rival claims of animals and man for food? In a perfectly balanced system of agriculture the human and livestock populations should normally derive their nutrients from complementary sources. Thus where man consumes the refined flour from the wheat berry, animals subsist on the coarser milling offals and the straw; where man derives his margarine from oilseeds, animals utilize the unpalatable cake and meal; where man extracts his sugar from the beet, animals thrive on the rejected tops and pulp; where man derives his nourishment from butter and cheese, animals consume the separated milk and whey; where man selects the choicest portions of the carcass, animals fulfil the role of scavengers in disposing of the offals of the slaughter house; where man regales himself with beer, animals enjoy the cognate taste of brewer's grains. This complementary relationship should, too, apply to the utilization of land itself. The best land should be reserved for arable cultivation from which, however, livestock would still share fully in the produce of the root crops and rotation grass. Except for permanent grazing areas, livestock should be relegated to land incapable of supporting the growth of more productive crops. Thus, in a balanced agriculture, the needs of animals should dovetail closely with the needs of man.

The country's pre-war specialization on livestock husbandry has upset this ideal balance, and has resulted in a livestock population out of all proportion to the potential output of nutrients from the land. The acquisition of this excessive livestock population has been accompanied by two retrograde developments. *First*, much of the better land has been diverted from arable cropping to livestock grazing, with a resultant

fall in the output of both human and, incidentally, animal food. Thus some 4,000,000 acres, or 30 per cent. of the country's best cropping land has passed out of regular cultivation and has been transformed into grassland of mediocre quality. *Second*, in order to make good the deficiency of animal nutrients, the imports of feeding stuffs have been increased out of all proportion to the supplies of home produced feeds. Thus, in the period between 1870 and 1930, there was more than a three-fold increase in the volume of imported cereals and concentrates for stock, but, whereas these retrograde changes took place over a relatively prolonged period, the exigencies of war have demanded an extremely rapid return to the older balanced system; what developed as a gradual trend over a period of some 60 years has had to be corrected in less than as many months. It is this factor more than any other which has served to stress in so acute a fashion the apparent rivalry for food of animals and man. It would, perhaps, be well to face the problem in more concrete form. Before the war some 60 per cent. of the total nutrients available for the livestock population were derived from grassland in the form of grazing or hay. The adoption of the plough policy has already resulted in a turn over to arable cultivation of more than 3,000,000 acres, or some 15 per cent. of the country's grassland. Moreover, much of this ploughed up land is derived from the more highly productive grazing areas, so that the actual reduction in grassland output probably does not fall far short of 20 or even 25 per cent. It is true that improved methods of management, and particularly the liberal application of fertilizers, have tended to make good this loss. It is also true that *in the long run* the effect of ploughing up should be to increase the productivity of outworn pastures. Indeed many agriculturists would favour the permanent extension in our post-war agriculture of some such system of "alternate" husbandry. Meanwhile, however, the turn over of pasture to arable cultivation is bound to stretch severely the supplies of grassland nutrients for grazing stock.

What alternative sources of nutrients are available? In Table 1 is set out a summary of the war time supplies of feeding cereals and concentrates in comparison with pre-war figures. While accurate statistics for war time production and imports are not available, experience during the last war can be used as a rough guide to the probable shift in war time supplies. Reference to the table will show the very marked effects of reduced importations and the relatively limited extent to which increased home production has filled the resultant gap. Thus the loss of imported maize and other feeding cereals is far from counterbalanced by the increased yield of oats and barley. But it is in respect of the by-products of the oilseed crushing and wheat milling industries that the gap appears most striking. Both oilseeds and wheat grain are, of course, linked with human needs, and their importation is probably assured. Our pre-war supplies of the by-products of these two commodities were however only derived in part from the home crushing and milling industries; we imported in addition large amounts of foreign crushed and milled products, which will now be no longer available. Moreover the raising of the percentage extraction of wheat from 70 to 75 has already reduced the supplies of wheatfeed by nearly half-a-million tons, while a further increase in extraction to the 85 per cent. level, which is being so strongly

advocated by many nutrition experts, would effect a further substantial reduction in the supply, amounting in all to over a million tons. In round figures our imports of feeding stuffs will have been reduced by some 6,000,000 tons out of a pre-war supply of 8,000,000 tons. The substantial increase in the home output of food for stock will have gone some way to counterbalance this, but the summarized totals show clearly that the livestock nutrients available from feeding cereals and concentrates will, in effect, have been almost halved.

