# PRODUCTIVITY FOR THE FUTURE: FOOD PRODUCTION

by
F. J. Francis
Department of Food Science and Nutrition
University of Massachusetts
Amherst, Massachusetts

The ability to increase food production from unconventional sources does exist, however, is it attractive from an economic point of view?

I would like to talk this afternoon on the topic of "Food Production". This infers a discussion of what we consider traditional methods of food production plus unconventional sources which may enter the food stream in the future. This is a very big topic, and obviously, I can only deal with the highlights in the time allocated to me. First of all, we should consider what we mean by increased food production. What we really mean is the possibilities of increasing food production in a manner which is attractive from an economic point of view. I think we should be very realistic about this economic aspect, since we can make food out of literally anything of organic nature. We can literally take almost any organic material and treat it either from a microbiological point of view and transform it into something of nutritional value. The only question is--can we do it in a manner which can compete with the economics of conventional food production. Some of the ideas for increasing food production from unconventional sources have been pretty far out, which really means that maybe our society isn't quite ready for some of these suggestions yet.

I would like to spend a few minutes talking about what we would consider as conventional food production. By this, I mean, food produced by conventional agriculture and food production from the sea. We have heard a good deal of rhetoric in the past few years about the possibilities of feeding the world population. One tends to get a sense of complete unreality, depending upon which source of information one is listening to. For example, we can dispense with the food from the sea concept fairly simply. Ten years ago in the popular press and in a number of books, we heard the forecast that the sea could easily support ten times the world's population. Well, the realities of the situation are that maybe it can, but we know of no technology which is capable of exploiting this potential at the present time. Food production from the sea increased continually until about 1970 and then started to decrease. The production from the sea at the present time is decreasing, because most of the major stocks have been overfished; and conservation measures have simply not been adequate to conserve the fishing stocks at steady state. Consequently, I think most realistic forecasters would say that on a purely theoretical basis, based upon carbon assimilation, the sea is capable of producing about one hundred million tons of fish suitable for human consumption on a world wide basis. In 1970, the world was harvesting approximately 70 million tons; so even under the best of circumstances, the increases that can be expected are of the order of 1/2 of present consumption. I personally believe this is optimistic, since present indications are that the catches are decreasing, not increasing. So in terms of increased food production from the sea, we have to either develop an

entirely new technology or face the realistic situation that food from the sea cannot be increased to any appreciable extent.

Let us turn very briefly to the world food situation from the conventional agriculture point of view. Here we have a broad diversity of opinions. Some of the alarmists would have us believe that we are on a crisis basis certainly within the next ten years. It is rather curious that the crisis is always ten years away. When we reach that point the forecasters forecast another ten years. I remember reading as a student the fascinating forecast by George Orwell in his book 1984. I will have a daughter who will graduate from high school in 1984. And for those of you who have read the book, I don't believe we are going to have alcohol in the surrogate fluid in 1984. The facts of the matter are that in terms of conventional agriculture food production has had a rather dismaying habit of keeping up with population. Admittedly, the production has not been uniform around the population centers, but the total production roughly correlates with the total population. On the other hand, the economists, whom we assume should be in a better position to judge this situation than others, give us an optimistic point of view of the ability of conventional agriculture to increase its production in the near future. We can certainly do this in the U.S., Canada, Australia and Brazil. I firmly believe that with the technical knowledge at hand, we will have no difficulty in coping with the increases in population in the immediate future, meaning ten years. I should note, however, that with world population increasing at the rate it is, I can't believe that science will be able to cope with this forever. Undoubtedly, we are going to reach a point where population outstrips food supply. I suspect it is closer than we believe in spite of the optimistic food supply situations as we hear described, for example, by Mr. Quentin West of the U.S Economic Research Service. I shall leave this area of conventional agriculture with one very pertinent comment. This world is destined to use conventional agriculture as a major source of nutrients for the future, at least as long as I have any conceivable hope of living. However, nutrient sources for conventional agriculture will be supplemented by nutrients from other sources. At the present time, they are exceedingly small indeed, but they will grow gradually, slowly and continually in the future. Let us discuss for a few minutes some of the sources that, in my opinion, are likely to become important as sources as human nutrients. I mentioned previously that we can make human nutrients out of almost anything of organic nature. So we should merely look at what materials of organic nature we have at our disposal. A number of fascinating possibilities come to mind. One, obviously, is petroleum. In my opinion, this is bound to be a very important development for human food in the future. At the present time, there are very large installations being planned in Britain, France, Czechoslovakia, Italy and Japan to produce yeast protein from petroleum sources. Their schedule is such that the yeast will probably be used as animal feed, due to problems of clean-up. We will feed the yeast being grown on petroleum to animals and eat the animals for human food. Eventually, as technology develops and the volume of production increases, undoubtedly, the yeast will be incorporated directly into human food. The present size of some of the contemplated plants make this a very obvious development. We will also see an increase in the use of yeast for animal food and human food from a number of other sources. For example, in the production of cheese, in this country, tremendous quantities of whey are disposed of. Unfortunately, with our anti-pollution laws, it is no longer possible to utilize streams and rivers as disposal sites and it may be less costly to convert whey into a form of yeast, which can be used as animal food. This is not to say that the collection,

