

Rothamsted Research Harpenden, Herts, AL5 2JQ

Telephone: +44 (0)1582 763133 Web: http://www.rothamsted.ac.uk/

## **Rothamsted Repository Download**

A - Papers appearing in refereed journals

Pirie, N. W. 1953. Research for plenty. No.8: New foods for a crowded world. *Agriculture: the journal of the Ministry of Agriculture.* 60, pp. 116-20.

The output can be accessed at:

https://repository.rothamsted.ac.uk/item/8wy79/research-for-plenty-no-8-new-foods-for-a-crowded-world.

© Please contact library@rothamsted.ac.uk for copyright queries.

20/09/2019 14:11

repository.rothamsted.ac.uk

library@rothamsted.ac.uk

## RESEARCH FOR PLENTY

NO. 8. NEW FOODS FOR A CROWDED WORLD
NO. 8. N. W. PIRIE, M.A., F.P.C.

Rothamsted Experimental Station, Harpenden, Herts

contributors to this series have described many ways in contributors affected, or could affect, food and agricultural knowledge has affected on vigorously, the present agricultural high new knowledge acted on vigorously, the present agricultural high new knowledge has abolished. But there were acted to this series have described many ways in the present agricultural high new knowledge has affected. But there were acted to the present agricultural high new knowledge has affected. But there were not a series have described many ways in the present agricultural high new knowledge has affected. But there were not agricultural high new knowledge has a series have described many ways in the present high new knowledge has affected. But there were not agricultural high new knowledge has a series have a series have described many ways in the present high new knowledge has a series have a series contributors affected, or could affect, food and agriculture.

The carlier knowledge has affected on vigorously, the present world food and agriculture.

But there would be contributors and the montangement world food. Represent population; and the population is liver and agriculture. But there would be only just enough their probably be abolished. But the population is likely to great the present population and improving standards. their probably be addition; and the population is likely to grow, the present population and improving standards of living the present urbanization and there may sometimes of living the present population and there may sometimes are of increase, and there may sometimes are of increase. the present population and improving standards of living may increase, and there may sometime be a state of assume this and we do not live the rate of assume this and we do not living the rate of assume the rate of assume this and we do not living the rate of assume the rate of assum the property of the property o increase of increase, and there may sometime be a stable as the rate of the ra All improvements normally advocated that may solve the immediate problems appulation is likely to be. All improvements normally advocated that may solve the immediate problems appulation is thought and experiment are needed. that may solve the immediate problem.

If the population is likely to with; that may solve the immediate problem.

If the population is likely to with; that may solve the immediate problem.

If the problem is likely to with; that may solve the immediate problem. diberefore be pushed on the experiment are needed on the problem.

It population if it goes up from its present value of rottle world population to four or six thousand million to four or six thousand million. dibersone time, thought and population if it goes up from its present value of rather at the world population to four or six thousand million. If we have the the world million to four or six thousand million. If we have the world population to four or six thousand million. If we have this thousand million to four of six thousand million. If we have this thousand radical reconsideration of the processes of agriculture. At the same time the thousand million to reconsideration of the processes of agriculture and the feed, a radical reconsideration from her will be called for. At the same time, we might think of the population from her will be called for the population from her to feed, a radical recome. At the same time, we might think about will be called for. At the same time, we might think about doubting will be cance the population from becoming so large.

Advantages of keeping the population from becoming so large.