TABLE 1

COMPARISON OF PRE-WAR AND WAR TIME SUPPLIES OF FEEDING CEREALS AND CONCENTRATES

	Average 1934–38 (tons)		Estimate 1941–42 (tons)	
Cereals				
Oats, barley, etc., home produced	2,857,000		4,000,000	
,, ,, ,, imported	802,000		—	
Maize, imported	3,233,000		—	
Total		6,892,000		4,000,000
Milling by-products				
Wheat by-products				
From home produced wheat	333,000*		368,000†	
Home milled from imported wheat	1,450,000*		1,014,000†	
Foreign milled, imported	625,000		—	
Rice meal, etc.	390,000		—	
Total		2,798,000		1,382,000
Oilseed by-products				
Imported oilseeds, home crushed	1,107,000		800,000	
Imported cake and meal	595,000		—	
Total		1,702,000		800,000
Total, all supplies		11,392,000		6,182,000

* 70 per cent. extraction. † 75 per cent. extraction.

Note. The raising of the percentage extraction rate from 70 to 75 has already reduced the supply of wheat by-products by 410,000 tons. A further rise to 85 per cent. extraction would increase this loss to 1,060,000 tons.

Thus the return towards a balanced agriculture, while assuring to both man and animals a greater home production of their food supply, has unfortunately synchronized with a severe shortage of nutrients for stock. It would, I think, be a grave mistake to characterize this coincidence as "cause and effect." I have, indeed, endeavoured in this paper to stress the complementary relationship which exists between animals and man in their mutual search for food. Rather is it the result of our pre-war specialization in livestock husbandry being unduly dependent on imported feeds. Let us hope that in the post-war agricultural era we shall have learnt our lesson, and that we shall be able to plan our home production on a basis more in keeping with our needs.

REFERENCE

Burt, B. (1941). Personal communication.

Discussion

Dr. B. S. Platt (London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), opener: While it cannot be denied that animal produce, meat, eggs and milk, improve the nutritive value of a diet, there is evidence that their consumption in much smaller quantities than is customary in this country is consistent with the maintenance of good health, activity and longevity as, for example, in the case of the Chinese peasant who uses meat and eggs in his diet mainly to add flavour to his dishes, yet his expectation of life after having attained adult life is only second to that of the New Zealander.

There must be a level for the numbers of livestock of the different categories maintained in this country above which they compete with the human population for food. Thus Dr. Wright's thesis that the animal population of this country is complementary in its food requirements to the human population can only be sustained if the numbers of livestock are kept below this level.

The case for retaining for human consumption all the materials which may be directly utilized by man is a strong one in war time. In arguing, for example, for the retention of that part of the milling offals which it is proposed to add to white flour to produce national flour of 85 per cent. extraction, the amount involved should be considered in relation to the total bulk of feeding stuffs still being used in this country for feeding livestock. On the authority of the agricultural correspondent to *The Times*, livestock numbers, especially of beef and dairy cattle, have not been reduced since war began. If farm animals are being fed at pre-war levels, the figures given by Leitch and Godden (1941) may be taken, which show that for 1938 nearly 37 million tons of dry matter were fed, to yield nearly $1\frac{1}{2}$ million tons of dry matter animal produce, an over all efficiency rate on a dry matter basis of 4·1 per cent. Roughly $\frac{1}{4}$ of the dry matter was consumed by the dairy herd to produce about $\frac{1}{2}$ of the total dry matter food for human consumption, but the beef herd consumed about $\frac{1}{2}$ of the total dry matter and yielded only about $\frac{1}{4}$ of the dry animal produce. The amount of feeding stuffs for farm animals which would be eaten by the human population in changing to national flour of 85 per cent. extraction would be about $\frac{3}{4}$ million tons on a 12 to 15 per cent. moisture basis, and this amount should be considered against the total dry matter of the feeding stuffs which is involved in the feeding of the present farm animal population.

One of the arguments generally advanced in favour of retaining large numbers of cattle is that farmyard manure is required for maintaining soil fertility. In this connexion attention should be given to the salvage of the nutrients lost in human excreta. The following comment quoted by Hall (1936) was made by Liebig some 100 years ago:

> "England is robbing all other countries of their fertility. Already in her eagerness for bones, she has turned up the battlefields of Leipzig, and Waterloo, and of the Crimea; already from the catacombs of Sicily she has carried away the skeletons of many successive generations. Annually she removes from the shores of other countries to her own the manurial equivalent of three million and a half of men, whom she takes from us the means of supporting, and squanders

down her sewers to the sea. Like a vampire she hangs upon the neck of Europe, nay, of the whole world, and sucks the heart blood from nations without a thought of justice towards them, without a shadow of lasting advantage to herself!"

Attention should be directed also to the competition for nutrients which arises between human inhabitants of one country and another when soils are exploited without consideration for their future fertility. The temperamental tropical soils are being used to produce millions of tons of feeding stuffs imported to this country which are in large measure ultimately washed down to the sea. We cannot, in forming our agricultural policy, ignore the serious effects the continuance of this drain must inevitably have on our colonial resources.

References

Hall, A. D. (1936). *The Improvement of Native Agriculture in Relation to Population and Public Health*. London: Oxford University Press, p. 19.
Leitch, I. and Godden, W. (1941). *Tech. Commun. Bur. Anim. Nutrit., Aberd.* no. 14.

