tose corn syrup, imitation milk products, meat extenders and analogues.

Mr. Laurent was generally pessimistic about the prospects of converting the knowledge and abilities in food technology and agronomy of the most advanced nations to benefit those nations where hunger and malnutrition are major problems.

The implementations for the food and flavor industry of shortages and dependence on climate conditions

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John Kenneth Galbraith has referred to economic life as a process of constant adjustment to things that have never happened before. This helps to explain why economic forecasts are often viewed with about the same degree of suspicion as weather forecasts. It also provides us with an inescapable truth, which we should keep clearly in mind in considering the issue to which this symposium is addressed. For the issue of natural vis-a-vis artificial has many aspects—cultural, legal and medical notably—in addition to economic. But of them all, it is the economic aspect which is the most inflexible, which we can least afford to ignore. If you have any doubt of this, think back to the traumatic days of the oil crisis. None of us could avoid the immediate implications of that shortage, and each of us has had to make some adjustments to accommodate the new economics of oil. Even Detroit!

Energy is involved in every step of the modern food chain: farming, fertilizer, processing, transportation, storage and cooking. The real costs of food and energy are inextricably connected and the energy required to deliver each food calorie is increasing in quantity as well as cost.

Nevertheless, I hope to show that, for the food and flavor industries and for consumers in developed countries, the implications of shortages and climatic dependence are by no means all negative.

Let's first define our terms. A shortage occurs when supply fails to meet demand. But shortages also exist, for all practical purposes, when for example, goods are available but unaffordable as sugar and coffee have been for many, within recent memory, or when price and availability fluctuate widely as cocoa has, or when food is available but undistributable as has happened in India.

And what is the meaning of climatic dependence? It means unpredictability of total crop volume. It means variable cost of husbandry. It means uncertainty as to the exact time of harvest. It means swinging from surplus to shortage; from self-sufficiency to importing, or to building reserves. And more reserves have been drawn upon in recent years than have been built up. All of these uncertainties man has lived with through the centuries. 9,000 years ago the celebrated walls of Jericho were begun in a massive tower, built to defend a spring. 1,000 years later, Jericho was a large walled agricultural settlement, raising bread wheat irrigated by the spring. The extent of this fortification underlines the extremity of man's dependence then upon the climate. 90 centuries later, the Hudson Institute looks ahead, and foresees the end of farming as we know it. Instead, the institute envisages reliance upon crops that lend themselves to completely indoor agriculture, raised in greenhouses, growing rooms or tanks, and being far freer from climatic dependence than we are today. Even if the present overall changes in weather patterns do prove to be a real shift in climate zones, the institute believes that man would have enough time, technology and resources to recreate such a food supply system ahead of schedule, and more or less independent of nature. This is a reassuring view in the face of such reports as a recent one issued by the Worldwatch Institute: that the deserts of Africa, Asia, Australia and the Americas are enlarging; and remembering that powerful empires once flourished in what is now the Sahara.

Clifford E. Desch, president of the Society, welcomed the attendees.

What is the meaning of shortages and climatic dependence in developing countries where these conditions have the most profound impact? Cropland is inadequate. Production is inadequate. The means of distribution are inadequate. A degree of malnutrition is inevitable. Poverty is perpetutated. This constitutes a vicious circle, almost inaccessible to the modern food manufacturer. The impulse to growth must come from within. In the long term, donated food tends to inhibit the development of an indigenous agricultural industry. The developing nations not only have to raise enough food to eat, to save foreign currency, but also to export, in order to gain foreign currency for creating new jobs in agriculture and for the further processing of their agricultural products. Employment and increased purchasing power are indispensable ingredients in breaking the vicious circle. Here natural and artificial are academic abstractions.

In industrialized nations, the impact of shortages and climatic dependence appears on a relatively banal level, as inconvenience, and higher prices. If the shortage is protracted, or the price rise particularly steep, consumers shop for substitutes. Substitution leads to reappraisal, and, eventually, to a change in eating habits. The process leads to greater flexibility. It is a benign circle. The impact is something we can assimilate and even profit from, in a positive sense. It fosters greater choice and wide acceptance. It taps new resources, catalyzes new developments and technologies. For the food and flavor industries, it is one of the greatest instruments of change and progress. Here, natural and artificial are aspects of abundance.

