INSTITUTE for ALTERNATIVE FUTURES

FOOD 2028: Key Forecasts

A White Paper
for
Fleishman-Hillard
June 10, 2008

Clement Bezold
Devin Fidler
Robert Olson
Institute for Alternative Futures

Table of Contents

Introduction **1**
Rising Food Prices **3**
“Sustainably Produced” Food **8**
Personalized Nutrition **11**
Evidence Based Medicine and Nutrition **14**
Ethical Eating **16**
Preventing and Reversing Obesity and Diabetes **19**
Endnotes **21**

Introduction

The generation ahead will see important changes in all areas of business related to food and nutrition. We believe that these changes will be driven primarily by developments in the larger environment rather than normal industry developments that are usually the focus of attention. This White Paper identifies some of the key forces driving that change and develops forecasts for the next two decades out to 2028

In developing these forecasts we have drawn upon our own previous work at the Institute for Alternative Futures[1] (IAF), interviews with food and nutrition experts,[2] and additional research. The forecasts begin by acknowledging the likelihood of a significant rise in food prices. This has already begun and will almost certainly continue in the U.S. and globally. We also forecast a growing concern for social justice and sustainability. The earlier Green Revolution will need to be repeated in ways that meet these concerns. This perspective shapes many of our forecasts. The forecasts also highlight how progress in health care and health-related technologies could have dramatic impacts on food choices and dietary patterns.

Our forecasts raise more questions than they answer; how these questions are answered by our collective efforts to shape the future will help determine the directions for successful food-related businesses between now and 2028. The first forecast below dealing with rising food prices is a prime example. Questions this forecast raise include:

- Will higher food prices make it more expensive to eat a healthy diet? Or on a dollar-per-nutrient basis, is healthy food really no more expensive than the highly processed foods and convenience foods so common in current U.S. eating patterns? Will the present pattern of commodity subsidies tend to make U.S. eating patterns more or less healthy as prices increase?

- Given the current epidemic of obesity, could higher food prices actually tend to improve many people's dietary patterns? Could rising food prices create a situation where people are highly receptive to information about how to eat better for less? If poorer people find it increasingly difficult to afford the products they have previously consumed, how can the government and food industry best reach them with information about how to maintain good nutrition?

- Will there be a widespread shift to smaller portion sizes in restaurants and homes? Will fast food become more or less healthy?

- Will the bloom go off organics if the price of organic food continues to increase even faster than the price of conventional food?

- How will rising prices change consumer preferences for different kinds of meat? Will higher meat prices open the way for cultured meat to enter the marketplace?

- Will higher prices encourage more fortification? Increased use of supplements?

- How can we best help to prevent growing starvation around the world and the rage against the rich and terrorism it could ultimately trigger?

- Will people blame business for rising prices, or can business and government help people understand the long-term underlying causes of price inflation and increase public support for dealing effectively with energy, water, climate change and other fundamental challenges?

If we were taking these forecasts and extending them into more complete scenarios, there would be three "archetypes", consistent with IAF's "aspirational futures" approach which emphasizes that the future is not predetermined but is shaped, to a significant extent, by how we aspire and act to shape it. The three archetypes would be:

- A most likely extrapolation of current trends – rising food prices, hardship for some U.S. consumers and more severe global impacts. But science, commerce, and agriculture respond to the challenges and food choices become healthier for many Americans. Evidence-based medicine and personalized medicine and nutrition begin to influence our dietary patterns.

- Challenge or hard times – rising food prices, soaring oil prices, water scarcity, climate and natural disasters are worse than we expect. Our responses are slow. Tensions, riots, and failed states are recurring results. As healthy eating becomes increasingly costly, diet-related health problems worsen and rising health care costs become unsustainable.

- A food future that works for all – we deal forcefully with the underlying issues driving food price inflation such as energy, water scarcity and climate change, move rapidly toward an Advanced Sustainable Agriculture, and collaborate internationally to prevent famine in poor food-importing nations. Dramatic improvements in dietary patterns and nutrition are driven by educational efforts, industry innovation, and breakthroughs in personalized medicine and nutrition.

The forecasts below can be seen as initial elements for the first and third of these scenarios. They point out that the future is uncertain and challenging and will be shaped by our choices.

Rising Food Prices

Food prices will increase sharply over the next two decades. This will be driven by increased costs of farming inputs, transportation, and energy generally; challenges from climate change; and land, soil and fishery conditions. Meat prices will see particularly significant increases.

A broad set of trends are acting to raise food prices, and each of these trends has a great deal of momentum. Major initiatives to address the challenges these trends pose can alleviate price pressures, but cannot take hold fast enough to prevent significant price increases in the years ahead. Key trends include:

- Increasing demand from rising affluence and changing diets in developing nations
- Rapidly rising oil/energy prices
- Climate instability
- Water scarcity
- Conversion of cropland to nonfarm uses
- Competition of biofuel crops with food crops
- Cutbacks in food exports
- Decline and collapse of fisheries

Food prices have already risen 83 percent worldwide since 2005. Key staples such as rice and wheat have risen by 141 percent and 130 percent respectively in the last year alone.[3] These price trends are beginning to affect U.S. food producers and consumers, but they are already having severe impacts in many poorer countries. Americans spend on average about 9 percent of their annual income on food, but in poor developing countries food often accounts for more than half of a family's spending. Recent price increases have already triggered protests and civil strife in countries such as Afghanistan, Cameroon, Egypt, Ethiopia, Haiti, India, Indonesia, Italy, Ivory Coast, Mauritania, Mexico, Pakistan, the Philippines, Somalia, Thailand, Uzbekistan, and Yemen.[4]

Local factors, like the millions of pounds of citrus that froze in California last year, affect the price of food over the short term. But over the next twenty years the biggest drivers of price inflation will be fundamental long-term developments: surging global demand for food, higher energy prices, and constraints on the expansion of food production.