Dr. W. K. Slater (Dartington Hall, Ltd., Totnes, S. Devon): How far can the shortage of feeding stuffs indicated by Dr. Wright be met by increased efficiency on the farms? Would it be possible for dairy farms to equal the efficiency of Dr. Wright's Institute, where production has been maintained without the use of rationed feeding stuffs?

The loss of human food due to the neglect of proper scientific care in cultivation cannot be estimated. Potatoes alone suffer great losses each year from diseases capable of control. Wastage due to cattle diseases and bad production methods is very great. Finally, loss in quantity and deterioration in quality of food caused by faulty distribution, represent the equivalent of large quantities of animal feeding stuffs.

Dr. G. S. Fraenkel (Biological Field Station, London Road, Slough, Bucks.): Dr. Wright claims that raising the percentage extraction rate of wheat from 75 to 85 would considerably reduce the supply of wheat by-products and thereby seriously diminish the milk production. It has been shown in several articles and letters in *Chemistry and Industry* (Bacharach, 1941; Graves, 1941; Jones, 1941; Kent Jones, 1941; Wright, 1941) that this view is incorrect, because it leaves out of consideration an appreciable quantity of shipping space saved. No reduction in milk production would result if this shipping space were used to import suitable cattle food.

References

Bacharach, A. L. (1941). *Chem. and Ind.* **60**, 791.
Graves, H. C. H. (1941). *Chem. and Ind.* **60**, 852.
Jones, H. J. (1941). *Chem. and Ind.* **60**, 869.
Kent Jones, D. W. (1941). *Chem. and Ind.* **60**, 819.
Wright, N. C. (1941). *Chem. and Ind.* **60**, 623.

Dr. F. Yates (Rothamsted Experimental Station, Harpenden, Herts.): The labour requirements involved in changes of agricultural policy must not be forgotten. For each million acres brought under the plough an additional labour force of 25,000 workers is required, on the assumption that the land was previously supporting beef cattle and sheep and that the distribution of arable crops would be similar to that on the existing arable acreage.

Professor J. R. Marrack (Haymeads Emergency Hospital, Bishop's Stortford, Herts.): More attention should be paid to the nutritive value of foodstuffs; the vitamin A content of milk and eggs may vary by several 100 per cent., depending on the feeding of the cows and hens. Also, efficiency of milk supply would be much improved by the formation of local pools at which milk could be pasteurized; by this means the wholesomeness of the milk would be improved and the waste of petrol in overlapping deliveries would be avoided.

Dr. W. R. Wooldridge (N.V.M.A., 36 Gordon Square, London, W.C.1): The conclusions drawn by Dr. Wright from his statistical examinations would be materially altered if he allowed for the fact that the efficiency of agricultural production in this country could be greatly increased. Particularly is this so with those animals which are producers of food for human beings. It is an unfortunate fact that preventive medicine on the farm has scarcely begun, yet much could be achieved by the introduction of a bold progressive national policy directed to maintain and improve the health of farmstock, to control the incidence of animal disease and to increase the production of milk, dairy products, eggs and meat. To give figures concerned with just three diseases of dairy cattle, mastitis, contagious abortion, and sterility, a recent report by the National Veterinary Medical Association computed the loss of liquid milk from these diseases alone to be 198,000 gallons per annum. This represents 83,000 tons of protein, sugar and minerals and over 31,000 tons of butter fat.

Dr. N. C. Wright gave the following replies:

To Dr. Platt: The implications of the figures quoted cannot be accepted. The total of 37 million tons covers all forms of animal feeding stuffs, including pasture grass, hay, straw and other coarse fodders. If these are excluded on the grounds that they are only available during the summer season or for certain classes of stock such as beef cattle and young non-producing dairy cattle, the amount of concentrated foods available for dairy cows, poultry and pigs is reduced by over 12½ per cent. as a result of the adoption of the national wheatmeal loaf. As regards efficiency of conversion, animal products are not consumed merely for the "dry matter" which they contain, but to increase the intake of certain specific nutrients, notably first class protein, animal fat, mineral salts and vitamins. The estimate of an over all efficiency of 4·1 per cent. is, therefore, misleading; the true figure for protein and energy conversion probably varies from 15 to 30 per cent. for egg and bacon production to as high as 50 to 60 per cent. for milk production. Imported feeding stuffs have an important part to play in maintaining soil fertility; this is a case where The Nutrition Society might play a valuable part in harmonizing the conflicting views of agriculturists and of the medical profession.

To Dr. Slater: With regard to farm self sufficiency, much more could be done on many farms, but some areas are more suitable in this respect than others.

To Dr. Fraenkel: The contention cannot be accepted that shipping space, saved by the adoption of the national wheatmeal loaf, would be used to import other animal feeding stuffs; the chief intention in raising the extraction level of wheat would be to save shipping space, *not* to improve the nutritive value of the loaf for its own sake.

