depot preparation may require reinforcement with the crystalline penicillin, but subsequent daily dosage with the depot product should prove adequate.

The development of procaine penicillin has been rapid, and many preparations are now available. There is no doubt that the reinforced monostearate preparation gives the greatest prolongation of effect in combination with relatively high initial blood levels. It is, however, an oily preparation which presents some difficulty in administration, particularly in cold weather; this is a serious disadvantage for routine use in general practice. It is nevertheless a valuable preparation which should be very useful when it is desirable to give the injection at longer intervals than 24 hours. Considerable prolongation of the blood levels can be achieved by increasing the dosage of the monostearate preparations; but such injections tend to produce local discomfort, and difficulty in administration may be experienced (Peacock and Gillespie, 1950).

The aqueous preparation (400,000 u./ml.) has proved a satisfactory product for daily administration. It is stable, and if well shaken can be injected without difficulty. In this trial effective levels have been consistently maintained in adults for 24 hours after the injection of 1 ml. This should be a convenient preparation for general use.

It is interesting to note that throughout this investigation no instance of hypersensitiveness to the procaine was observed, and that, apart from the initial prick, no local discomfort was reported.

Summary

Blood levels have been estimated in adults after the intramuscular injection of 1 ml. of various procaine penicillin preparations.

With procaine penicillin (300,000 units) in arachis oil with 2% aluminium monostearate plus crystalline potassium penicillin G (100,000 units), effective levels were maintained for the 24-hour period in 28 out of 28 individuals (15 out of 21 gave assayable levels after 48 hours), but some difficulty in administration was experienced.

Aqueous procaine penicillin (300,000 units per ml.) is a convenient preparation, but assayable levels were not produced in 7 out of 44 subjects after 24 hours.

A stable aqueous procaine penicillin suspension (400,000 u./ml.) proved a satisfactory product. It was injected without difficulty and gave satisfactory levels for a 24-hour period in 40 out of 40 cases. This preparation should prove particularly valuable in general practice.

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FOOD AND MANKIND*

BY

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Malnutrition, famine, starvation, have been man's lot since the beginning of his existence. The drive of industrialization which a century ago was expected automatically to fill his life—and his belly—with all his needs has instead been found only to raise quite other problems. Yet in the last decade man's conscience has more and more been awakened to the belief that, with the potential riches at his disposal, the problems of feeding himself and his world family could be solved. These problems may be put in this way: (1) Can the earth produce enough food for its inhabitants? (2) Can the food be equitably distributed among the countries according to their population? (3) Can the food be equitably distributed among the population of each country according to their individual requirements?

World Food Production

Before the war there were indications that the world was already producing too much food. Some of the chief food-producing countries were adopting restrictive practices, such as limiting the areas to be planted with grain or pouring away thousands of gallons of milk. Yet side by side with this were the ever-recurring famines in countries such as India and China, with, in the intervening years, stunted growth, ill-health, pestilence, and misery, affecting more than a third of the world's inhabitants. Those whose conscience was disturbed when they thought of the masses who hungered while food was destroyed began to speak of "poverty in the midst of plenty." It is certainly true that millions might have been fed, and hundreds of thousands might have lived who otherwise starved to death, if the distribution of food could have been better organized. But was there in fact plenty? The answer is most emphatically "No."

With our present nutritional knowledge we can make reasonably intelligent estimates of the amount of food required properly to feed the whole of mankind (Fig. 1). For practical purposes we can say that an increase of food of something like twofold is needed in order adequately to feed humanity. For such an increase to be possible three separate problems must be tackled. First, it is necessary to prevent the wastage and loss of food after it has been produced. Secondly, since by far the greater part of our food comes from the soil, it is necessary to prevent the erosion which is occurring in alarming degrees over most of the world's surface. Thirdly, it is necessary to improve the techniques at our disposal to achieve greater yields of food (Fig. 2).