There are terrible contrasts between these two scenarios. But there is one common factor that unites them: human habit, familiarity, cultural acceptance—what a human being will accept, and what he or she will not. In developing countries when shortages strike the normal limited diet, populations often go hungry, rather than eat unfamiliar emergency supplies provided. In industrialized countries, the only consistent exceptions to the rule occur when the pressure to change is abnormally high, as happens during wartime or strikes, for example, or conversely, when a population increases its standard of living and can trade up by substituting what are seen as superior foods to their normal fare. For example, Japanese per capita consumption of red meat tripled in the 1960-1972 period, presumably mostly at the expense of fish. The only time that the American consumer accepted soy extenders for red meat in significant numbers was under the economic pressure of unparalleled price hikes for meat itself. It is an anthropological truism that food habits are deeply ingrained, and change very slowly. We are all traditionalists at heart.

Because of the disappearance of world surpluses of many food commodities, and the recent volatility of the food commodities market, the food industry has been turning increasingly to the use of alternative ingredients to control manufacturing costs of processed food products, and hence, retail prices. Most traditional ingredients have become preferred food items as a result of centuries of human consumption. The highest volume traditional ingredients are commodities such as flour, sugar, meats, fats and oils. Like traditional food ingredients, many alternative ingredients are also derived from agricultural products, but they tend to depend on the use of new processing techniques, and they usually represent a more efficient use of available resources. Soy protein is, of course, a classic example, since it delivers about 17 times as much protein per acre as does grass-fed beef. And the most commonly eaten fish, like tuna, consume far more feed to produce a pound of protein than a beef steer. Alternative food ingredients that already play a significant role in this country also include milk-derived proteins, high fructose corn syrup, fat and oil replacers (including thickeners and stabilizers) and, of course, natural and artificial flavorings. These have generally achieved their position because of shortages in the supply of their traditional counterparts. Vanillin, for example, gained marketshare as a vanilla substitute after major increases in the agricultural cost of the vanilla bean crop. Margarine, on the other hand, did not achieve substantial market acceptance until high butter prices coincided with improvements in the aesthetic quality of margarine and recognition of its dietary advantages.

This heralded a change in consumer attitudes towards imitation foods. Considerations of diet and convenience were added to the economic

impetus for accepting traditional food alternatives. In turn, this has allowed food manufacturers more freedom to consider alternative ingredients when shortages and high prices threaten a standard ingredient. Such alternatives must, of course, be readily available, more cost effective, have the functionality of the traditional ingredient, and not disturb the character of the end product in any way that might lessen its appeal. In short, the value of the end product to the consumer must be maintained in terms of satisfaction and nutrition as well as actual price. The process, therefore, involves ingredient suppliers in the development of substitutes which duplicate as many as possible of the traditional ingredient's attributes, and involves the food processor in adapting to the use of new ingredients without rocking the boat. A new USDA survey has confirmed that food shoppers' biggest single motivation is "satisfaction appeal," and that this still comes ahead of price.

Let's look at a current food ingredient shortage in detail, see what some of its ramifications are, and how they arise. You might say that the first cocoa shortage lasted a hundred years, while Spain jealously guarded the secret of cacao, the royal drink of the Aztecs, which Cortes had uncovered during the Spanish conquest of Mexico in 1519. The cat finally got out of the bag in the early 1600s, and by 1650 chocolate was an established luxury drink in Europe. In another 100 years, drinking chocolate had come to America to stay. About the same time, European manufacture of drinking chocolate began to gather momentum. It is particularly interesting to note that by the turn of this century, a leading brand of cocoa was being advertised as "a substitute for tea and coffee—cheaper and more satisfying." Chocolate itself was the serendipitous by-product of a process patented by van Houten 150 years ago, to make chocolate powder. This produced cocoa butter as a by-product of the defatting process involved. The use of cocoa and chocolate is still only really widespread in Europe and North America. In many countries, chocolate is even now regarded as something of a luxury, and only a relative handful of the world's population have ever tasted cocoa or chocolate. The major cocoa bean producing countries are the developing nations of Ghana, Nigeria, The Ivory Coast, and Cameroun, plus Brazil. Their interest is to command the highest possible price for their cocoa crop. Much of the cocoa bean income of the African nations is devoted to other uses, rather than ploughed back into expanding production, although cocoa development programs do exist in all four countries. One result is that