Advantages difficulties, too, but with reasonable research for the population from becoming so large. difficulties, too, but with reasonable research facilities it presents difficulties socially—and aesthetically—acceptable be possible to devise socially—and aesthetically—acceptable contrabe possible to devise so that the invariable reason for the birth of a child is techniques so that the invariable reason for the birth of a child is wanted. When children are no longer conceived techniques so unat the When children are no longer conceived inad-that child is wanted. When with under-rather than over no inad-thasic research on foodstuffs was done by primitive man some thousands plants and animals were examined to see whether there was part that could be eaten with satisfaction and safety, and the better resed but the process, in essence, remains the same and were cultivated in essence, remains the same and research is sincreased, but the process, in essence, remains the same and research is involved towards getting a greater total yield of one of the conventional notices, or at increasing the proportion of a plant or animal that is edible. thely that, with the familiar domesticated animals, this process has reached a limit, but, as Dr. Alan Fraser explained,\* there are many has that have not been subjected to careful selection. Fish have hardly selected at all. But the most important improvements are likely to me from increases in the useable portion of plants; for the plant is the damental food on which both land and water animals depend.

Of the half million or so known green plants, only a few hundred are used a significant scale and many of these are only used indirectly. They are to animals and we eat the animals. But many of the others grow Gardeners know well how readily weeds grow, but a plant is weed for as long as we have no use for it. If we wished simply to the largest possible amount of vegetable matter, many other plants— With a little would be as good as our domesticated With a little attention and breeding, they might even be better. The will have gained nothing if we make a great mass of vegetation that ther man nor beast will eat.

Agriculture, 1953, 60, 10-4.

RESEARCH FOR PLENTY: edible and inedible plants or parts of plants?

That then defines one problem: what are the essential differences be Inefficiency of Animals in The higher green plants, when they igorously, have similar general structure root system in the ground coll structure.

The higher green Plants, when they are similar general structure of system in the ground collective of the structure of the ground collective of the structure simple nutrients, and a leaf system traps light and collects and collects water the air. The process is driven by the energy of sunlight and air very efficiently, but the exposure Plants. simple nutrients, and a lear system maps ngm and collects that from the air. The process is driven by the energy of sunlight carbon damage and sunnight plant of sunnight carbon damage and sunnight carbon damage from the air. The process is driven by the energy of sunlight. The process is driven by the energy of sunlight their leaves to light and air very efficiently, but the exposure their leaves to light and air very efficiently, but the exposure their leaves of the plant is protected from damage and supplied with the plant is protected from damage and supplied with the plant is protected from the energy of sunlight to the plant is protected from damage and supplied with the plant is protected from the energy of sunlight to the plant is protected from the energy of sunlight. their leaves to light and air very emerging, our the exposure ranks effective if the plant is protected from damage and supplied with many aim of the techniques of agriculture is to enter the primary are designed to increase the water than the primary are designed to increase the plant is to enter the primary are designed to increase the primary are designed to increase the plant is to enter the primary are designed to increase the plant is protected from damage and supplied with the plant is protected from damage and supplied with the plant is protected from damage and supplied with the plant is protected from damage and supplied with the plant is protected from damage and supplied with the plant is protected from damage and supplied with the plant is protected from damage and supplied with the plant is protected from damage and supplied with the plant is protected from damage and supplied with the plant is protected from damage and supplied with the plant is protected from damage and supplied with the plant is protected from the plant is protected effective if the plant is protected from damage and supplied with water nutrients. The primary aim of the techniques of agriculture is to make the which water, light and carbon dioxide are united in the leaf Basically, improvements in musually are designed to increase the with which water, light and carbon dioxide are united in the leaf.

