RESEARCH FOR PLENTY

No. 8. NEW FOODS FOR A CROWDED WORLD

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THE earlier contributors to this series have described many ways in which new knowledge has affected, or could affect, food and agriculture. If their proposals were acted on vigorously, the present world food shortage could probably be abolished. But there would be only just enough for the present population; and the population is likely to grow. Apart from increasing urbanization and improving standards of living may cause a fall in the rate of increase, and there may sometime be a stable population, but we dare not assume this and we do not know how large the stable population is likely to be. All improvements normally advocated should therefore be pushed on with; that may solve the immediate problem. But, at the same time, thought and experiment are needed on the problem of controlling the world population if it goes up from its present value of rather over two thousand million to four or six thousand million. If we have this number to feed, a radical reconsideration of the processes of agriculture and food-making will be called for. At the same time, we might think about the advantages of keeping the population from becoming so large. That course presents difficulties, too, but with reasonable research facilities it should be possible to devise socially–and aesthetically–acceptable contraceptive techniques so that the invariable reason for the birth of a child is that that child is wanted. When children are no longer conceived inadvertently, we may well be concerned with under- rather than over-population.

The basic research on foodstuffs was done by primitive man some thousands of years ago. Plants and animals were examined to see whether there was any part that could be eaten with satisfaction and safety, and the better species were cultivated and improved. Recently the rate of improvement has increased, but the process, in essence, remains the same and research is mainly directed towards getting a greater total yield of one of the conventional products, or at increasing the proportion of a plant or animal that is edible. It is likely that, with the familiar domesticated animals, this process has about reached a limit, but, as Dr. Alan Fraser explained,* there are many animals that have not been subjected to careful selection. Fish have hardly been selected at all. But the most important improvements are likely to come from increases in the useable portion of plants; for the plant is the fundamental food on which both land and water animals depend.

Of the half million or so known green plants, only a few hundred are used on a significant scale and many of these are only used indirectly. They are fed to animals and we eat the animals. But many of the others grow luxuriantly. Gardeners know well how readily weeds grow, but a plant is only a weed for as long as we have no use for it. If we wished simply to grow the largest possible amount of vegetable matter, many other plants—even in their uncultivated state—would be as good as our domesticated plants. With a little attention and breeding, they might even be better. But we will have gained nothing if we make a great mass of vegetation that neither man nor beast will eat.

* *Agriculture*, 1953, 60, 10-4.

That then defines one problem : what are the essential differences be
edible and inedible plants or parts of plants ?

Inefficiency of Animals in Converting Leaf Protein

The higher green plants, when they are gr
vigorously, have similar general structure
root system in the ground collects water
simple nutrients, and a leaf system traps light and collects carbon di
from the air. The process is driven by the energy of sunlight. Plants ex
their leaves to light and air very efficiently, but the exposure can onl
effective if the plant is protected from damage and supplied with wate
nutrients. The primary aim of the techniques of agriculture is to ensure
Basically, improvements in husbandry are designed to increase the effici
with which water, light and carbon dioxide are united in the leaf. On
process almost all life depends.

The process, like most biological processes, works through an integ
group of enzymes, and enzymes, so far as is known, consist mainly of pro
Whether we use a plant as a source of seeds, tubers, fibre or later
whether the product we get from it contains protein or not, the plant
leaves first and the other things from the leaves ; the leaf is its factor
proteins are the tools in the factory. In the normal development
mature plant the protein moves out of the leaf and reappears in the se
tubers that we eat. Similarly, when an animal eats the leaf it convert
protein into meat or milk. Dr. Norman Wright* discussed the conve
into meat or milk and explained that the merit of the ruminant ani
that it can also digest the fibrous parts of many types of leaf and so us
fibre as a source of energy. But these conversions are inefficient bo
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 ineff
because all the nitrogen of the protein goes back on to the land, nouri
and reappears in the next crop. In part this is so ; elements are not
troyed during agricultural operations. But there is waste of effort if nitr
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 a
while a colleague shovelled nine-tenths of the fish back into the sea
the other side. In a sense the fish are not being wasted ; the fisherma
always catch them all over again. But no one would argue in favour o
as a good technique of fishing.

One way to avoid this inefficient cycle, and so get more human food
the same amount of agricultural effort, would be for us to eat leaves
and it would undoubtedly be possible for people to eat more leafy ma
than they do at present. But not much more. The ideas attribu
Nebuchadnezzar and Joseph Foullon are not very good ideas, and lea
likely to go on being condiments rather than foodstuffs. Unsuitable
leaf may be for direct human consumption, there is good reason to thi
protein, glucose and other foods could be made from it in nutritio
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. A
rubbish that is normally burnt or rotted is potentially useful.

Another problem can therefore be defined : could we take leafy or w
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 ?

* *Agriculture*, 1953, **59**, 559-63.