Surging Demand Demand for food is increasing rapidly primarily due to growing affluence in China, India and other dynamic emerging economies. Hundreds of millions

of people are, for the first time, rich enough to start eating more like Americans. They are eating more food, and even more importantly, eating more meat (for instance, Chinese per capita meat consumption has grown from 44 pounds in 1980 to 100 pounds in 2008).

Higher Energy Prices As oil prices have risen to above $100 per barrel, energy costs have become a major factor increasing food costs.[5] Every stage of modern industrial agriculture is energy-intensive, from manufacturing fertilizers and pesticides to irrigating and using tractors and other farm equipment to processing food and transporting farm products long distances to consumers. Energy costs will fluctuate over time, and the current bubble in oil prices may deflate for a time if more supply comes online, but the overall price trend will be upward because energy demand is rising rapidly and becoming harder to meet.

Earlier this year Royal Dutch Shell, which has done the best long range planning of any oil company, released planning scenarios based on the assumption that by 2015 – seven years away – global oil production will be unable to keep pace with growing demand.[6] When that occurs, energy costs are likely to escalate further and faster than ever before. Major improvements in energy efficiency across the economy and the development of alternative sources of energy can eventually stabilize energy prices, but this cannot happen rapidly enough to prevent price increases in the years ahead.

Constraints on Food Production Many developments are coming together to make it more difficult to increase food production. *Conversion of cropland to nonfarm uses* is a major factor. Urban expansion, industrial construction and highway construction are shrinking the land available for crops. According to the World Bank, in Asia, almost all suitable land is under cultivation and urbanization is rapidly encroaching on that land.[7] In China, for example, the grain harvested area shrank from 90 million hectares in 1998 to 76 million hectares in 2003, and production of each of the three grains that dominate Chinese agriculture – wheat, rice and corn – has dropped.[8]

Water scarcity is likely to emerge as a major constraint over the next 20 years. In its *Global Trends 2015* report, the CIA projects that "By 2015 nearly half the world's population – more than 3 billion people – will live in countries that are 'water-stressed,' with less than 1,700 cubic meters of water per capita, mostly in Africa, the Middle East, South Asia, and northern China."[9] As water becomes scarcer it will become more expensive, adding to the cost of food. And in some areas, water will simply become unavailable. It is estimated that, worldwide, aquifer withdrawals are exceeding recharge rates by some 160 billion cubic meters per year. Water tables are falling rapidly in the U.S., China, and India, which are responsible for producing half of the world's food.[10] As aquifers are depleted and irrigation wells go dry, farmers will either have to revert to low-yield dryland farming or, in more arid areas, abandon farming altogether. The emerging

water crisis can be alleviated by the spread of technologies that enable more efficient water use, reuse water, and desalinate seawater, as well as by agreements to share water fairly and avoid conflicts over water access. But as with energy, new technologies cannot come into place rapidly enough to avoid growing water stress over the next two decades.

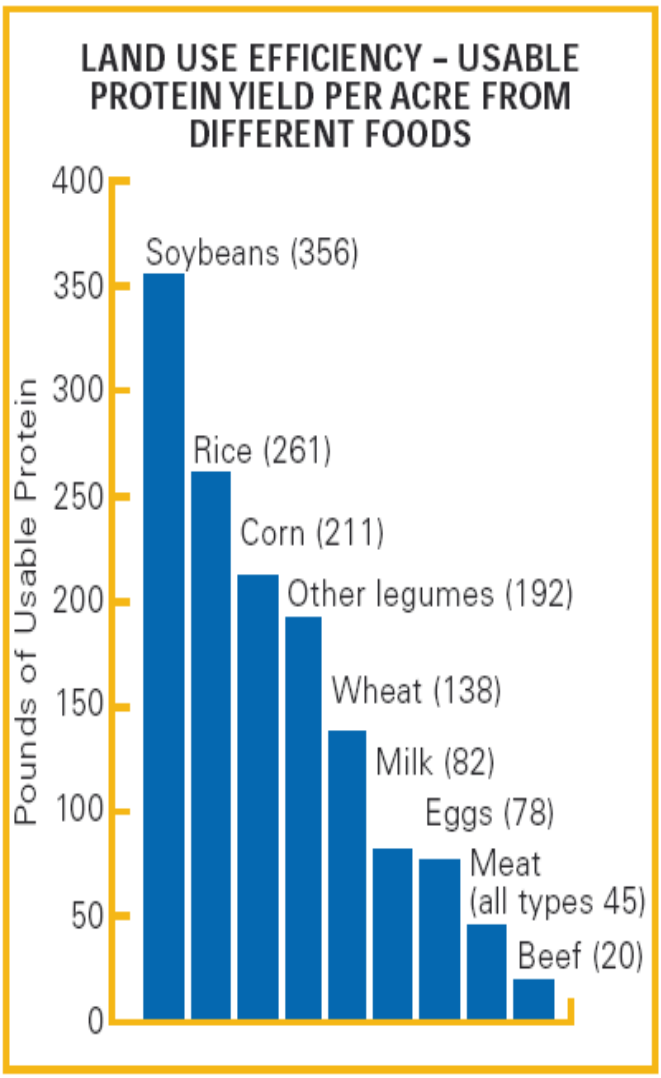
A new factor is the *race among western countries to produce biofuels*. First-generation grain-based biofuels, such as corn-based ethanol, directly compete with food crops for prime agricultural land. In the U.S. this year, nearly a third of total corn production will be used to make an estimated 9.3 billion gallons of ethanol, triple the 2003 total.[11] Competition between food and biofuels is likely to worsen over the decade ahead because biofuel development is being driven by government mandates and large subsidies in both the U.S. and the European Union. But this competition can be reduced before 2028 by the development of second-generation biofuels based on wastes and on low-water, low-energy input crops like switchgrass and sweet sorghum and fast growing trees like honey locust and eucalyptus, and possibly even by third-generation biofuels where specifically tailored organisms develop fuels from raw materials and sunlight.

As global food markets tighten, food supplying countries from Argentina to Ukraine have begun to *limit exports* to assure that food is available for domestic consumers.[12] Key countries like Russia, China, India and Vietnam are implementing or considering more drastic measures, including banning food exports.[13] These actions are causing food prices to increase all the more rapidly in food importing countries.