The process, like most biological processes, works through an interpretation of anythms, and enzymes, so far as is known, consist mainly anythms. The process, like most biological processes, works through an integroup of enzymes, and enzymes, so far as is known, consist mainly of we use a plant as a source of seeds, tubers, fibre or the group of enzymes, and enzymes, so iai as is known, consist mainly of the product we get from it contains protein or not, the plant as a source of seeds, tubers, fibre or late Whether we use a plant as a source of secus, tubers, fibre or late whether the product we get from it contains protein or not, the plant whether the other things from the leaves; the leaf is its feature. whether the product we get from the leaves; the leaf is its factory. In the normal development leaves first and the other things have a leaf is its factory. In the normal development the protein moves out of the leaf and reappears in the protein moves. mature plant the protein moves out of the leaf and reappears in the seat. Similarly, when an animal eats the leaf in the seat. mature plant the protein moves that we eat. Similarly, when an animal eats the leaf it conventions to meat or milk. Dr. Norman Wright\* discussed the protein into meat or milk. Dr. Norman Wright\* discussed the convenience of milk and explained that the merit of the ruminary into meat or milk and explained that the merit of the ruminant and the fibrous parts of many types of leaf and an also digest the fibrous parts of many types of leaf and an also digest the fibrous parts of many types of leaf and an also digest the fibrous parts of many types of leaf and an also digest the fibrous parts of many types of leaf and an also digest the fibrous parts of many types of leaf and an also digest the fibrous parts of many types of leaf and an also digest the fibrous parts of many types of leaf and an also digest the fibrous parts of many types of leaf and an also digest the fibrous parts of many types of leaf and also into meat or milk and capitalist that it can also digest the fibrous parts of many types of leaf and so we that it can also digest the fibrous parts of many types of leaf and so we have conversions are ineffective. fibre as a source of energy. But these conversions are inefficient by for every 100 lb. of leaf protein that the cow eats we only get 20-30 lb. in the milk when she is in milk, and only 5-10 lb. back as meat from cattle. It is sometimes argued that the process is not really interest. because all the nitrogen of the protein goes back on to the land, nour and reappears in the next crop. In part this is so; elements are no troyed during agricultural operations. But there is waste of effort if the or protein goes fruitlessly round a cycle without being intercepted and by us. It is as if a fisherman laboriously netted fish on one side of while a colleague shovelled nine-tenths of the fish back into the see the other side. In a sense the fish are not being wasted; the fisherms always catch them all over again. But no one would argue in favour as a good technique of fishing.

One way to avoid this inefficient cycle, and so get more human for the same amount of agricultural effort, would be for us to eat leave and it would undoubtedly be possible for people to eat more leafy m than they do at present. But not much more. The ideas attribute Nebuchadnezzar and Joseph Foullon are not very good ideas, and leas likely to go on being condiments rather than foodstuffs. Unsuitable leaf may be for direct human consumption, there is good reason to this protein, glucose and other foods could be made from it in nutrition palatable form in a factory. Ultimately this will be done with special grown for the purpose, but work of this type should start using the supplies of forest and agricultural waste that we already have. rubbish that is normally burnt or rotted is potentially useful.

Another problem can therefore be defined: could we take leafy or material that is at present either not being grown or is being thrown when grown, and convert it on a large scale into palatable food?

NEW FOODS FOR A CROWDED WORLD In the laboratory those statement of the laboratory t In the laboratory those things are easily done.

In the factory glucose has already been made.

In the factory glucose has already been made.

In the factory glucose has already been made. In the factory glucose has already been made already been made attempts to improve these processes, and attempts to improve the processes, and attempts to improve the processes, and attempts to improve the processes and attempts to improve the processes are processes at the processes and attempts to improve the processes are processes at the processes are processes at the processes are processes at the processes at the processes at the processes are processes at the pr by several different processes, and attempts to improve these pro-by several different countries. So far, no sustained work on an and the several countries of leaf protein, but a beginning made in several done on the extraction of leaf protein, but a beginning made in several done on the extraction of leaf protein, but a beginning the several done on the extraction of leaf protein, but a beginning the several done on the extraction of leaf protein, but a beginning the several done on the extraction of leaf protein, but a beginning the several done on the extraction of leaf protein, but a beginning the several done on the extraction of leaf protein, but a beginning the several done on the extraction of leaf protein, but a beginning the several done on the extraction of leaf protein, but a beginning the several done on the extraction of leaf protein, but a beginning the several done on the extraction of leaf protein, but a beginning the several done on the extraction of leaf protein, but a beginning the several done on the extraction of leaf protein, but a beginning the several done on the extraction of leaf protein, but a beginning the several done on the extraction of leaf protein, but a beginning the several done on the extraction of leaf protein and the several done on the extraction of leaf protein and the several done on the extraction of leaf protein and the several done of the by several countries. So far, no sustained work on an an extraction of leaf protein, but a beginning fresh leave been done on the extraction of leaf protein, but a beginning fresh leave been well as been preliminary tests of machines for grinding fresh leaves all has been protein in the juice, have been well as and the protein in the juice, have been well as and to fithe protein in the juice. we sale has the preliminary tests of machines for grinding fresh leaves in the juice, have been very encouraging.