Ways of Food-Making In the laboratory those things are easily done.
wn by several different processes, and attempts to improve these pro-
es are being made in several countries. So far, no sustained work on an
ute scale has been done on the extraction of leaf protein, but a beginning
been made, and the preliminary tests of machines for grinding fresh leaves
ssing out part of the protein in the juice, have been very encouraging.
dy seems certain that such a process will be both possible and useful.
s going to be done sometime it might as well be done now, but this
ns very much more extensive research than is at present envisaged.
ay to avoid the sometimes unfortunate impact of science on daily life
the research more thoroughly and to start it before the need is urgent.
defects, if any, can then be discovered and corrected in the privacy of
boratory, whereas if the work is done hurriedly it may be applied before
complete. The people of Britain should not be experimented on. They
eir share by supplying the money and, through their fecundity, the
blems. They should not be used unnecessarily as guinea-pigs as well.

far I have argued the case in negative terms : because the world is
of food, materials are worth making as food on a large scale if they are
table and do not have objectional flavours or textures. But eating is
imply a matter of fuelling the body. We expect it to be fun, and, to a
extent, digestion depends on that expectation being fulfilled. The third
tion, therefore, is : could we turn materials made in the manner I have
ed into good, as well as useful, foods ?

time, it is certain that we could, because the materials themselves
datable and so is the human appetite. Do not misunderstand me.
not looking forward to these new foods. When it comes to eating I
conservative as anyone else, but we must accept the fact that without
ale slaughter of the world's population, the old ideal foods are unlikely
me back in quantity. The foods of which we think nostalgically—
, roast beef and so on—have never been more than the foods of a
ored minority in a favoured country. They have not been the foods of
ge aggregations of population, and it does not seem likely that we will
ablish sufficient commercial ascendancy to enable the whole population
Britain to eat the pre-war middle and upper class diet. Regretfully,
refore, I turn to what most of the world has always eaten. Rice, wheat,
e, potatoes and other starchy foods enlivened with a little meat, fish
k, and with a range of herbs to give flavour ; that is the world's diet,
f the population goes up it will be ours too. Leaf protein would
ve such a diet greatly and, at the worst, would not be noticed in it.

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

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

were persuaded that things like this would always be with us, and if the co
were convinced that the new foods would be the basis of their operati
during the foreseeable future. Thousands of years of skill and acciden
behind our present cooking and eating habits, and it is not to be expe
that novel products will be handled effectively right away. Interm
effort over many years is likely to be called for. But when we consider
surprising variations that local enterprise has given to cheese in France,
Italy, or to fish in Scandinavia and the Far East, or to fermented and
fermented drinks everywhere, there is no reason to think of any mat
as unredeemably dull. If the project looks difficult, there is all the
reason for starting work on it early before the need has become acute.

Agriculture and cooking are old and traditional skills. Even
changes in them are resented fiercely for various reasons, and the resent
is, in part, justified. An innovator is apt to be preoccupied with his
facet of a large problem and does not always pay due attention to a
consequences of a change. We have had many examples of this, and
cynic is apt to say that with every advance of science something becom
little worse, or some process a little less satisfactory. Sometimes, how
scientific advance opens up new and widely welcomed possibilities
control of electricity is an obvious example. Then science does not pro
a cheaper substitute for something we already know and like. The
change is important not as a substitution but as an innovation. New
of activity become possible which the innovator thinks people will e
and the innovator is often right.

What are the best Raw Materials ? My thesis is therefore simple.
intensification of the familiar proce
of agriculture could overcome the present shortage but would not cope
probable future demand ; that could, however, be met if high-yielding
crops were used as the raw material for a biochemical engineering ind
This thesis is not generally accepted. There are those who take a gloo
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 h
plants are the best raw material for the work. Some would start with
or limestone and the nitrogen of the air, and make wholly synthetic fo
others would concentrate on bacterial and fungal synthesis ; and yet ot
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 c
" 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 w
made synthetically. Fats and vitamins are already ; some of the am
acids—the building blocks of which proteins are made—could be m
and could be used to supplement proteins that happen to be deficient
particular amino-acid. But I doubt if more than a small fraction of
food will be synthesized directly in this way. What would be the po
unless starvation threatens otherwise ? Under good conditions farm
is as pleasant a job as factory work, and it uses the free energy supply
sunlight. This is the real difficulty ; the raw materials are abundant.
for large scale synthesis we would need enormous amounts of energy.

* *Agriculture*, 1952, **59**, 351-5.

ossibility of the exhaustion of our coal supplies is already causing alarm.
ar fission might help, but solar energy is more probable. The leaf
s uses this. While it is obviously wise to look for other methods of
ng sunlight, the possibility of simply making the leaf more efficient
d not be lost sight of.

teria and funguses could be a source of food but they need some form of
soup to grow on. For as long as we only think of small-scale
ction there are many wastes that could be used ; but for large-scale
ction, by-products would not suffice and we would have to grow crops
ively to feed the micro-organisms. This would sometimes be an
ge but more often it would involve precisely the type of wasteful
sion that we are trying to avoid. The single-celled green plants have
reat merit that they use our undiminishing asset—sunlight—as the
of energy and then, like any other green plant, unite water, a nitrogen
s and carbon dioxide. But they seem to have no merit that the higher
lack. They do not make an accustomed food but only the raw
ial for biochemical engineering ; they do not grow in the open on fields
tanks and tubes of comparable acreage. The capital outlay and the
ific results of such a conversion of the countryside are alike alarming.
true that when pampered ideally in the laboratory they give a greater
per square yard per hour than we get by normal farming, but no one
and pampering the higher plants in the same assiduous and expensive
Where we have sunlight, soil and fresh water, we are not likely to
ive on the leaf ; where we lack soil, water culture could be used ; where
ck water, things become more difficult. It may be that sunlit deserts
advantageously be used to grow single-celled plants. Each technique
s place and there is probably a most efficient use to which each area or
product could be put. The various processes should be looked on as
ements rather than alternatives.

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

This article completes the series