Price increases in farm-based food are being matched or exceeded by price increases for fish caused by *overfishing*. The UN Food and Agricultural Organization's (FAO) *State of World Fisheries and Aquaculture 2004* report estimates that in 2003, of the main fish stocks for which assessment information is available, more than one-quarter were "overexploited, depleted or recovering from depletion…."[14] A major international scientific study released in November 2006 in the journal *Science* found that about one-third of all fishing stocks worldwide have collapsed (with a collapse being defined as a decline to less than 10% of their maximum observed abundance), and that if current trends continue all fish stocks worldwide will collapse within fifty years.[15] Environmentally responsible fisheries management and practices can reverse this decline and allow fishing to continue at a "maximum sustainable yield" level, but this will also require decades to implement.

Over the long run, the biggest factor limiting food production may be *climate change*. Extreme weather events like the epic drought in Australia that is entering its 10th year, the recent drought in the Ukraine, and the cyclone last year that destroyed $600 million of rice in Bangladesh may already be the result of growing climate instability, although it is hard to definitively link specific events to global climate trends. The UN Intergovernmental

Panel on Climate Change (IPCC) predicted last year that even a slight warming will lower agricultural output in the tropics and subtropics.[16]



Source: USDA; FAO/WHO/UNICEF Protein Advisory Group (2004)

Building on the IPCC's work, scientists at Stanford University recently warned that climate change could cause severe crop losses in south Asia and southern Africa over the next 20 years. They estimate that, by 2030, southern Africa could lose almost a third of its maize production, the main crop, while losses of many regional staples, such as rice and millet could be over 10% in south Asia.[17] Moderate warming could actually benefit crop and pasture yields in northern nations like Canada and Russia over the mid-term,[18] but failure to respond forcefully to the climate challenge is projected to have devastating longer-term consequences. Computer models at the Hadley Centre for Climate Prediction and Research in Great Britain forecast that, if greenhouse gas emissions are not dramatically reduced by 2100, extreme drought could reduce the world's land surface usable for agricultural production by 30 percent.[19]

These factors will affect all food prices, but prices for meat will be affected most of all. Food price inflation is already forcing the middle classes in poor countries to cut out meat from their diets. No such drastic dietary change will occur in the U.S., but continued price increases are likely to lead to changes in the meat products consumers buy as well as an overall reduction in meat eating.

Meat prices will rise more steeply than other food prices because meat is the most resource-costly form of food. As the accompanying chart shows, all meat products require a comparatively large land area to produce a given amount of protein. Meat

production generally requires proportionally more water and more inputs of every kind. Among meat products, beef is the most resource-intensive and therefore will experience the highest price increases. It takes 10 pounds of feed to produce one pound of beef, 4.0 to 5.5 pounds of feed to produce a pound of pork, and only 2.1 to 3.0 pounds of feed to produce a pound of poultry meat.[20]

A reduction in meat-eating could adversely affect the nutrition of poorer people because meat is an excellent source of protein, B group vitamins, and minerals such as iron, zinc, potassium, phosphorus and magnesium. On the other hand, reduced meat eating could address health problems created by overconsumption of meat. The relationship between dietary fats and heart disease, obesity, adult-onset diabetes and several forms of cancer has been extensively investigated, with strong and consistent associations emerging from a wide body of evidence developed from animal experiments, observational studies, clinical trials and metabolic studies conducted in diverse human populations. The studies have all come to essentially the same conclusion: that to reduce these health risks we should eat less animal fats and refined carbohydrates and more dietary fiber, fruits and vegetables. [21]

Surging demand, rising energy prices and constraints on increasing food production assure that food prices will be substantially higher over the generation ahead. Price pressures could ease temporarily due to short-term changes, such as an end to the drought in Australia. Policy changes could also ease price pressures. The new UN report Agricultural Outlook: 2008-2017 urges policy changes such as rethinking biofuel subsidies and export bans and increasing investment in agricultural research. It urges people who have opposed genetically modified crops to recognize that genetic modification is essential for improving agricultural productivity. Policy changes like these can have a significant impact over the next 20 years, but prices will only stabilize as we deal with the fundamental issues of energy, water and climate change.[22]

While some of the trends driving this forecast are beyond the normal discussion of nutrition and food markets, it is essential that professionals concerned with the future of food understand this larger pattern of forces driving toward higher food prices.

"Sustainably Produced" Food

An Advanced Sustainable Agriculture will emerge over the next 20 years. Consumer preferences will shift toward favoring these "sustainably produced" products.

The key trends and developments behind this driver include:

- Food supply shortages
- Drive for crop productivity
- Unsustainable water pollution, soil erosion and agrochemical dependencies
- Development of precision agriculture technologies
- Development of biotechnology

Just a decade ago, the term *sustainable* was almost a "dirty word" for many farmers and even for professionals in the field of agricultural education. It was generally equated with *organic* farming, which was viewed as too inefficient to ever play a major role in the food system.[23] By now, however, organic products have surged into the mainstream. And nearly everyone involved in agriculture wants to claim that their methods are "sustainable," although there is little agreement about what that term means. Over the generation ahead, sustainability in agriculture will continue to become more important. There will be growing agreement on at least the main elements of an *advanced sustainable agriculture* that is both highly productive and better for the environment.