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worldwide production has seldom exceeded 1.5 million metric tons, and it takes only a very small movement in the level of output or consumption to set prices off on a dramatic upward or downward spiral. Last season, for example, trade estimates of a projected shortfall of a mere 7,000 tons in global output was enough to triple cocoa prices. Unlike most other commodities, cocoa beans do not keep for very long without costly refrigeration, so the holding of large reserves over any period of time is not very practical, and the market is unusually susceptible to unfavorable weather on the crop. Add to this the fact that eastern bloc consumption becomes an important variable when supplies are tight, and you have some indication of why the cocoa market is so characteristically volatile.

Until quite recently, the cocoa butter or liquor required for chocolate and coatings have usually been the premium priced derivatives of the cocoa bean, and cocoa powder something of a by-product, since van Houten's patent. Yet last summer, the relationship was reversed. Cocoa powder sold at higher prices than cocoa butter—in fact at over eight times the low of only two years earlier. What happened? One explanation is that cocoa powder has been promoted as a flavoring for confectionery, baked goods, ice cream and desserts, for example, in addition to its original use as a nutritious drink. So now there are a variety of industries which are steady users of cocoa, who were faced, not for the first time, with large cost increases for an ingredient used basically for its flavor. Some established programs to free themselves from the vagaries of this volatile market by switching permanently to the use of replacements, even when the price of cocoa would fall below that of the replacement.

We have all seen chocolate bars get smaller, and more expensive. We have all sensed the cocoa identity receding in baked goods, drinks and desserts as the natural cocoa content has been stretched to compensate for the volatile behavior of this luxury ingredient. The flavor industry had foreseen the need for more economical flavor substitutes, and over the years has devoted considerable efforts to developing acceptable chocolate flavors. The need reached fever pitch last year. But three factors had prevented any easy solutions: First, the number of aroma volatiles identified in roasted cocoa beans is well over 400, yet none of these ingredients by itself is reminiscent of cocoa. Secondly, although cocoa is used in many products primarily for flavor, it imparts additional effects which are an inseparable part of its identity: color, bulk, fatty mouthfeel, astringency, bitterness, particulate texture, and an elusive dark taste. Thirdly, cocoa and chocolate are not synonymous, and over the years, much more attention had been paid to developing chocolate flavors than to cocoa, which was normally far more cheaply available.

If all this sounds like "Catch 22," remember Galbraith's law—that economic life is a process of constant adjustment to things that have never happened before.

Well, what's the answer? There are many, of course. Some food manufacturers are developing ways to replace all but the flavor properties of cocoa themselves and turning to outside help for the latter only. Others have joint projects with suppliers who can help to replace the most important attributes of cocoa in their end products. And a handful of suppliers have taken on the challenge of developing replacers for cocoa powder that are virtually complete. To replace all of the significant sensory, functional and nutritional aspects of cocoa powder in a freely available, lower cost, food grade form is a tall order indeed. It's a challenge that no one in the ingredient supply industry could have seriously considered without the cumulative experience and resources that have been built up in combating food ingredient shortages.

What are some of the lessons that can be learned from this particular shortage and used in the future by the food and flavor industries?

When a food manufacturer is faced by shortages of a necessary ingredient, it has several choices. It can accept higher costs and decide what proportion to pass on to the consumer in higher prices or it can maintain present prices and reduce the level of use of the critical ingredient by blending off or otherwise, at the cost of sensory quality changes. It can also seek substitute ingredients in the form of extenders, enhancers, flavors or complete replacers, all of which will necessitate considerable testing, label changes on the product, new buying positions, and assuring the availability of the new

ingredients.