How much food is lost by pests, infestation, and disease we do not know. One authoritative estimate is that about one-fifth of the total grain is destroyed each year—an amount which would be enough to feed 300 million people. Here is certainly a field for energetic investigation and action. The second problem of increasing food production is that concerned with the loss of good soil. We have only to look at the once fertile fields of Greece, North Africa, and Palestine to realize the devastating results of soil erosion. And a farmer from the Middle West United

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ESTIMATED INCREASE IN WORLD PRODUCTION NECESSARY FOR ADEQUATE NUTRITION

FIG. 1

States need not even bother about history and geography—he has seen himself how fertile fields can be converted into arid, dusty deserts. This insidious but still disastrous process can be truly appreciated only when its extent is realized. In the United States alone, 8,000 acres daily are being lost by soil erosion— $2\frac{1}{2}$ million acres a year. In that country probably some 300 million acres have already been lost, an area which could produce enough food for 10% of the present population of the world. Of the whole cultivated surface of the earth, some 3,000 million acres, we are losing soil at the rate of 10 to 20 million acres a year—good, rich soil, an inch of which may take 500 years to form and which, with all our scientific and technical ingenuity, we cannot fashion ourselves.

The prevention of erosion requires a co-ordinated programme involving vast projects of reforestation. Implementation of such a scheme means the vesting in some authority of powers to take action for the wider interests of the community against the immediate interests of individual farmers, timber concessionaires, and the like. This is perhaps why the most noteworthy measures for soil conservation are to be seen on a small scale in Israel and on an enormously large scale in the U.S.S.R. In Israel they are possible because of the self-sacrificing idealism of the pioneers, who have literally been able to make the desert blossom like the rose. In the U.S.S.R., for good or for evil, private interests are subordinated to communal interests. Thus is possible the vast plan of reforestation and land improvement to be carried out over the next 15 years in European Russia. This is to include the planting of $12\frac{1}{2}$ million acres of forest, with four strips totalling 3,000 miles in length.

The third method of increasing supplies of food is to improve and increase production. In large areas of the world agriculture is still carried on in the most primitive way. Improvement in agricultural technique, possible only in many countries by almost revolutionary changes in their

economic situation, could go a long way to improving yield. Examples of what can be done are the production of ground-nuts and sunflower seeds in East Africa, the improvement of breeds of cattle, for both meat and milk, by artificial insemination, and the production of strains of wheat which can be grown within the Arctic circle. The elimination of diseases such as those of wheat or potatoes or cattle would greatly affect the yield of food. For example, bovine mastitis, which could be almost entirely eliminated by treatment with penicillin, seems to be responsible in Europe for the loss of about 1,500 million gallons of milk each year, enough to give one pint a day to more than 30 million people, or, in Britain, enough to give an extra pint of milk each day to every child under 5.

Other possibilities also present themselves for increasing world supplies of food. Among these are projects for fertilizing enclosed or nearly enclosed seas in order to increase the yield of fish, and projects for the growth of food yeast on media derived in the main from wood or from useless plant products. What such schemes may eventually mean in satisfying a hungry world we can at this time only guess.

The Problem of Population

The question of total supplies of food is, of course, bound up with the question of world population. The present population of about 2,300 millions will probably grow to 3,000 millions or more by the end of the century. The growth is particularly rapid in Eastern Europe and Asia. In 50 years' time the population of Asia is expected to reach a figure something like that of the present population of the whole world. Thus a failure to increase the world supplies of food not only means no improvement in the nutritional standards of humanity, but will indeed mean the deterioration as more and more mouths will need to be fed. The problem is not only one for ourselves but for our children and their children. Many of us are not satisfied with the solutions suggested by the new followers of Malthus, that medical aid such as would

ACTUAL AND POTENTIAL FOOD SUPPLIES

FIG. 2

lead, for example, to the virtual elimination of killing diseases like malaria should be withheld from countries in which the population is increasing rapidly. Nor are we looking forward to a new war, atomic or bacteriological, to check the rise in population.