Advanced sustainable agriculture will incorporate many of the methods of today's industrial agriculture, from modern equipment to certified seed. Above all, it will share industrial agriculture's emphasis on improving crop productivity. This emphasis will be needed to meet the challenge of helping poor countries improve their agriculture. The Green Revolution of the 1970s, whatever its shortcomings, dramatically increased production and prevented massive famines. Today, with demand again outstripping supply, food prices soaring, and food riots beginning to erupt around the world, another wave of improvement in agricultural productivity is urgently needed. The research capacity to do that needs to be rapidly rebuilt because, ironically, the food surpluses made possible by the Green Revolution led governments and development agencies to assume that food security is no longer an issue. As a result, sharp cuts have occurred in the funding for the network of agricultural research centers in Asia, Africa and Latin America that have contributed so much to progress in the past. [24]

At the same time, advanced sustainable agriculture will draw heavily on agroecology and adopt some of the methods of organic farming in order to solve problems that plague our current agricultural system such as water pollution, soil erosion, pest resistance to

pesticides, pesticide residues in foods, and the soaring percentage of total operating costs required to purchase inputs of fertilizers, chemicals and energy. There will be no single "best" approach but rather a spectrum of farming practices geared to different ecosystems, climates, soils and crops. However there will be common emphases such as moving away from monocultures toward more diverse crop and livestock systems; rotating crops to provide better weed, insect and disease control; building up soil with crop residues and animal manures and cover crops while reducing the use of fertilizers; and using more biological-control techniques instead of relying so heavily on pesticides to control pests.[25]

Advanced sustainable agriculture will also draw on leading edge developments in information technology, biotechnology and other areas. New tools for superefficient "precision agriculture" will allow water and other inputs and corrective actions to be precisely applied, where needed and as needed, minimizing waste. For example, drip irrigation systems linked to soil moisture sensors will increasingly be used to irrigate only when and where needed, reducing water use while optimizing soil moisture. Satellite information analyzed by computer programs designed to detect evidence of pest damage will be quickly relayed to farmers for corrective action. Comprehensive approaches to on-farm energy efficiency and growing integration of wind turbines and other renewable energy technologies with crop production will cut agricultural energy costs. Green biotechnology, based on a greater understanding of plant physiology and the interactions between plants, microbes and soil, has the potential to dramatically reduce the environmental impacts of agriculture. Genetic modification can make crop and forestry species more resistant to stresses such as heat, drought, freezing, poor soil, salinity, pests and disease. Further in the future, biotechnologists may be able to transfer nitrogen fixation from legumes to grains like wheat and corn, eliminating all need for synthetic fertilizers.

As energy prices increase, transportation costs will become a major factor in calculating sustainability. This will reinforce the emerging "buy local" trend among consumers, which may eventually become more significant than the trend toward organic foods. If transportation costs go sufficiently high, backyard vegetable growing will expand, innovations in urban agriculture will spread, and technologies like solar greenhouses to extend local growing seasons will begin to be economically viable in some areas.

The combination of rising costs and scientific progress may lead to novel forms of protein development. Biotechnology may make it possible to develop cultured meat (e.g., "steak in a Petri dish"). Many of the scientists at the "In Vitro Meat Consortium", held this April at the Norwegian Food Research Institute, believe that within a generation *in vitro* meat production will be both possible and economically viable.[26] According to New Harvest, a group dedicated to advancing meat substitutes, "Cultured meat has the potential to be

healthier, safer, less polluting and more humane than conventional meat. Fat content can be more easily controlled. The incidence of foodborne disease can be significantly reduced, thanks to strict quality control rules that are impossible to introduce in modern animal farms, slaughterhouses and meat packing plants. Inedible animal structures…need not be grown. As a result, cultured meat production should be more efficient…."[27] Over the next two decades, cultured meat would probably initially take the form of ground meat, sausages and chicken nuggets, and would only replace a portion of total meat consumption. But this might allow the livestock production system to continue without placing unsustainable demands on land, water and other resources.

The emergence of a more advanced sustainable agriculture will cut through the old polarization between industrial agriculture and organic farming. "Sustainably produced" food products (or some similar term) will become a major food category, with "organic" foods being a subset, and possibly a shrinking subset as food prices increase.[28]

Personalized Nutrition

Personalized nutrition will integrate our tastes with our health needs and our biochemical uniqueness. Sophisticated, low cost passive biomonitoring, along with genomic and nutrigenomic knowledge about the individual will guide much of our shopping and menu choices.

There are a number of forces favoring the growth of personalized nutrition:

- Development of widespread and non-invasive biomonitoring technologies
- Availability of inexpensive individual genetic profiling
- Expanding nutrigenomic knowledge
- Development of artificial intelligence and data-mining functions

Personalized nutrition will unite our advancing knowledge of genomics with sophisticated biomonitoring. Nutrition recommendations and related coaching will become focused on each of us as individuals.

Personalized nutrition recommendations will be generated using biomonitoring data, genomic analysis, and information on current health conditions. All this data will be integrated into increasingly sophisticated behavior coaching tools that will eventually take into account different individuals language and culture, literacy level, interest level, learning style and stage of readiness for change. The trend to personalized nutrition will eventually have a large impact on food consumption and related behaviors but over the next two decades is likely to be less important than a person's cultural setting, physical environment, and economic choices (see the obesity and diabetes forecast below).

By 2028, low cost, sophisticated, non-invasive biomonitoring will be common place for most Americans. Simply by wearing a watch, bracelet or earring, sleeping on a special bed pad, or even simply moving around your home, many individuals will be able to collect their personal biometric information.

Advances in saliva, breath, skin, and body monitoring are already quite significant.[29] Over the next decade their reliability, utility and affordability will be proven in applied use. Blood tests, already a standard platform for assessing components of health, will become more sophisticated, with gene and protein markers for pre cancer as well as early cancer. Given current research, breath tests and saliva tests are also likely to provide signs for oral cancer, lung cancer and diabetes, respiratory infections, inflammation, and serotonin levels in the brain.[30]

Passive biomonitoring, whether worn by the individual or done in their home, has already been shown to capture information that can improve health care and shape healthier behavior. Monitoring physiological parameters such as motion, body heat, heart rate, breath rate, and sleep quality, these systems will develop huge data bases which will yield new insights into disease and general health and enable new and more appropriate definitions of "normal" and "normal ranges" both for individuals and general populations. New "vital signs" will also evolve.