If the short ingredient is a significant part of the end product, then it is essential to have complete realism in the substitute. Consumer advocate, Betty Furness, confirmed that our industries are finally beginning to approach this goal by her reaction to some of the substitutes shown at the Philadelphia IFT Exhibition last year.

If the short commodity is the food product, the marketer had better be ready with competitive alternatives. If not, today's flexible minded consumer may switch to anything that fills the same basic need. Nowhere was this better demonstrated than by the great defection from high priced coffee to tea over the last two years.

Food commodity surpluses are no longer so common as they once were. Food manufacturers who are not already doing so should consider defensive programs to develop alternatives to those of their important ingredients that seem most vulnerable. Remembering that consumer satisfaction is a paramount feature of successful foods, we should be careful to focus on the end rather than the means when selecting ingredients for new food products under development. Care should be taken to distinguish between those ingredients which are needed to provide nutrition and those whose chief function is to provide flavor. For example, if the new product is to have a cocoa character, or cheese, tomato, or onion, then using flavors in place of these commodities should be deliberately considered from the outset. Alternatively, the respective commodity could be used in the new product in conjunction with an extender or replacer, to give the manufacturer more flexibility of action if the commodity does come into short supply. The proportion of the substitute ingredient in the blend may be increased so that neither the availability nor the price of the end product need be affected. For such defensive ingredient programs to be fully effective, supplier and manufacturer must work very closely together, preferably in a joint development program protected by a confidentiality agreement.

There's a very subtle long-term implication for us all in one of the most positive contributions to the world food supply problem. Plant breeding and hybridization have been successfully used to produce higher yielding crops, increase disease resistance, adapt vulnerable crops to mechanical harvesting, and improve storage life and many other features, with the notable exception of taste and flavor. As this process is

presently a very gradual one, this particular side effect is only perceptible by making comparisons between produce from different countries, but it's an important consideration for the flavor industry when dealing internationally, because it's yet another aspect of the differences which occur in regional taste preferences. This kind of genetic engineering is entering a new phase that could speed up the process immensely, first by developing new and improved plant types from cell masses of the original strain, and later, it is envisioned, by a technique called somatic hybridization, which would enable hybrids to be developed from quite different plant types. Already the British National Vegetable Research Station has crossed several broccoli types with cauliflowers to produce a giant broccoli, suitable for mechanical harvesting. The flavor industry has learned to deal with moving targets, but the inference here is that the targets are soon going to be moving faster than we have been accustomed to.

Another subtle implication of future shortages here in the States lies in our demographic makeup. The median age of the population is growing older—from just under 28 in 1972 to 35 in 22 years' time. This is already reflected in the growing conservatism in American society, and in its simplest terms, will intensify the demand for realistic acceptable substitutes when food ingredient shortages hit.

NATURAL VS. ARTIFICIAL

Necessity is the mother of invention. What began as an industrial response to shortages and higher prices of basis foodstuffs has begun to go much further. The new ingredients and techniques that have resulted from this basic cause have given us the power to rebuild foods, stressing their positive nutritional values, and to delete negative dietary elements such as saturated fats and cholesterol. This growing ability is tremendously important from a health standpoint, enabling food processors, as it does, to make modified forms of traditional foods that better suit our lifestyles, in the light of current medical knowledge. But just like the alternative ingredients from which they stem, these engineered foods must seem traditional and familiar in their form and sensory properties if they are going to be widely accepted. People will not eat what they do not like, even if it is better for them. If you are under doctor's orders to avoid cholesterol, you will probably stick to no-cholesterol foods. These now include cholesterol-free engineered substitutes for such traditional goodies as eggs, bacon and sausages. The more effectively such substitutes deliver the appetite appeal and satisfaction of the real McCoy, the more they will sell beyond the confines of their presently restricted medical (and sometimes religious) markets. The time is already ripe for this, as the country moves into a period of moderation and awareness of the close links between diet and health. The revised dietary goals of the Senate Select Committee on Nutrition and Human Needs focus on reduction of obesity through control of caloric intake and judicious eating habits. This entails reducing consumption of fat, saturated fat, cholesterol, alcohol and sugar by significant percentages. Imagine the cumulative shortage of satisfaction in that! The Council for Agricultural Science and Technology points out that the public is unlikely to pursue optimal eating habits without information and encouragement. It recommends priority nutrition education at all levels for the medical profession and the general public—both adults and children—plus reenforcing food regulatory activities. I might add that our industries can play an important role in this intended revolution, by increasing the palatability and appeal of these reduced-calorie foods, drawing upon the knowledge and resources already built up in dealing with ingredient shortages. The flavor industry is preeminent in this sphere, followed, I believe, by the stabilizers and thickeners industry. These products essentially give pleasure to the consumer, and can restore satisfying food characteristics, when these have been reduced.