Afternoon Session: Chairman, SIR JOHN ORR

Animals as Food Converters

Mr. E. T. Halnan (School of Agriculture, Cambridge)

Three main groups of feeding stuffs are recognized by farmers, succulents which comprise root crops and green foods, roughages such as hay and straw, and concentrates, which comprise cereal grains, pulses, oilseeds, and by-products of the milling, brewing and oilseed crushing industries, together with other by-products of the food industry. Horses, dairy cows, cattle and sheep can make efficient use of all three classes, but pigs and poultry, while making efficient use of the third class, are distinctly limited in their capacity to deal with the first two classes. These facts have to be borne in mind when considering the relative efficiencies of these various kinds of animals for the conversion of the protein and energy of feeding stuffs to human food protein and energy.

The feeding of livestock in this country during peace time depends largely on the efficient utilization of cheap imported foods and feeding stuffs rather than on home produced feeding stuffs. The feeding of livestock during war consequently throws a severe strain on the farming community, since not only are supplies of imported feeding stuffs drastically cut, but the farmer, in addition, has to change his farming methods so as to produce the major part of the food required for feeding his livestock.

From the national point of view, policy has to be directed towards encouraging the continuance and expansion of those classes of livestock which are the most efficient converters of feeding stuffs to human food. This policy operates in two stages, a short range policy for the first year of a war, in which most efficient use of the existing livestock is made, and a long range policy, in which the breeding and rearing of stock as well as their production capacity have to be taken into consideration.

An attempt has been made to assess the relative efficiencies of animals for the conversion of feeding stuff protein and energy into human food protein and energy, the digestible protein (protein equivalent) and the starch equivalent of the feeding stuff, and the edible protein and energy of the product being taken as a basis of comparison. The limitations imposed by the inadequacy of the basic data available prevent the acceptance of these comparisons as scientifically accurate, nevertheless it is considered that they do reflect in the main a true representation of the relative efficiencies of farm animals as food converters. The results obtained are given in Tables 1 and 2.

Regarding need for protein as the first essential, the short range national policy would be directed towards encouragement of milk production with discouragement of beef or lamb production. Egg production would be encouraged as far as feeding stuff supplies permitted with the killing of cockerel chicks at the *petit poussin* stage; the fattening of cockerels or pigs would be discouraged. Regarding need for energy as the first essential, the national policy would be directed towards the encouragement of milk production and winter beef production and, if supplies

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permitted, the fattening of store lambs. Pork and bacon production would be encouraged as far as feeding stuffs supplies permitted, as well as the Surrey fattening of fowls. Egg production would be discouraged.

TABLE 1

EFFICIENCY OF PRODUCTION. SHORT RANGE POLICY

Product	Protein conversion efficiency, per cent.	Energy conversion efficiency, per cent.
Milk (600 gals.)	32·5	48·3
Eggs (140 per year)	36·7	22·9
Poultry meat (Surrey)	14·0	39·1
Poultry meat (1 lb. liveweight, *petit poussin*)	25·4	24·5
Beef (winter fattening)	9·0 to 10·8	36·9 to 37·5
Beef (grass)	4·6	28·8
Lamb (70 to 100 lb.)	12·0	32·3
Bacon	12·0 to 13·8	41·0 to 51·4
Pork	13·9 to 17·2	40·7 to 50·4

TABLE 2

EFFICIENCY OF PRODUCTION. LONG RANGE POLICY

Product	Protein conversion efficiency, per cent.	Energy conversion efficiency, per cent.
Milk (3 lactations)	17·0	30·0
Eggs (2 years)	33·1	22·1
Poultry meat, cockerels (3½ lb.)	17·9	15·6
pullets (3½ lb.)	18·2	12·5
Beef (birth to 7 cwt.)	11·1	14·0
,, (birth to 9 cwt.)	8·8	19·0
,, (grass fattened, birth to 10·7 cwt.)	7·3	15·1
,, (stall fattened, birth to 12·5 cwt.)	7·2	15·3
Pork	13·8 to 16·0	34·4 to 39·4
Bacon	12·4 to 13·8	36·4 to 43·4
Lamb	5·9	9·6

The nature of a long range policy would depend on whether protein needs or energy needs formed the primary consideration. From the standpoint of protein need, milk production would be encouraged and beef and lamb production discouraged. The available supplies of concentrates left after the needs for milk production had been met should be earmarked for egg production, and no cockerel chicks should be reared beyond the *petit poussin* stage except those required for breeding. Pork and bacon production should be discouraged.

From the energy standpoint, milk production again should receive priority, and beef and lamb production should be discouraged. The available supplies of concentrates left after the needs for milk production had been met should be earmarked for pork and bacon production, egg production taking second place as far as energy need is concerned.