What will make personalized nutrition possible is the integration of this biomonitoring data with personal genetic information. In 2008, several commercial companies are competing to develop a $1000 personalized genome mapping service.[31] The price of genome mapping has fallen dramatically with time and by 2028 a cost equivalent to $100 or less in today's dollars is a realistic possibility. As a result, a personal genetic assessment is likely to become a key component of most people's medical records between now and 2028. Over this time period, it is also likely that data mining of large populations of genomic information will provide much greater understanding of the complexities of both the genetic code and the ways that a person's environment effects gene expression.

Within the context of nutrition, nutrigenomics, which studies the relationship between nutrition and genes, will allow scientists to better understand how the whole body responds to foods from an integrated systems standpoint. In the next few years, these approaches are likely to help to better define the relationship between specific nutrients and overall human health. This information will lead to insights into individual variance in metabolism, nutritional requirements, incidence of diet-related diseases, and nutritional therapies for disease. As a result, personalized nutrition will become relevant for most people in the U.S. over the next two decades.

Personalized nutrition will incorporate advances in nutrition science as they are proven. For example micro flora are likely to get more attention as we learn more about their role in digestion and food/energy processing. Some experts think that changes in micro flora driven by widespread use of antibiotics might be a contributing factor to the significant weight gain in the US population over the last 20 years. Studies in animals have shown that adjusting micro flora can yield a 10 percent increase in energy uptake. **(**

For the individual, the increasing complexity of personalized nutrition information will require sophisticated information tools that give us (directly or through our health care providers or other professionals) effective guidance. Within ten years, many Americans will be getting their nutrition and health coaching from their own "avatar" or intelligent agent. We might meet this avatar on our home computer or in virtual space, such as future versions of Second Life. The latest advances in biomedical and nutritional science would be incorporated and aid us in making wise decisions about our health. The

nutritional coaching components could eventually consider how we metabolize specific foods given the time of day, size of meal, stress level and other similar factors. This can be integrated with the individual (and family's) taste preferences and linked to their budget, buying habits and experience with specific foods and brands, and the cycle of availability and sales at their food stores and restaurants.

There are many uncertainties about just how far all these developments will unfold over the next twenty years, but there is no doubt about the direction of change. A focus on personalized nutrition will become inevitable as biomonitoring, genetic profiling and nutrigenomic knowledge advance.

Evidence Based Medicine and Nutrition

As the trends outlined in the personalized medicine forecast mature, they will drive an increasing overlap between the fields of nutrition and medicine as both become more evidence-based. Continued study into evidence of the healthful properties of nutritional components will blur the line between many foods and natural medicines among many consumer segments. Foods will play a greater role as medicines.

Drivers contributing to the convergence of food and medicine include:

- A sustained move toward evidence-based medicine
- New testing approaches
- Comparative effectiveness studies including natural treatments
- Sustained growth of the "functional foods" category
- Integration of dietary and medical information

Already, "functional foods," often with health benefits, are a fast growing product category.[32] Moving forward, comparative effectiveness studies of medical treatments, nutrigenomics, and data-mining will highlight the historical health claims of phytonutrients as well as new medicinal properties in more whole foods and their components. Based on progress in personalized nutrition, this emerging evidence will differentiate effectiveness for differing genotypes and phenotypes. An enhanced body of medical evidence is likely to rapidly accumulate around the medicinal properties of specific foods and nutrients. As this happens, food (both whole foods and phytonutrient enhanced functional foods) will be increasingly used in place of or in addition to medicines.

In medical treatment, the growth of evidence on treatment and nutrition will shape clinical protocols. Most treatment in the US is based on medical consensus with modest, weak or no evidence.[33] In two decades that will have changed. Most treatment will be evidence based, reflecting both clinical testing and the results of treatments as they are used. Electronic medical records and personal health records will be in place for most people before 2020. For many this will include the sophisticated biomonitoring described in the forecast above. This growing body of experience will be mined to determine what works for whom. This growth of evidence and experience will occur for whole foods, supplements and functional foods and drinks. As a result, personalized nutrition will be paralleled by personalized medicine – relevant to the individual, their genome, tastes, and experience. Already comparisons between restaurants are starting to become available to consumers. For food and food service providers the degree of consumer satisfaction,

price, nutritional quality, range of food choices and menus will be factored into shopping decisions.

For pharmaceuticals, safety and efficacy regulation will evolve from the current reliance on random controlled clinical trials to assure “safety and efficacy” before a drug is marketed to a mixture of systems for assessing safety. These systems will use predictive preclinical models that simulate molecular and cellular responses, making possible earlier release/marketing of new drugs with much more specific and consistent collection of post-marketing experience and public availability of information on outcomes and side effects. Postmarket studies will take advantage of electronic health records with biomonitoring data. Open source networks of research scientists will study data to assess the safety, efficacy and value of new medicines. Individuals (and their health care providers or avatars) will be able to develop personalized recommendations that take into account phenotype and genotype data, the evidence base on the medicine in question, other medical treatments or approaches, as well as the stress levels and social and economic conditions relevant for the individual’s health.

Evidence based nutrition will also develop along similar lines. Biochemical individuality in the nutrition field was proposed as early as the 1950s by Roger Williams.[34] It will become a major focus within two decades. Consumers will better understand the impact of various foods and specific nutrients and their interaction, as well as their food sensitivities and allergies.

Information systems that integrate data to produce personalized dietary guidelines will be ubiquitous and in the background for most individuals. Each person will determine how they want their systems to communicate with them. For many they will be integrated with personal menus and the development of food shopping lists and restaurant choices.

Personalized nutrition will be supported by more explicit food labeling and certification. Food manufacturers will likely be able to make more expansive health claims about their products, but will need to provide the evidence base supporting these assertions. Increasingly, the evidence for health claims will be segmented by genotype and phenotype.

Ethical Eating

In the U.S., a rising emphasis on social justice and equity, supported by increasing transparency, will drive a growing percentage of consumers toward food products that meet ethical production and distribution criteria. Food availability for low-income people, in the U.S. and around the world, will receive increasing attention as a social justice issue.