The protein in the juice, have been very encouraging.

The protein in the juice, have been very encouraging.

The protein in the protein in the juice, have been very encouraging.

The protein in the juice, have been very encouraging.

The protein in the juice, have been very encouraging.

The protein in the juice, have been very encouraging.

The protein in the juice, have been very encouraging.

The protein in the juice, have been very encouraging.

The protein in the juice, have been very encouraging.

The protein in the juice, have been very encouraging.

The protein in the juice, have been very encouraging.

The protein in the juice, have been very encouraging.

The protein in the juice, have been very encouraging.

The protein in the juice, have been very encouraging.

The protein in the juice, have been very encouraging.

The protein in the juice, have been very encouraging.

The protein in the juice, have been very encouraging.

The protein in the juice, have been very encouraging.

The protein in the juice, have been very encouraging. I the protein in the juice, have been very encouraging, and the protein in the juice, have been very encouraging, will be both possible and useful. I had such a process will be done now, but this sometime it might as well be done now, but this sometime sometime than is at present envisaged. I solve very much more extensive research than is at present envisaged. I solve very much more unfortunate impact of science on daily life avoid the sometimes unfortunate impact of science on daily life. out this research than is at present envisaged. In the sometimes unfortunate impact of science on daily life and the sometimes unfortunate impact of the need is urgent. The solid the sometimes thoroughly and to start it before the need is urgent. The solid daily life start it before the need is urgent.

I daily life to start it before the need is urgent.

I daily life to start it before the need is urgent.

I daily life to start it before the need is urgent.

I daily life to start it before the need is urgent.

I daily life to start it before the need is urgent.

I daily life to start it before the need is urgent.

I daily life to start it before the need is urgent.

I daily life to start it before the need is urgent. urgent.

and corrected in the privacy of any, can then be discovered and corrected in the privacy of any, can then be work is done hurriedly it may be applied before the work is done hurriedly it may be applied before.

The people of Britain should not be experimented on.

The people of Britain and through the money and through the money and through the people of Britain and through the money and through the money and through the people of Britain and through the money and through the money and through the people of Britain and through the money and through the people of Britain and through the money and through the people of Britain and through the money and through the people of Britain and through the people of Britain and through the people of Britain and th The people of Britain should not be experimented on. They supplying the money and, through their fecundity, the supplying the wind unnecessarily as guinea-pigs as well the state of the supplying the case in negative to the supplying the case in negative to the supplying the case in negative to the supplying t

pigs as well, that argued the case in negative terms: because the world is that argued are worth making as food on a large scale if the have argued the case in flogative terms; because the world is a food on a large scale if they are logical materials are worth making as food on a large scale if they are objectional flavours or textures. But active the scale of the scale o materials are worth in the state of the stat We expect it to be fun, and, to a matter of fuelling the body. We expect it to be fun, and, to a digestion depends on that expectation being fulfilled. a matter of fuening the coarse of the expectation being fulfilled. The third digestion depends on that expectation being fulfilled. The third herefore, is: could we turn materials made in the manner. the third digestion depends on turn materials made in the manner I have therefore, is: could we turn materials made in the manner I have

dinto good, as well as useful, foods? mime, it is certain that we could, because the materials themselves the and so is the human appetite. Do not misundant phable and so is the human appetite. Do not misunderstand me.

When it comes to eating I are looking forward to these new foods.