On balance, when protein and energy needs are both considered it

would appear that the available feeding stuffs will be most efficiently used if the livestock policy of the country is concentrated on the production of milk, with veal as a by-product, and on egg production, with *petit poussin* meat as a by-product. Lamb production should be confined to hill grazings, sheep production on arable land being too inefficient to justify its continuance.

Discussion

Mr. A. N. Duckham (Llys Euryn Cottage, Rhos-on-Sea, N. Wales), opener: Comparison of Mr. Halnan's figures with previous estimates confirms the following general ranking of farm animals for efficiency of conversion of total calorie or protein intake:

1. Dairy cow
2. Pigs and poultry (approximately equal)
3. Beef cattle and sheep (approximately equal).

There are, however, great differences between estimates, mainly because of different assumptions about farming systems in this country, but also because estimates do not compare the same periods of the life history of each species, and because of other variables.

It is good to learn that an attempt is to be made to produce one authoritative set of figures. It is hoped, however, that these calculations will take into account the gross efficiency not only under peace time conditions but the gross efficiency at present, and in particular the efficiency with which different species under different farming systems utilize concentrated feeding stuffs such as oil cakes and cereals as distinct from grass, hay and roots. Such estimates can, at best, only be approximate but they should be of considerable value to those responsible for determining policy.

Dr. J. Hammond (School of Agriculture, Cambridge): The differences in efficiency of conversion between different species are remarkable. What is the physiological explanation? Why should one animal or type of production be more efficient than another? In my opinion efficiency consists in the presence of activated cells in the body which have a great affinity for nutrients in the blood stream. For example, the cells of the mammary gland are activated during pregnancy so that they become very efficient in taking up substances from the blood. As Edwards (1936) has shown, the mammary gland is much more efficient in the early stages of lactation than in the later stages, the percentage efficiency being 38 at the 1st month of lactation as compared with 29 at the 10th month, and the efficiency is much greater in cows well bred for milk production than in those badly bred. In any policy which aims at the efficient use of feeding stuffs it is just as necessary to eliminate inefficient individuals as to distinguish between different types of production.

Another point which requires consideration in meat producing animals is the efficiency at different stages of life. For example, as Mr. Halnan's tables show, the animal which is killed at light weight is more efficient for protein than the animal which is killed at heavy weight, because in early life muscle is making its most rapid growth. In energy conversion, however, the reverse holds, because at the heavier weights fat cells continue to develop. Efficiency is therefore linked with the correct weight for slaughter, according to whether protein or fat is required.

When efficiency tables, such as those for beef and bacon, are compared, it should also be borne in mind that while the pig is competing with man for concentrated foods the bullock is utilizing a bulky type of food, roots and hay, which could not be used for human food direct.

REFERENCE

Edwards, J. (1936). *J. Dairy Res.* **7**, 211.

Mr. D. J. Ewing (Essex Institute of Agriculture, Writtle): The appropriate percentage figure to quote in determining the efficiency of the cow as an energy converter, in relation to her contribution to the national food larder, is the *whole life figure*. This is of the order of 14 per cent. The figure usually quoted, based upon the short period, is misleading and ignores the fact that, in general practice in this country, farmers have to rear their own heifers. On the whole life basis, it is not the cow, but the pig, which is the most efficient converter of energy.

There appears to be an erroneous impression that there is a particular virtue in farmers being self sufficient in respect of feeding their livestock. This is only true in so far as they are able to make the best use of land *unsuitable* for the production of crops for *human* food, and of the by-products of human food crops. Where it involves the utilization of land which might be used for human crops, it is a question involving comparison between the relative merits of the particular crops and the relative merits, from the shipping point of view, of importing animal or food crops. It is a fallacy to state, as is so often done, that the growing of fodder on arable land is a direct saving of shipping.

Dr. S. Bartlett (National Institute for Research in Dairying, University of Reading): Mr. Halnan's figures suggest that while the milking cow is highly efficient in the conversion of the energy part of foods it is much inferior to the laying hen for converting protein. In case this should lead anyone to doubt the efficiency of the cow for protein conversion it should be pointed out that the figure of 3 lactations used as the life of a cow is certainly too short; it should be 4 or possibly even 5 lactations. Such an amendment would materially increase the estimated efficiency of the cow and leave in no doubt the wisdom of placing milk first on the priority scale. On the question of whether protein or energy is more likely to be scarce, there seems relatively little danger of protein shortage provided animals are given a reasonable and not an excessive amount of protein.

Professor J. R. Marrack (Haymeads Emergency Hospital, Bishop's Stortford, Herts.): Conversion tables are misleading as animal protein has a higher biological value than vegetable protein, but animal products are not much more valuable than vegetable foods as sources of energy. Milk and eggs provide also other valuable nutrients. Milch cows and laying hens, therefore, give far better return for their food than beef cattle.