The drivers of the societal trend toward *Ethical Eating* include:

- Increasing social justice movements focused on the US and globally, and growing public support for these movements
- Concern for rising food prices, shortages
- Media enhanced & user-generated content easily accessible
- Broader and more explicit standards for ethical food production, distribution and marketing
- Greater organizational transparency

The rising food prices forecast above will be felt by all, but will affect the poor the most. At times in American history, such as the New Deal, we have responded to challenges with social policies aimed at helping those facing poverty and hardship. We forecast that the next two decades will see similar responses. Concern for "ethical eating" will develop and lead to greater questioning of current patterns of food production, distribution, and marketing, as well as a focus on ensuring that food is sufficiently available and is developed in sustainable ways. This movement will be facilitated by the internet-accelerated trend toward greater transparency.

Growing internet enabled "mass-scrutiny" will change the nature of the relationship between businesses and consumers.[35] A lot of attention has been given to user generated content, created online by the general public rather than paid professionals. But other aspects of emerging mass collaboration technologies are still not well understood. Deep transparency, the enhanced scrutiny of organizations facilitated by advanced communications technology, will allow individuals to monitor business activity in a way that few companies currently are prepared for.

Over the next twenty years, ubiquitous internet access and user-generated content is poised to dramatically increase the transparency of nearly all industries. Armed with ubiquitous cheap digital video technologies similar to those available in many cell phones today, consumers and activists will be able to graphically document all aspects of

organizations and the way they do business.[36] In recent years, for example, bestselling books like “Fast Food Nation” and “The Omnivore’s Dilemma” have impacted eating behaviors and corporate strategies, simply by comparing the supply chains of different meals. In the years ahead, it will be possible to deliver information on the location, treatment and pay for workers and growers, genetic modification, and environmental practices for both whole foods and prepared foods. Consumers will increasingly make decisions about the foods they buy and eat on the basis of this newly available information.

This move toward transparency is likely to make consumers more aware of how the food on their table got there and where it comes from. Already, early indicators of this trend are beginning to take shape. Dole Organic, for example, recently piloted a program in which it lets consumers “travel to the origin of each organic product”. By typing in a fruit sticker's three-digit Farm Code on Dole Organic’s website, customers are able see the farm where their produce was grown.[37] While this early application is promotional, by 2028 all aspects of food growth, production and distribution are likely to be more “customer facing,” whether a company approves of this or not.

As part of this larger trend, animal protections will evolve. In many cases, complex labeling and certification standards could potentially be replaced by the simple requirement that organizations maintain accessible and verifiable online video of their facilities, allowing consumers to make their own judgments about humane animal treatment and “free range” status, for example. The results of an undercover investigation launched by the Humane Society in early 2008 hint at the scale of changes to come. Video collected by the organization has led to congressional hearings on transparency in the meat industry and has led to a USDA endorsement of a ban on use of downer cattle.[38]

Given the forecasts above, including the relative costs of growing meat, vegetarianism is likely to increase and vegetarian product categories will continue to grow.

These trends are likely to be particularly pronounced in Millennial Generation consumers, a group who are still in the process of forming long-term eating habits and who have the most widespread access to user-generated media.

“Fair trade” movements and the drive toward ethical labor standards will also be reinforced. Unfair labor practices will become well-documented headline news when employees transmit pictures from their cell phone, or activists get on site and video cameras capture questionable practices. Organizations holding companies accountable will have significant publication/broadcast capacities via the internet. As this transparency grows, companies will go to great lengths to avoid negative attention from advocacy groups.

This movement toward ethical eating will be shaped by lack of availability of food for low-income people, both in the US and internationally. In 2004, there were 850 million food insecure people in the world,[39] and that number is likely to increase even as a push toward social justice strengthens. Politically, this will translate into an unprecedented push to reframe agricultural and trade legislation in ways that favor distribution to low income regions, even if this raises the cost for developed country consumers.

Among better off consumers, the emphasis on food quality will be greatly strengthened, "connoisseur buying behaviors" will become more common, and they will impact an increasing number of products. Already, mass-market grocery retailers like Whole Foods have found ways to feature aspects of product supply chains in their marketing. The state of the economy and the degree of rise in food prices will determine whether this high end segment grows or shrinks. Also, as the stages of food production become more transparent, it is likely that luxury buying will move toward demanding a well-documented "food provenance" of each of the steps involved in the production of a given food. This trend is likely to have a substantial impact not only on luxury consumers, but also on the behavior and growth of the broader "foodies" market segment. Already experiments in this direction are emerging. The Cabernet, Merlot and Chardonnay varietal grape juices that recently have been introduced into the market could be a hint at the future of high-end foods categories.

Preventing and Reversing Obesity and Diabetes

Obesity and diabetes have been increasing in epidemic proportions. Over the next two decades there will be sustained campaigns to reverse both obesity and Type 2 diabetes. These efforts will focus on individual choices, but also on community conditions or social and economic determinants for food choices and behavior. And, as with tobacco control, these efforts will make a significant difference.

The drivers for effective campaigns to reverse the epidemics of obesity and diabetes include:

- Rapid increase in obesity and diabetes, particularly at younger ages
- Decline in US life expectancy due to obesity in children and youth
- Increasing medical costs
- Understanding of the limited role of medical care in prevention
- Recognition of the "obesogenic environment" and the role of the social determinants of obesity and illness
- Growing ethnic, racial and income disparities in obesity and related diseases
- Successful community policy and tax based strategies

America is experiencing epidemic levels of obesity and diabetes.[40] Currently, nearly two out of every three Americans are overweight or obese and one out of every eight deaths in America is caused by an illness directly related to overweight and obesity. For the first time, life expectancy in the U.S. is forecast to decline, largely because of the long term effects of childhood obesity.[41] The link between obesity and type 2 diabetes is well established (in fact Type 2 is no longer considered "adult onset diabetes" because of the obesity related rise in incidence among the young). There is growing recognition of this problem and growing efforts to reverse these twin epidemics.