When it comes to eating I accept the fact that looking forward to these but we must accept the fact that without we slaughter of the world's population, the old ideal foods are unlikely also also be should be shou back in quantity. The foods of which we think nostalgically nost beef and so on—have never been more than the foods of a minority in a favoured country. They have not been the foods of reggregations of population, and it does not seem likely that we will with sufficient commercial ascendancy to enable the whole population to eat the pre-war middle and upper class diet. Regretfully, Iturn to what most of the world has always eaten. Rice, wheat, potatoes and other starchy foods enlivened with a little meat, fish and with a range of herbs to give flavour; that is the world's diet. The population goes up it will be ours too. Leaf protein would mesuch a diet greatly and, at the worst, would not be noticed in it.

we and leaf protein are only two examples, but there are many others. posibilities are sometimes criticized on the grounds that they are and unnatural. They are: but so are most of our present foods. allows are as artificial and sophisticated as our clothes and there is no to think we have reached perfection with the one than with the Even if there was no necessity to find more food, it is likely that new dals would alter our foods as they have already altered our clothes.

dring the last decade several new foods have figured in the British diet, tome of them have been received coldly. This is partly because they shen looked on as temporary expedients—something to tide us over an rad shortage. Those interested in the preparation of food have not doe thought it worth while to concentrate on making from them somerally tasty in its own right. The position would be different if we

<sup>\*</sup> Agriculture, 1953, 59, 559-63.

No. 8. NEW FOODS FOR A CROWDED WORLD were persuaded that things like this would always be with us, and if the future. Thousands of years of skin their on were persuaded that things like this would always be with us, were convinced that the new foods would be the basis of and if the during the foreseeable future. Thousands of years of skill and and acting habits, and it is not to acting the bandled effectively. during the foreseeable future. Indusands of years of skill are operations of the skill and skill and skill and skill and skill and skill and skill are operated be called for be called for be salled behind our present cooking and causing mades, and it is not accept that novel products will be handled effectively right away to be on the cooking and enterprise has given to the cooking and causing mades, and it is not accept that novel products will be handled effectively right away to be on the cooking and enterprise has given to the cooking and causing mades, and it is not accept that novel products will be handled effectively right away be on the cooking and enterprise has given to the cooking and it is not accept that novel products will be handled effectively right away. In the cooking are the cooking and it is not accept to the cooking and it is not accept to the cooking and it is not accept to the cooking are the cooking and it is not accept to the cooking are the cooking and it is not accept to the cooking are the cooking are the cooking accept to the cooking are the cooking are the cooking accept to the cooking accept to the cooking are the cooking accept to the co that novel products will be nanoted effectively right away. be entered over many years is likely to be called for. But when we consider and the Far Fact to cheese in the effort over many years is likely to be called for. But when when surprising variations that local enterprise has given to cheese in Francher there is no reason to third third. surprising variations that local enterprise has given to cheese in Francisco difficulty of thinks everywhere, there is no reason to think of an arched difficulty of a contract difficulty of a con Italy, or to fish in Scandinavia and the Fair Dast, or to fermented fermented drinks everywhere, there is no reason to think of any fermented drinks difficult, there is all fermented drinks everywhere, there is no reason to think of any as unredeemably dull. If the project looks difficult, there is all the for starting work on it early before the need has become as unredeemably dult. If the project looks difficult, there is all the reason for starting work on it early before the need has become acute reason for starting are old and traditional alim

Agriculture and cooking are old and traditional skills. Even Agriculture and cooking are old and traditional skills. Even changes in them are resented fiercely for various reasons, and the resent instified. An innovator is apt to be preoccupied with the resent the contract of the preoccupied with the pr changes in them are resented notedly lot various reasons, and the reasons, is, in part, justified. An innovator is apt to be preoccupied with his large problem and does not always pay due attention is, in part, justified. An innovator is applied to be preoccupied with in facet of a large problem and does not always pay due attention to facet of a change. We have had many examples of the facet of a large problem and we have had many examples of this a consequences of a change. We have had many examples of this a consequence of science something. consequences of a change.