Mr. V. C. Fishwick (South Eastern Agricultural College, Wye, Kent): Food conversion figures, valuable as they are, only tell part of the story, since, from a national point of view, especially in war time, the economy of an animal is determined by the amount of land required to produce the protein and calories consumed per unit of output rather than by the amount of protein and the number of calories consumed. An acre of land will produce approximately double the number of calories if cropped

with roughages such as potatoes, cow cabbage and kale, that it will if cropped with corn. Thus the type of food consumed has an important influence upon the economy of animals, those which are fed entirely or mainly on roughages being more economical than those fed entirely or mainly on corn; the most economical of all animals are those pigs which are fed on kitchen scraps for, in spite of the fact that the efficiency with which they utilize their food is comparatively low, no land has to be allocated for their maintenance.

Mr. E. T. Halnan gave the following reply:

To Professor Marrack: It is impossible to weight the protein, as suggested, according to biological value, because of lack of data and because of the extra complication that the biological value of a mixture of proteins is not the same as the weighted arithmetical mean of the biological value of the individual ingredients.

Planning for Agricultural Production

Sir E. John Russell (Rothamsted Experimental Station, Harpenden, Herts.)

The soils and climatic conditions of Great Britain are more varied than in any other region of equal size in the world and in consequence the range of possible crop production is great. If optimum production only were considered, we should concentrate on grass and trees over almost the whole of the country excepting a strip running along the east coast from Aberdeen to somewhere about Hastings, with an extension along the south coast as far as Devon. An agriculture based on this type of cropping would provide milk, eggs, poultry, beef, lamb, vegetables, fruit, potatoes and also a certain amount of grain, but it might not employ many men; and unless prices were satisfactory it would tend to be extensive rather than intensive. Much of the meat production would be on ranching rather than on farming lines, and there would be a good deal of processing, that is purchasing of animal food from overseas and supplying it to animals on farms here. This is what happened during the period from 1920 to about 1935; the area of arable land shrank very considerably, so did the number of workers on the land; many small holdings disappeared and much of the grassland was abandoned and became rough grazing. The loss of capital value and of production capacity was considerable. It was sometimes stated that the fertility of the soil decreased, but of this there is no evidence.

It seems safe to assume that this process will be resumed after the war unless steps are taken to prevent it, and no one can foresee how far it will go if it is left unchecked. An agriculture left entirely to the play of economic forces tends to be on a low level because the farmer is bound to play for safety; he must assume that prices will have fallen still further by the time his produce is ready for the market, and so he must plan to keep his expenditure below the level at which he fears his receipts may stand. The reason for this pessimistic outlook is that much of the agricultural produce sent here from overseas is offered at prices bearing little relation to the cost of production, and made possible only by special marketing arrangements or subsidies of one kind or another.

There has been no definite announcement of agricultural policy after the war, only some general statements that agriculture is not to be allowed to fall into neglect and that farmers and farm workers are not to be let down as in the 1920's. Further, the public is being habituated to the idea of a certain amount of planning in national life. Whether in practice the accompanying official procedure will be tolerated remains to be seen, but for the present it can be assumed that it will be tried and some of the consequences may, therefore, be considered.

Any planning of agriculture presupposes a definite idea of what it is expected to do. In war time the problem is relatively simple; fairly definite aims can be set up, farmers can be told what they are expected to produce, what prices they will get and what wages they must pay, and can shape their course accordingly. Many competent observers declare that agricultural production is actually better now than in peace time, in spite of the calling up of many skilled men and their replacement by a good deal of unskilled labour. I am prepared to accept this view, and the explanation appears to be that farmers know where they are financially and can go to the limit of expenditure on fertilizers, feeding stuffs, labour and any other aid to production that they can obtain. Any attempt to improve our agricultural output in peace time would necessitate the establishment of conditions similar to these; farmers would need to be told what to produce and what prices they would be offered, and what wages they must pay. There is nothing particularly novel in this; it is simply a contract arrangement, such as forms the basis of most industrial and commercial activities. Nor is its application to agriculture new, for contract arrangements operate already for the production of milk, sugar beet, wheat and certain other products.

The basal decisions which must be taken before anything important can be done are to settle what proportion of the total value of the food supply ought to be produced at home and, as all the necessary food cannot possibly be produced here, what are the items on which to concentrate. These two decisions are of national importance and so could not be taken by any section of the community, but only by the whole community. Before the war we produced about 40 per cent. of the money value of our food, importing the rest and paying for it by exports of manufactured articles and services of various kinds. We imported about half our meat, about 70 per cent. of our cheese, 75 per cent. of our wheat and 90 per cent. of our butter. After the war we could, if we wished, produce more than 40 per cent. of our food, in which case there would probably be less export of goods abroad, but perhaps more sale in our own villages. This is not the place to discuss what percentage of our requirements we could plan to fulfil; we can safely put it at 50 per cent. and if a higher figure were decided upon it could be attained. It can even be assumed that the demand for higher levels of national nutrition would be accepted, so that a production of 50 per cent. after the war would mean a considerably larger gross output than 50 per cent. before the war would have done.