More than a year ago, a national opinion poll on soy protein foods conducted by the Gallup organization suggested that Americans are positively receptive to these foods of the future. One-third of the respondents thought that soy beans will become the most important protein source—well ahead of meat or fish. More than half of the respondents believe that soy protein products provide adequate or superior nutritional value. Eleven percent said that listing soy protein as an ingredient on food labels would make them more likely to buy such foods, while 50% said it would not affect their buying decision. This flexibility of attitude is a healthy sign for the future of foods engineered to optimize dietary, nutritional, and economic needs. The onus is now on our industries to deliver the goods.

With this kind of background today, what can we say about the issue of natural vs. artificial? There is obviously a need for both, or they wouldn't both exist. In part, the issue stems from a far larger issue that resurfaced in the western world more than a decade ago, questioning our whole way of life. That issue was basically material versus non-material, and it pitted the coun-

ter-culture against the establishment. Although the noise of that battle has died down, it has made people more apt to question issues that affect their daily lives and to take little for granted. There is a feeling that artificial devalues somehow, as opposed to natural. In France, over the past two years, food additives such as colors, antioxidants, preservatives and even citric acid and vanillin have come under such attack from consumer groups that many food manufacturers reformulated the most affected food products completely free of coloring and other additives, using only natural ingredients. Within a year of their successful introduction, the overwhelming majority of these crusading products have vanished from supermarket shelves—from lack of demand. In Britain, a 1978 Mintel survey of housewives revealed that 38% believed additives to be harmful to health, 27% said they were used to cover up inferior products, 23% felt that additives made food less nutritious, and 19% said they made food more expensive. Many respondents believed all manufactured food to be impure, and took a cynical view of food labels carrying purity claims. The American approach has been more cautious. It has been recognized by government and industry alike that to stress foods containing only natural ingredients will further confuse public confidence in foods containing perfectly safe food additives—the very instruments that increase shelf life and enhance product acceptability, tools in fact that are indispensable in the alleviation of ingredient shortages. General Foods took a far-sighted position in their campaign to educate the public about the role of food additives in everyday foods. Consumers must be responsibly informed so they are fully aware of the issues and not influenced to buy this food or that on the basis of emotional reaction or misinformation.

What we are all truly concerned with is our ability to provide an abundant, nourishing and acceptable food supply. We have a wealth of new resources and capabilities to achieve this, but for these to be used to the full, the walls of mistrust and ignorance that still divide and confuse us must be brought down as the walls of Jericho were brought tumbling down long ago.

Part II. Safety Aspects and Consumer's View

Consumer's View

Nancy Harvey Steorts, President, Nancy Harvey Steorts and Associates, and formerly Special Assistant to the Secretary of Agriculture for Consumer Affairs

I am delighted by the great concern by the flavorists that the food products that are produced are products that the consumer truly wants and products that are truly nutritious.

As you know I had been in the government for several years and now am out of the government. Through these years I have had the opportunity to hear many different consumer comments. I would like to share with you some of the many consumer viewpoints. Although I do not necessarily always agree with some of these