cynic is apt to say that with every advance of science something become process a little less satisfactory. Sometime cynic is apt to say that with every action of solution something become little worse, or some process a little less satisfactory. Sometimes, however, and widely welcomed possibility scientific advance opens up new and widely welcomed possibilities. Then science does scientific advance opens up to control of electricity is an obvious example. Then science does not provide the science does not prov a cheaper substitute for something we already know and like. The change is important not as a substitution but as an innovation. Never the change is important not as a substitution but as an innovation. Never the change is important not as a substitution but as an innovation. of activity become possible which the innovator thinks people will be of activity become possible which the innovator thinks people will be of activity become possible which the innovator thinks people will be of activity become possible which the innovator thinks people will be of activity become possible which the innovator thinks people will be of activity become possible which the innovator thinks people will be of activity become possible which the innovator thinks people will be of activity become possible which the innovator thinks people will be of activity become possible which the innovator thinks people will be of activity become possible which the innovator thinks people will be of activity become possible will be of activity be of activity become possible will be of activity be of activity become possible will be of activity be of activity become possible will be of activity be of activities and activity be of activities activity be of activities acti

What are the best Raw Materials? My thesis is therefore simple intensification of the familiar pro of agriculture could overcome the present shortage but would not conprobable future demand; that could, however, be met if high-yielding crops were used as the raw material for a biochemical engineering in This thesis is not generally accepted. There are those who take a glo view of the present; but the other contributors to this series have with them. There are those who agree that technological advances opened up new possibilities, but who do not think that the leaves of plants are the best raw material for the work. Some would start will or limestone and the nitrogen of the air, and make wholly synthetic for others would concentrate on bacterial and fungal synthesis; and year would use the single-celled green plants. The objections to those views be stated briefly.

At the end of his talk, Sir James Scott Watson\* indulged in what he "a pleasant dream" of the chemist in the factory making all the basic like starch and sugar while the farmer concentrates on the dietary It is a possibility certainly, and undoubtedly a wider range of things made synthetically. Fats and vitamins are already; some of the acids—the building blocks of which proteins are made—could be and could be used to supplement proteins that happen to be deficient particular amino-acid. But I doubt if more than a small fraction food will be synthesized directly in this way. What would be the unless starvation threatens otherwise? Under good conditions is as pleasant a job as factory work, and it uses the free energy supplicable and it is the free energy supplicable and it is the free energy supplicable and it is the first and it is the free energy supplicable and it is the free energy supplicable and it is the first and it is the first and it is the first and it is the free energy supplicable and it is the first and it is the firs sunlight. This is the real difficulty; the raw materials are abundant for large scale synthesis we would need enormous amounts of energy

of the exhaustion of our coal supplies is already causing alarm.

The least is more probable. The least to look for other while it is obviously wise to look for other while it is obviously wise to look for other least while it is obviously wise to look for other least while it is obviously wise to look for other least while it is obviously wise to look for other least while it is obviously wise to look for other least while it is obviously wise to look for other least while it is obviously wise to look for other least while it is obviously wise to look for other least while it is obviously wise to look for other least while it is obviously wise to look for other least while it is obviously wise to look for other least while it is obviously wise to look for other least while it is obviously wise to look for other least while it is obviously while it is obviously wise to look for other least while it is obviously wise to look for other least while it is obviously wise to look for other least while it is obviously while i of our coal supplies is already causing alarm.

The leaf but solar energy is more probable. The leaf but solar energy is more probable of the exhaustion of our coal supplies is more probable. The leaf but solar energy is more probable. The leaf but solar energy is more probable. The leaf more efficient while the possibility of simply making the leaf more efficient with the possibility of simply making the leaf more efficient with the possibility of simply making the leaf more efficient the possibility of the possibility of simply making the leaf more efficient with the possibility of the possibility of simply making the leaf more efficient the possibility of the possibi

Jack sight of.