Then it must be decided what foods should be produced. At the outset let us assume that we do not seek to produce 50 per cent. of every item of our food but that we make a selection. I should not suggest any marked extension of our production of wheat or of butter. It is not that wheat is unimportant, quite the contrary. It is indeed our chief source

of calories and one of our chief sources of protein; it is truly our staff of life and if supplies failed we should be in an extremely difficult situation. But we could not grow the whole of our food requirements in this country; something must be imported even in war time, and of all things wheat is one of the easiest of foods to import, since it comes largely from Canada along a route that we must at all costs keep open. It is so concentrated that a single shipload can satisfy the need of a whole town for a year. Butter makes a longer journey; much of it comes from New Zealand and Australia, but, like wheat, it is very concentrated. After the war we shall probably concentrate more on milk and meat production, and if we combine this with arable farming it will enable us to raise our standards considerably and this will automatically increase our output of wheat and of other grain crops. An increased output of milk would necessitate improvements of our grassland because grass must always be the basis of food for our animals. Fortunately farmers have now at their disposal a number of methods by which grass can be improved by cultivation, drainage, manuring or ploughing up and reseeding. The area of grass would need to be increased by reclaiming some of the land now become derelict and classified as rough grazing; this would almost certainly have to be assisted by the State as the financial returns would probably not encourage any individual to undertake it. Except in times of high prices land reclamation does not pay, and those who have tried it have usually been bitten rather badly. Large areas could be tackled by a body like the Forestry Commission and, although it would not recover all its expenditure, the State would of course gain from having the land in use instead of lying waste.

With the increase in milk would necessarily come an increase in meat production, for there cannot be milk without calves and half the calves are male and fit only for beef; even those female calves that are kept for milk production would ultimately be fattened for beef. Then, too, an increase in cattle could advantageously go with an increase in the sheep and lamb population, for mixed grazing of grassland is better than grazing with one kind of animal only. And, as grass is very seasonal in its growth, coming much more vigorously in summer than in autumn and winter, there would be the need for more fodder crops to provide for the months when grass is insufficient; these fodder crops properly chosen and used would considerably augment the productiveness of the soil. Further, some of the concentrated foods for the animals could be grown here, though we should always have to import a good deal from our tropical and subtropical Empire. Oil is needed for many industries and the residue of the seed after some of the oil has been extracted is excellent food for animals, but oil is essentially a tropical product and the oilseeds must be imported. Poultry too could advantageously be increased in units of about 1000 birds, which is about what one trained man can look after, for poultry are great improvers of soil fertility. There is no doubt that an intensification of animal husbandry, leading to the production of more milk, meat, eggs and poultry, would raise our agricultural production considerably.

Before the war we produced almost all the potatoes we consumed, and we shall probably do so after the war, but we are not likely to increase our consumption of potatoes unless new methods of serving them should

come in. Potatoes in the past have been badly treated by cooks and landladies and they deserve a better fate, but it is very doubtful if they will get it. Vegetables will, however, probably continue to be used in larger quantities as people discover new kinds and new ways of treating old kinds, and a considerable expansion of vegetable growing may be expected after the war. It is safe to assume that the production in private gardens and allotments will fall but that need not affect supplies; with the return of labour to the farms and market gardens an abundant supply of all kinds of vegetables can be assured. This is also true of fruits of all kinds that will grow in this country, and, with increasing fruit culture, there should be an increase in bee keeping for the sake of pollination as well as of honey production. With increased fruit and vegetable production there has to go the development of canning and preserving industries, for the growers must have several outlets for their produce. These industries fit very well into village life; they are not large enough to disintegrate it, on the contrary they provide useful occupation within the village for those who are unable or unwilling to work on the land.

If it is assumed that our total food consumption is to be increased on the basis indicated by Sir John Orr, and that provision for our livestock is to be made as indicated by Dr. Wright, we can without difficulty produce half our total food requirements made up somewhat as follows: the whole of our liquid milk and potatoes, 80 per cent. of our vegetables, eggs and poultry, 60 per cent. of our meat, 35 or 40 per cent. of our cheese, and much of our malting barley, but we need not aim at more than about 10 per cent. of our butter, and this only as a way of using surplus milk. It should be made clear that the figure for production of 50 per cent. of our consumption is not intended as a maximum; it would be possible to produce more if we wanted to. But every increase in the proportion produced at home means some re-organization of our export trade and any figure would need very careful consideration before it was finally adopted.