Obesity and diabetes mirror many of the larger determinants of health. Michael McGinnis argues that the variance in health over the course of our lifetimes is attributable to four major factors, with these rough relative weights 1) personal behavior 40%, 2) the environment 20% (5% physical, 15% social), 3) our genes 30%, and 4) health care 10%. For people with few choices (e.g. no grocery stores in the neighborhood, low income) the weight of personal behavior is reduced. So the opportunity for personalized nutrition and the related advances forecast above to shape behavior is conditioned by larger factors, particularly social determinants or community conditions.

Healthy eating and activity are the keys to reducing obesity. Simple activity like walking, done for 30 minutes 5 times a week has been shown to prevent 58% of those will pre-diabetes from converting to full blown diabetes and its crushing burden of related diseases. Obesity and diabetes are disproportionately high in low income communities and communities of color which means that reducing obesity needs to be approached as a community issue and not just a matter of individual choice and behavior. Eight national programs funding local healthy eating and active living initiatives in communities around the country worked with IAF to identify lessons for making community initiatives effective. The resulting "strategic principles" highlight the potential for leveraging community networks and cultural strengths.[42]

IAF has developed scenarios on the obesity and diabetes epidemics through 2025. Two of the critical factors for reversing the epidemics were the recognition of the "obesogenic environment" most Americans live in as well as the social determinants of health.[43] Successful strategies for lowering tobacco use included labeling, taxes, age requirements, smoking bans in restaurants, bars and public spaces. Similar social policies will need to be developed for reducing obesity.

Food labeling standards relevant to combating obesity are likely to become more stringent. This product information will take many forms, and be easily integrated into the individual's shopping or ordering systems. Specific ingredients deemed to contribute disproportionately to obesity and chronic disease will be restricted, much the way trans-fat use has been reduced recently. Regulations may be developed affecting the overall sugar, caloric and fat content, particularly in foods marketed to children. Some have already suggested that a "sin tax" be placed on high-fat fast foods.[44] If the epidemics of obesity and diabetes continue to worsen, expect this type of initiative to expand nationally in much the same way that smoking bans did. From a technological standpoint, the response to the obesity epidemic is likely to include both food and pharmaceutical interventions to increase satiety and/or metabolic rate.[45]

Endnotes

[1]Reports from the Institute for Alternative Futures relevant to this White Paper include:
Clement Bezold and Jennifer Kang, ***"****Looking to the Future—The Role of the 1998 ADA Environmental Scan", Journal of the American Dietetic Association*. Aug. 1999,
and "Climate Change, Sustainability and the New Technology Revolution, Forecasts for Climate Change Impacts on Florida and Emerging Sustainability Technologies" for The Century Commission for a Sustainable Florida, March2007, available at
http://www.altfutures.com/draproject/images/uploads/Report_06_08_Most_Important_Disparity_Reducing_Advances_in_US_Healthcare__Public_Health.pdf
and The DRA Project Report 06-08, "*Most Important Disparity Reducing Advances un U.S. Healthcare and Public Health"* September 2006 available at
http://www.altfutures.com/draproject/images/uploads/Report_06_08_Most_Important_Disparity_Reducing_Advances_in_US_Healthcare__Public_Health.pdf,
and Robert Olson and Jessica Biamonte. "A New Global Agenda." IAF White Paper for the Woodrow Wilson International Center for Scholars, 2005,
and Robert Olson and Dave Rejeski, eds. *Environmentalism and Technologies of Tomorrow.* Island Press, 2004,
and National Council on Environmental Technology and Policy. "The Environmental Future." US Environmental Protection Agency, 2002, available at http://www.epa.gov/ocem/nacept/pdf/2002_09_epa_nacept_pub_final.pdf,
and The Institute for Alternative Futures. "Diabetes & Obesity 2025 Four Future Scenarios for the Twin Health Epidemics." June 2006, available online at:http://www.altfutures.com/foresight/Diabetes_Scenarios_June_1st.pdf ,
and Devin Fidler and Robert Olson and Clement Bezold. "Evaluating a Long-Term Livable Communities Strategy in the U.S." *Futures* forthcoming,
and The Institute for Alternative Futures. "The Future of Mechanical Engineering 2028.. Publication forthcoming.

[2] Experts interviewed for this White Paper include: Eric Hentges, Ph.D., Executive Director, International Life Sciences Institute, North American Branch; Eileen Kennedy, Ph.D., Dean, Friedman School of Nutrition Science and Policy, Tufts University; Alan Rambaum, SVP of Youth Marketing, Fleishman-Hillard; Mark Senak, J.D., Senior Vice President, Fleishman-Hillard; Roniece A. Weaver MS RD LD, Founding Partner, Executive Director, Hebni Nutrition Consultants, Inc.; Kathleen M Zelman, MPH, RD, LD, Director of Nutrition, WebMD. While we used this input in developing our forecasts, we bear the responsibility for the resulting forecasts presented here.

[3] "Food Price Crisis 101: Causes and Solutions to the Crisis," Center for American Progress, May 2008, available online atwww.americanprogress.org/issues/2008/05/food_crisis.html.

[4] Keith Bradsher, "A Drought in Australia, a Global Shortage of Rice," *New York Times*, April 17, 2008, available online at:
www.nytimes.com/2008/04/17/business/worldbusiness/17warm.html?_r=1&scp=1&sq=A+Drought+in+Australia&st=nyt&oref=slogin.

[5] Paul Krugman, "Grains Gone Wild," *New York Times, April 7, 2008,* available online at:*www.nytimes.com/2008/04/07/opinion/07krugman.html?scp=1&sq=grains+gone+wild&st=nyt.*

[6] Royal Dutch Shell, *Shell Energy Scenarios to 2050*, March 2008, available online at:http://www.shell.com/static/aboutshellen/downloads/our_strategy/shell_global_scenarios/shell_energy_scenarios_2050.pdf.

[7] *Livestock Revolution: Implications for Rural Poverty, the Environment, and Global Food Security*. World Bank Report 23241, November 2001.

[8] Lester Brown, "China's Shrinking Grain Harvest," Earth Policy Institute, March 10, 2004.

[9] Central Intelligence Agency, *Global Trends 2015: A Dialogues About the Future With Nongovernmental Experts*. Washington, DC: CIA, 2000.