If subject to the lost sight of.

If subject to the lost sight of th This would be a source of rood but they need some form of small-scale as long as we only think of small-scale be used; but for large-scale that could be used; but for large-scale would not suffice and we would have to grow on the following wastes that could be used; but for large-scale would have to grow crops there are many wastes that could be used; but for large-scale would not suffice and we would have to grow crops. This would sometimes be an precisely the micro-organisms. Precisely the type of wastes and the micro-organisms. would sometimes be an would involve precisely the type of wasteful but more often it would. The single-celled green plants that we are trying to avoid. but more often it would involve precisely the type of wasteful to avoid. The single-celled green plants have that we are trying to avoid undiminishing asset—sunlight—as the they use our undiminishing asset—sunlight—as the sit that they use our undiminishing as the sit that the sit that they use our undiminishing as the sit that the sit that the sit they use of the sit that the sit that the sit the sit that the sit the sit that we are trying to avoid. In single-cented green plants have use our undiminishing asset—sunlight—as the nerit that they use on any other green plant, unite water. a nitro merit that they use our uncomming asset—sunlight—as the underly and then, like any other green plant, unite water, a nitrogen But they seem to have no merit that the bigger and then be any other green to have no merit that the bigger and then be any other green to have no merit that the bigger and then be any other green to have no merit that the bigger and then be any other green to have no merit that the bigger and then be any other green to have no merit that the bigger and then be any other green to have no merit that the bigger and then be any other green to have no merit that the bigger and then be any other green to have no merit that the bigger and then be any other green to have no merit that the bigger and the bigger and then be any other green to have no merit that the bigger and the bigger and then be any other green to have no merit that the bigger and the bigger and then be any other green to have no merit that the bigger and the bigger a therefy and then, like any other seem to have no merit that the higher and darbon dioxide. But they seem to have no merit that the higher they do not make an accustomed food but only the They do not make an accustomed food but only the raw They do not make an they do not grow in the open on fields the biochemical engineering; they do not grow in the open on fields they do not grow in the open on fields the biochemical engineering, and the capital outlay and the was and tubes of comparable acreage. The capital outlay and the was and the countryside are alike at the capital outlay and the country ide are alike the capital outlay and the capital outlay tubes of comparation of the countryside are alike alarming.

results of such a conversion of the laboratory they give a conversion of the country side are alike alarming. that when pampered ideally in the laboratory they give a greater what when pampered hour than we get by normal farming. that when pamperous than we get by normal farming, but no one square yard per hour than we get by normal farming, but no one pampering the higher plants in the same assiduous and expensive pampering the higher plack soil and fresh water, we are not likely to where we have sumper, to there we lack soil, water culture could be used; where where, things become more difficult. It may be that sunlit deserts divater, inings become described plants. Each technique divantageously be used to grow single-celled plants. Each technique diantageously of brobably a most efficient use to which each area or moduet could be put. The various processes should be looked on as ments rather than alternatives.

for Food Research If, therefore, imaginative, long-range research is undertaken soon to discover how to make a ange of agricultural products into human food and how to give novel spleasing flavours and textures, the outlook for world feeding during hundred years or so seems hopeful. The food eaten in Britain is be different but not necessarily worse; that eaten in much of the the world should improve. If the proposals made by the earlier to this series are carried out, the world could have a brief respite nger, but it will not be long before pressure of population catches Ultimately there must be a population limit, and establishing for a stable population throughout the world will be a slow It is urgent, therefore, for radical research on food production to With sufficient luck and skill, the research may keep human fecundity brobably be crite dies generations, and after that interval the probprobably be quite different from those that we recognize now.

(Copyright reserved to author)

This article completes the series

<sup>\*</sup> Agriculture, 1952, 59, 351-5.