Although we do not know what it is, there must, of course, be a limit to the earth's capacity to produce food and so meet the needs of an expanding population. It may be that an improvement in living conditions, which would follow improved feeding, may result in a decreased birth rate. This has been the experience in most of the civilized communities of the world. It is also possible that rapidly increasing populations may be persuaded to make more use of contraceptive techniques. It cannot, however, be expected that even simple methods of contraception will be used to any appreciable extent in communities where living conditions and levels of education are very low. We seem to be faced, therefore, with a vicious circle in which improved living conditions are necessary for the extensive adoption of methods of birth control, but improvements cannot be expected until the more rapidly expanding population adopts such methods. Perhaps the solution lies in the discovery and use of new principles of birth control, as hinted by Lord Horder recently. In any event, it is certain that the population will continue to rise for the next 50 years or so, and our part is clear to produce as much food as we can so as to provide for ourselves and our children (Fig. 3).

International Distribution

Apart from attempting to obtain from the earth the food needed by all its peoples, it is necessary to ensure

FIG. 3

PROPORTION OF FOOD IN WORLD MARKETS PURCHASED BY BRITAIN PREWAR

FIG. 4

that each country gets its fair share. This is the more important since countries differ considerably in the extent to which each produces sufficient food for its population. In Britain, for example, we produced about 30% of our needs before the war and are producing between 35 and 40% of our needs now. Whereas about 70% of the world's population are engaged in agriculture, less than 10% of our population are so engaged. In order to obtain the high proportion of imported food that we need, we have to give in exchange, directly or indirectly, products of our natural resources or manufacture which are wanted by the food-exporting countries. So long as we were a comparatively wealthy industrial country, we were able to do this fairly easily. Before the war Britain took an enormous proportion of the supplies exported by all the other countries (Fig. 4).

The extent to which a food-importing country like Britain can buy the foods it needs depends chiefly on three factors: first, the amount of food which is put into the world market; secondly, the wealth of the importing country; and, thirdly, the wealth of other competing importing countries. The amount of food available for export by the food-producing countries such as the United States, Canada, or the Argentine depends not only on how much they produce, but also on how much they themselves retain for consumption. The amount they produced before the war, as we saw, was often deliberately restricted in order to maintain world prices. Nor is this a thing of the past, for the United States has decided to restrict acreage to be sown next year with grain by 17%. Apart, however, from the amount

AVERAGE CONSUMPTION of MEAT, PREWAR & POSTWAR

Figures give average annual consumption in pounds.

Fig. 5

produced, the amount of food available for export will also depend on how much is eaten in the producing country. As the standard of living has risen in some of the main food-exporting countries, the consumption by them of many of the more desirable foods has also risen. Meat consumption has increased appreciably in the United States, Canada, and the Argentine, so that less is available for export (Fig. 5). Africa and Asia, with 60% of the world's population, produce about the same proportion of the world's vegetable oils, yet they retain only 25% of what they produce. As their material conditions improve, it can be expected that they will themselves consume more of this food.

The second factor determining the amount of food a country like Britain can import is the wealth of that country. As we have so often been told, wealth means the amount of goods we can produce from our natural resources and manufacture. But it is more than that. Not only have we to *produce* the goods but we have also to produce the *goods*. That is, we have to produce commodities which are wanted by the countries from which we have to import food. With the increasing industrialization not only of countries like the United States but of countries formerly poorly industrialized, the demand for those commodities which we wish to exchange for food is falling. It is this which is the essence of our exchange problems.

Lastly, there are several countries which are anxious to import more food. As we have seen, before the war Britain was by far the largest importer of food. After five years of war, in which Britain was spending its resources, mostly its capital resources, at the rate of £15 million daily, we cannot expect it to have retained the same favourable position. Other countries which have suffered less material loss than we have are now more able to compete for the limited amount of food on the world's markets. It is true, therefore, that the food supplies of some European countries are, relative to their pre-war supplies, better than

that of Britain. But it is also true that, in fact, our food supplies are still in many respects better than those of most European countries.

Let us be clear on this point. It is futile to expect that any alteration of government, any making or unmaking of plans, can affect the factors we have discussed. There is simply not enough food produced in the world at present for every country to have all it would like. We in Britain have done very well so far—we cannot expect to recover our former position, and certainly not to improve on it, without a considerable amount of international co-operation and effort in improving the production and the distribution of food among nations.