sanitation and processing problems are going to make the process economic in its own right. However, if we introduce the cost of disposal, it may well be that this process may develop faster than we anticipate at the present time. The same type of thinking applies to the production of cellulose for pulp and paper in this country. Tremendous quantities of wood sugars are a disposal problem. Sulfite liquor is a particularly difficult material to deal with from both a disposal point and a processing point of view. However, it may be less expensive to convert the sugars into yeast as source of protein for feed and food. I anticipate that the production of protein from this source will increase. There are a number of other suggestions to produce protein from carbohydrates, as for example, yeast protein from molasses. The reason for the activity and apparent research interest in the production of protein foods as opposed to carbohydrate foods is that protein has been projected as being in short supply by the nutritionists for the past 15 years. However, the nutritional forecasts are changing. Human requirements for protein are gradually being lowered and the emphasis for protein may not be as acute as we would have believed ten years ago. This is not to say that it still is not important. It is, but other human nutrients are important too. There doesn't seem to be any good reason why we cannot take, for example, the carbohydrates as a by-product of the manufacture of cheese or the sulfite liquor sugars or molasses and use them directly as a source of carbohydrates for human use. I think there are good reasons why we do not really worry about the supply of carbohydrates to the same extent that we worry about the supply of proteins. The answer is that it is easier to produce carbohydrates. We have the vast production of cereal grains in the temperate areas and high carbohydrate crops such as sugar cane in the tropical regions.

The supply of protein suitable for human use has received considerable research interest from other areas, for example, the Amoco Company has concluded that they can make ethyl alcohol from a petroleum source and grow yeast on the ethyl alcohol and provide a source of human nutrients from the yeast. This, of course, would make the yeast economic in its own right. Other sources of protein which will become important are protein from cottonseed meal. There are two breakthroughs in this area which undoubtedly will make cottonseed more attractive for human consumption. One is the development of varieties of cotton which have a very low content of gossypol. This compound is a toxic yellow pigment. The other is development of milling processes, which enable the processor to actually remove the gossypol from conventional cottonseed sources. In either case, protein from cottonseed meal will be available for feed and food in the future in large quantities. Another obvious source of protein which has received considerable world-wide attention is protein from leaves. Dr. Pirie in England is an advocate of the development of relatively simple systems for removing protein enriched concentrates from green leaves. However, the problem is that these protein concentrates are virtually inedible by our standards. They require considerably more processing to make them attractive to the human public. Such processing is certainly possible, but at the present time, it does not look as if it is economically feasible. There is considerable interest in this area in the development of protein concentrates for human use from alfalfa. However, the areas that are important for alfalfa production also have an alfalfa weevil problem, so pesticide control measures will have to be utilized in conjunction. However, this is very localized, and the overall situation of protein from green leaves does not look very promising, to me, at the present time.

There is one potential source of food, which has received considerable attention in the lay press, simply because it is spectacular. This refers to the production of human food from sewage. Sewage is one material with no lack of

supply. There is no question in my mind that we can make material from sewage, which is suitable for human consumption, but I seriously doubt at the present time, whether we would be willing to pay the cost. Considerable processing is required to make acceptable products, and at the present time, the same nutritive value can be obtained much more easily from other sources. I am a firm believer in the antipollution sewage disposal techniques, which are being enforced in many parts of the country, and we may as well see the day when we will recycle sewage into material suitable for feed and food. However, I have sincere doubts as to whether it will happen in my life time. There are many other suggestions for food from unconventional sources. They are all fascinating from a technical point of view, but they will not show up on the decimal point in terms of the volume of production in our present world situation. We will still depend on conventional agriculture for the last bulk of our human nutrient supply.