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The Forecast Famines Become Gluts

IN THE YEARS just after 1975 there were many forecasts of coming desperate shortages of food, energy, some raw materials, and methods of controlling environmental pollution. Instead, all these things became gluts, because freer price mechanisms were sensibly applied and science then homed in on these fields. A third factor was summarized by an economist as early as 1973:

> The least useful and least credible sort of medium-term economic forecast today is whatever is at any moment the most fashionable one. The reason for this is now quite logical and rather technical. In modern conditions of high elasticity of both production and substitution, we will generally create a temporary but large surplus of whatever the majority of de-

cision-influencing people five or ten years earlier believed was going to be in most desperately short supply. This is because the well-advertised views of the decision-influencers tend to be believed by both profit-seeking private producers and consensus-following governments, and these two then combine to cause excessive production of precisely the things that the decision-influencers had been saying would be most obviously needed.

Down to the 1990s rich countries—which by then generally had only 3–9 per cent of their work-forces in farming—rigged markets in favor of those farmers, because it seemed politically necessary to woo these 3–9 per cent of voters. Although most of these rich countries were in the less lushly tropical parts of the world, they found these small agricultural work-forces provided far more food than they needed. They built towering butter mountains, undrainable wine lakes, mounds of unsaleable grain.

Poor countries often had 45–70 per cent of their work-forces in farming, and it might be supposed their rulers would therefore be even more intent on pleasing this mass of their subjects. Until 2006, they were not. The rulers of most poor countries were dictators liable to be overthrown by *coups d'état*. Coups were not organized by farmers, but by city-dwellers, who ate food but did not sell it. Dictators therefore kept down the price of food, and their peasants responded by not producing it.

With the coming of Centrobank the rulers of poor countries found it desirable to introduce free-market pricing policies; they did not qualify for Centrobank money unless they did. It is probable that these policies alone would have made many of them self-sufficient in food. But the Centrobank system also made it profitable for rich countries' scientists to devise and sell to the poor countries mechanisms for increasing their food production. At the same time, the revolution in genetic engineering made huge expansion rather easy in crop yields, meat, single-cell protein (SCP), and desert reclamation. Hence the food gluts.

Plant species are inherently more manipulable than animal species. Because plants can reproduce asexually, it is usually easy to produce an individual plant whose cells are all transformed once one has transformed cells in a particular tissue. A whole plant can then be regenerated from these few selected cells. Since the 1990s it has been relatively easy to produce transformed plants which breed true. In the years 1996–9 transformed rice, wheat, and other cereal plants were engineered that were capable of resisting common killers such as pests, drought and frost. By cloning as well as producing new individuals from transformed seeds, stocks of the transformed plants, which were capable of breeding true, could be produced very quickly.

This sort of crop engineering brought especially spectacular yields in the tropical areas where many poor countries were. To combat the pests commonly found in such climates, the plants' newly engineered immunity to the most virulent of them was backed up by the manufacture of bacteria which attacked other species of pests. New, sophisticated genetic engineering techniques ensured these were very specific in their effects and had none of the wider ecological consequences foretold by critics when the experiments in this field began in the 1980s; they also put an end to banshee wails about the effects of chlorinated hydrocarbons and other insecticides on the environment and on the health of nations.

Farming now became a more stable and reliable business, and an economist might have hoped that it would therefore become an unpolitical industry, moving to the areas which could produce food most cheaply. As long as national governments remained powerful, it did no such thing. In the poor countries even the first stages of the Centrobank system helped to create a food glut. They provided an external incentive for the development of food plants capable of growing in places where only dry grass, thorn scrub or cactus plants had grown in the twentieth century. We advanced in those years to the biological systems that allow the fullest exploitation of the land, the soil and the sunlight which streams from the heavens

to fuel our ecosphere. We began the business of transforming the surface of the earth by reclaiming the wilderness which was previously inhospitable to man.

As deserts bloomed and food production went into top gear in the lushest poor countries, the seeds were sown of the cereal glut and agricultural slump of 2011–14. Under previous political systems, governments would probably have responded to this agricultural distress by increasing agricultural subsidies. Fortunately, by 2014 computers told governments and Centrobank to cut off agricultural subsidies instead.

Man does not feed on cereals alone, and science was simultaneously creating a glut in meat. There has not been any substantial experimentation in the use of genetic engineering techniques to make heritable changes in human germ plasm. Our superstuds are not creating artificial superhuman beings. Supercattle, however, are being created in herds.

Primitive biological engineering has been practiced in animal husbandry for thousands of years, to persuade cows to produce milk for human use and hens to lay unfertilized eggs. By 1980 the artificial insemination of female livestock, using sperm from the best males of each species, was commonplace; and the first experiments in cloning by separating the cells of early embryos produced by *in vitro* fertilization had been carried out.

Even before the achievement of enhanced transformation rates in the 1990s, much work had been done on the engineering of animal embryos. Because egg-cells are so much larger than other kinds of cells they are much easier to transform. Multiple copies of new genes can be injected into them with a micropipette without the aid of a vector. Experimental transformations of mice were carried out by this method in the early 1980s, but there was initially little control over the number of copies of the gene to be transplanted or over the likelihood of the gene being expressed in the adult animal.

Gradually, in the last years of the twentieth century, a better understanding grew of the mechanisms which determine whether genes are switched on or off, and these difficulties disappeared.