The real difficulty of increased home production is likely to be not on the technical but on the financial side. This is not the place to discuss such matters; I need only say that in my view the best type of arrangement would be a system of contracts between the farmers, as represented by their Unions, and a Purchasing Board, somewhat on the lines of the present authorities and with consumers' interests adequately represented. Contracts are already in operation for milk, sugar beet, wheat and other products, and they can be drawn up to be fair to all parties, ensuring production and delivery of the stipulated quantities of commodities and fair wages to the workers. A contract system necessitates some degree of planning, because it is necessary to decide the quantity of each commodity that has to be produced, and, for everything except milk, potatoes and certain vegetables, that means deciding what proportion of each is to be imported. That would affect the price to the consumer because the imported fraction would cost less than the home produced fraction, and the Purchasing Board would have to see that the consumer rather than the middleman got the benefit of this difference. This question of balancing imports against home production is very difficult and delicate; it is one for the whole community to decide because it really means the balancing of export trade against home trade.

A contract system would have other advantages besides conferring stability on agricultural production. It would allow the Purchasing Authorities to make stipulations in regard to quality. At present farmers have little guidance in this matter; there are market standards but commonly little scientific basis for them. Milk is an exception; here the standards are pretty definite and, thanks to the work of the Dairy Research Institutes at Shinfield and Ayr, farmers know how to conform to them. About barley also a great deal is known, in consequence of the collaboration of the Institute of Brewing with Rothamsted and the Birmingham School of Brewing. But for other products farmers have little guidance and the general line taken by their advisors is that, if the crop is well and fully grown and healthy, its quality can be left to look after itself; maximum healthy growth and optimum quality are assumed as a working rule to go hand in hand. This may very likely be so, but it must be admitted that the evidence is none too good. As soon, however, as nutrition experts can lay down standards of quality, agricultural experts can show how to attain them, and the contracts could contain clauses requiring farmers to do this. But the contracts must be made on business lines, because farmers have to pay their way and to live and it is useless to draw up a contract whose effect would simply be to kill production. A further advantage of the contract system would be to stimulate long term programmes of production which give the scientific workers their very best chance of helping farmers. There are good grounds for believing that a better planned production on a contract basis would obviate many of the difficulties of the unorganized production of the past.

Discussion

Mr. F. H. Garner (County Hall, Ipswich), opener: While it is desirable to have a peace time policy, it is, unfortunately, still essential to have a war time policy. At this Conference it has been suggested there is room for greater efficiency in agriculture; this is undoubtedly true. This efficiency may be increased to a certain extent by an educational programme. Farmers still do not use balanced manures for their crops. More chalk, phosphates, salt and nitrogenous manures could be applied with advantage. Plant diseases and pests could be more strenuously attacked. Much grassland, as Sir John Russell has pointed out, remains to be improved by cultivation and manures. Diseases reduce the efficiency of livestock. The Ministry of Agriculture are about to launch a scheme to reduce the incidence of abortion, mastitis and sterility in dairy herds. There is room for improvement in the breeding of livestock, for instance, the Improvement of Livestock (Licensing of Bulls) Act, 1931, prohibits the use of unsuitable sires, but it is possible to cross breeds indiscriminately, thereby producing inferior stock. Finally, stock are often underfed; in particular store cattle receive too little protein. This may lead to stunted stock, and it is well known that such stunting may seriously impair efficiency.

Dr. M. E. Lampard (2 Lexden Road, Colchester): There is so much slack to be taken up in providing enough food for the third of the nation that now gets too little, that we could eat all the extra food we could

grow. The problem of getting that food eaten is an economic and political one, as our people cannot afford to buy the food they need.

Dr. H. A. Chodak Gregory (46 Portland Place, London, W.1): A very important point is not what and how much food an animal shall eat but which animal is foodworthy. The present crisis is a God given opportunity to get rid of many thousands of animals which produce only about 200 gallons of milk, when the same amount of food would maintain an 800 to 1000 gallon cow. The same applies to most animals.

Summing Up

Sir Joseph Barcroft (Physiological Laboratory, Cambridge): The dominant note of the meeting has been an urge to action, a desire to do something useful. The machinery of the Society ought to be elaborated to crystallize the views of each meeting and place them at the disposal of the appropriate authorities. This is desirable because Government Committees are made up of *selected* people but, in a democratic assembly such as The Nutrition Society, it is open to anyone, be he farmer, vitamin expert, or any other kind of specialist, to state his views. Each member of the Society has some specialized corner of experience or knowledge and, for that reason, machinery should be set up for getting their views into a form accessible to those responsible for policy.

It should be remembered that if man does not live by calories and love alone, neither does he live by milligrams and vitamins alone. Having been brought up in the school of the older physiologists, and imbibed the teachings of Pavlov, I appreciate that quality is as important in its way as quantities, be they milligrams or kilograms. I therefore agree with Macrae and other speakers, who emphasized the importance of palatability. If a food is not attractive, it may not be fully assimilated, and the importance of appetite must not be overlooked.

Finally, the meeting has drawn attention to the importance of wastage, such as that caused by abortion in cattle, or the staling of vegetables. There is absolute wastage, as when potential feeding stuffs are lost down the drain, and seasonal wastage such as occurs when there are gluts. I hope that this question may be considered at a later meeting.