Intranational Distribution

However well a country is supplied with food it cannot be assumed that all the individuals in that country are adequately fed. The United States, for its population, has a greater supply of many important foods, such as meat, milk, and fats, than most countries. But it is undoubtedly true that there is in the United States a higher proportion of ill-nourished people, even of people with obvious nutritional deficiency, than in Britain. If we consider only one nutritional disease, pellagra,

we find that, in spite of the energetic steps taken to eradicate it, there were in 1946 still about 100,000 people suffering from pellagra, of whom nearly 1,000 died.

Unless there is a superabundance of food at a price within the reach of even the poorest, it must be expected that the more nutritious foods, which are also the more expensive—foods like milk, meat, cheese, eggs, fruit, and vegetables—will find their way chiefly to the tables of the wealthier people. There is only one way of ensuring that the essential foods are available to all, irrespective of the length of their purse. That way is by the dual system of price control with food subsidies, so that the price is held within the reach of all, and rationing so that the better-off cannot take more than their share and leave insufficient for the less well off (Fig. 6). The alternative of free markets means that the wealthier, buying as much as they wish, will drive up the price until the demand by the less wealthy is reduced so as to be equal to the remaining small supply.

The effect of the dual system of price control and rationing can be illustrated by the distribution of milk in Britain. Before the war there were people who, we know, consumed

Fig. 6.—Diagram illustrating relation between consumption of more expensive foods and income. AB illustrates how consumption of such foods as meat, milk, eggs, and fruit increases with increasing income when their cost is regulated by "free markets." CD illustrates how consumption is ideally independent of income when foods are subsidized, their price controlled, and they are rationed. Rationing prevents the wealthier people from buying more than their share, so that their consumption falls (B→D). Price control and subsidies allow the poorer people to buy their fair share, so that their consumption rises. (A→C).

a pint of milk a week. Professional people like ourselves would have been consuming a pint of milk a day. We are now complaining when we are allowed only half of this. But this fact that many people are now getting less than before, together with the fact that the total amount of milk being consumed has risen by 40%, must clearly mean that many more people are now getting more than they did before.

It is the absence of this system in many European countries to-day which leads many of us unthinkingly to suppose that food conditions there are better than here. Of course shops can be filled with meat, butter, eggs, cheese, and sugar if the price of these foods puts them beyond the reach of a large proportion of the people. We are told, for example, that the Italians are better off than we are because meat is not rationed. The fallacy of this sort of argument is best seen if we compare this ability to buy as much meat as they like with the average consumption of meat in Italy, which is about one-fifth of that in Britain. These two facts must mean, not that the Italian worker is eating one-fifth as much as the British worker, but that, since more than the average can be and is bought by the wealthier people, the ordinary worker must be getting less than the average—less than one-fifth of British rations. If only one-tenth of the Italian population could afford to buy twice what we call our meagre ration of meat, there would be none whatever left over for the rest of the population.

INCREASE IN PRICE OF FOODS 1939-1949 (PERCENTAGE)

Fig. 8

As another example, we may compare the cost of food before and after the war in Britain and in Switzerland, countries in which earnings are much the same (Fig. 7). The two striking points are the far greater increase in cost in Switzerland since 1939 and the present far greater cost in Switzerland compared with Britain (Fig. 8).

It is surely obvious that without price control and rationing there must be a tremendous differential in the consumption of the more-sought-after foods, so that while some people are getting quite a lot some also are getting very little indeed. It is our system of fair shares in food which, as much as anything else, is responsible for the health of the nation.

A consideration of all these facts seems to lead to only one conclusion. So long as world production and international distribution continue as they are, we must continue with a system of rationing and price control. It is the only moral way in which we can try to ensure a full healthy life for everyone.

The problem of feeding a hungry world is, it is clear, not going to be an easy one to solve. Part of the solution is in our own hands and immediate—a realization, for example, of what is really implied by agitating for the early abolition of rationing. Much of the problem, however, can be solved only by international co-operation to a degree which we have unfortunately never yet reached. But if we mean all we say about the advantages of our type of Western democracy, we mean that our will can find expression in the action of our Government. The formulation of our will in this matter of food and mankind depends on adequate understanding of what faces us. This paper is an attempt to help in this understanding.

INCREASE IN PRICE OF FOODS

FIG. 7.—N.B.—Sterling prices were calculated on the exchange rates ruling in August, 1939, and August, 1949.