The first important innovation was achieved when several species of meat-producing animals were equipped with extra genes. They produced the compounds known as anabolic steroids—the hormones which control the rate at which muscle tissue (i.e., meat) is built up as an animal matures. At first, anabolic steroids were given to cattle, pigs and some Olympic shot-putters in their food, but it was much more economical and efficient to get these patients to breed their own steroids. The animals and athletes that these affected were so heavily built that locomotion became difficult, but it was already commonplace (though controversial) to breed and rear such animals in close confinement anyhow, rather than to allow them to roam free.

The next step was to make economies in the input of raw material to these large animals—i.e., in their method of digesting food. Although cows had the ability even in the 1980s to make use of the cellulose in their diet, the system which they used to do so was highly inefficient. One contemporary scientist commented:

> Cows have a complex system of stomachs which act as fermentation tanks where bacteria break down cellulose into compounds which the cow can handle through its own metabolism. The rate of processing is slow and energy-wasteful, much of the energy potentially present in the plant material being wasted as gas.

During the energy crisis of the 1970s, this led to some gloom among meat-eaters and some agitating from vegetarians. There is a great deal of cellulose in the biosphere, but by far the greater part of it sustains only micro-organisms and some higher organisms (like termites) which have entered into partnership with them. There are three-quarters of a ton of termites for each human being on earth. In the 1980s it seemed to some ecological pessimists that meat production was too wasteful a manner of exploiting the ecosphere. There were suggestions that it would be uneconomical to maintain it.

Thanks to genetic engineering, this fear proved absurd. The

efficiency of cattle and pigs in utilizing the energy stored in cellulose and woody plant tissues has been dramatically enhanced. Cows have been given new genes to produce enzymes which enable the animals to metabolize cellulose and other substances directly, without recourse to bacterial middlemen. This has made the feeding of livestock much more economical and much less messy. By the turn of the century it was possible to use artificial enzymes to break down lignin, an undesirable compound generally found in combination with cellulose in waste materials such as paper and some kinds of plastics, so that productive use could be made of these as food additives. This assisted pollution control as well as meat production, and by 2025 the term "waste" has almost lost its meaning because there is a productive use for almost everything.

We have made our food animals into hyper-efficient converters of the inedible into the palatable, but have thereby raised moral problems because the large, heavy, immobile meat animals of today offend many of the most decent instincts of mankind. This revolution helped to speed the development of SCP (single-cell protein).

The years 2005–10 saw frenetic research and development in this field by Western and Japanese entrepreneurial arrangers in food technology. The products were aimed at Third World markets through the Centrobank system. The sales arguments were strong. Young cattle take several weeks to double their mass. Most food plants are a little faster, but are restricted to a particular growing season. Algae and fungi, by contrast, can double their mass in a few hours. Bacteria and some yeasts, under favorable conditions, can do so in less than an hour. Green crusaders proved less worried about immobile bugs than about immobile cows, although there were early fears in the 1980s that the lobbyists who finance them would help see they were excited even about this; witness British Petroleum's lost millions in its problem protein plant in Sardinia which was stifled by environmental fears and pressure from the soya protein lobby.

There were three main problems inhibiting the development

of SCP as a human food-source. The first, palatability, had disappeared by the 1990s: food processing techniques were devised which made its texture, color and taste seem luscious to the young. The other two problems—possible toxicological worries and the problem of finding the most suitable food supplies for the growing micro-organisms—were closely linked.

Virtually all the early SCP projects envisaged that the protein-producing micro-organisms would be fed on waste materials. Which wastes? Many early experiments with petrochemical wastes were plagued with problems caused by toxic residues. As many people in the 1980s still believed the world faced an energy crisis, there were complaints when the first successful commercial SCP projects, in Japan and West Germany, used methanol as raw material to produce SCP which was largely used as animal feed. Methanol was not exactly a waste product. It had itself to be manufactured. Ethanol—a more effective raw material—was even more valuable commercially.

For these reasons the projects to develop SCP for human use moved away from the exploitation of petrochemical processes toward the more conventional processing of plant and animal foodstuffs, plus sewage. When fungal protein processes reaped the benefits of genetic engineering in the 1990s, the method was quickly adapted to the production of ultra-cheap protein-rich human foods.

Farmers of the 1990s, successors to the soya lobby, counter-attacked by saying that mankind was now eating bugs grown out of its own shit. One remembers the joke about the fastidious old lady in the last century who refused to eat sheep's tongue in a restaurant. "I won't eat anything that has come out of a dirty sheep's mouth; bring me something nice like an egg."

In reality SCP usefully substitutes for processes which happen in nature anyway. All organic wastes are eventually recycled within the ecosphere, entering long chains where they are converted again and again into single-cell protein. What the technological usurpation of the process permits us to do is to speed up the operation.

The SCP business is ecologically sound in every way. At no stage is carbonaceous material being taken out of the ecosystem by being converted into a non-biodegradable form. Essentially, this kind of industry is a matter of ecological streamlining. Within the context of the earth's complex life-system it is helping the ecosphere to function more efficiently and more economically. The problem with Mother Nature as a provider of human needs is that she has never had the benefit of good advice from a sensible time-and-motion analyst. Now, at last, we have the capacity to modify organisms that will allow us to act upon the results of such analysis.

If, as seems likely, we will eventually undertake the colonization of the farther reaches of the solar system and send self-sustaining space habitat units outside the system to distant stars, then SCP technology will be vital to the maintenance of ecological stability. Meanwhile it has helped to give the world an even bigger glut of food.