[10] Janice Cox and Sari Varpama, *The Livestock Revolution*. September 2000.

[11] "The Growing Food Cost Crisis," *U.S. News and World Report.* March 7, 2008.

[12] "Grains Gone Wild," see note 5.

[13] Kevin Whitelaw, "The Dangers From Rising Food Prices," *U.S. News and World Report*, February 8, 2008, available online at: http://www.usnews.com/articles/news/2008/02/08/the-dangers-from-rising-food-prices.html

[14] John Tierney, "A Win-Win for Fish and Fishermen," *The New York Times*, December 6, 2007.

[15] Cornelia Dean, "Report Warns of 'Global Collapse' of Fishing," *New York Times*, November 2, 2006. Available online at:
http://www.nytimes.com/2006/11/02/science/03fishcnd.html?bl&ex=1162616400&en=8e7132392e14b91f&ei=5087%0A

[16] Intergovernmental Panel on Climate Change, *Climate Change 2007: Synthesis Report*, November 2007, available online at: http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf.

[17] "Climate Change May Devastate Crop Yields," reported on the Met Office (the UK government's Meteorological Office web site) at http://www.metoffice.gov.uk/research/hadleycentre/news/maize_drought.html.

[18] Keith Bradsher, "A Drought in Australia, a Global Shortage of Rice," op. cit.
[19] E.J. Burke, S.J. Brown, and N. Christidis, N., 2006: Modeling the recent evolution of global drought and projections for the 21st century with the Hadley Centre climate model. *J Hydrometeorol*ogy, 7, 1,113-1,125.
[20] Council for Agricultural Science and Technology, *Contribution of Animal Agriculture to Meeting Global Human Food Demand*, 1999.
[21] Much of this research is summarized in *Diet, Nutrition and the Prevention of Chronic Diseases*, the report of a joint WHO and FAO Expert Consultation. World Health Organization, 2003. Available online at: http://libdoc.who.int/trs/WHO_TRS_916.pdf
[22] OECD-FAO, Agricultural Outlook: 2008-2017, May 2008.
[23] Institute for Alternative Futures. *Guidebook: Reinventing Agricultural Education for the Year 2020,* for the National Council for Agricultural Education, 1997.
[24] Keith Bradsher and Andrew Martin, "World's Poor Pay Price as Crop Research is Cut," *New York Times*, May 18, 2008.
[25] *Sustainable Agriculture: Definitions and Terms*. National Research Council, National Academy Press, 1999. Compiled by Mary V. Gold, Agricultural Research Service, U.S. Department of Agriculture. See also John P. Reganold, Robert I. Papendick, and James F. Parr, "Sustainable Agriculture," *Scientific American*, June 1990, 112-120.
[26] Andrew C. Revkin, "Can People Have Meat and a Planet, Too?" *New York Times* April 11, 2008.
[27] See the web site for New Harvest at http://new-harvest.org/faq.hym
[28] See the web site for SARE, Sustainable Agriculture Research and Education at http://www.sare.org/. Several SARE publications employ the term "sustainably produced." SARE is funded by the Cooperative State Research, Education and Extension Service of the U.S. Department of Agriculture.
[29] Institute for Alternative Futures, "The Biomonitoring Futures Project: Final Report and Recommendations", November 2006, Report 06-14, The Disparity Reducing Advances Project at http://www.altfutures.com/draproject/pdfs/Report_06_14_The_Biomonitoring_Futures_Project_Final_Report_and_Recommendations.pdf .
[30] Ibid. p. 29.
[31] Emily Singer "The $100 Genome" *Technology Review.* April 17,2008 Available online at: http://www.technologyreview.com/Biotech/20640/ .
[32] David T. Thibodeau. "Strong Growth for Functional Foods." *Food Product Design.* Jan 3, 2007. Available online at:http://www.foodproductdesign.com/articles/711persp.html .
[33] M.J. Field & K.N.Lohe (ed). *Guidelines for Clinical practice: From Development to Use* by Committee on Clinical Practice Guidelines. Washington: National Academy of Science, Institute of Medicine, 1992. p.34 (Available online from the National Academy Press Reading Room); cited in "What proportion of healthcare is evidence based? Resource Guide." By Andrew Booth, et.al, at: http://www.shef.ac.uk/scharr/ir/percent.html .
[34] Roger Williams. "Biochemical Diversity" McGraw-Hill Professional, 1998.
[35] The Institute for Alternative Futures. "IAF Identifies Mass-Scrutiny as the New Business Environment - Little Brother is Watching You!" March 2007. Available online at:http://www.altfutures.com/news/March07.htm .
[36] Charlene Li, Josh Bernoff. *Groundswell: Winning in a World Transformed by Social Technologies.* Forester Research. 2008.
[37] Springwise. Available online at:http://www.springwise.com/food_beverage/product_life_story_labels/ .
[38] Jonathan D. Rockoff. "USDA to tighten cow slaughter rules." *The Baltimore Sun.* May 21, 2008.
[39]Food and Agriculture Organization of the United Nations. The State of Food Insecurity in the World 2004.
[40] Francine Kaufman. *Diabesity: The Obesity-Diabetes Epidemic That Threatens America--And What We Must Do to Stop It.* Bantam 2005.
[41] S.J. Olshansky et al. *" A potential decline in life expectancy in the United States in the 21st century".* N Engl J Med. 2005 Mar 17;352(11):1138-45.
[42] Using Healthy Eating and Active Living Initiatives to Reduce Health Disparities, February 2008, available at: http://www.altfutures.com/draproject/pdfs/Report_08_01_Using_Healthy_Eating_and_Active_Living_Initiatives_to_Reduce_Health_Disparities.pdf .
[43]The Institute for Alternative Futures "Diabetes & Obesity 2025: Four Future Scenarios For the Twin Health Epidemics" June 1, 2006; available online at: http://www.altfutures.com/foresight/Diabetes_Scenarios_June_1st.pdf
and "Barriers to Chronic Disease Care in the United States of America: The Case of Diabetes and its Consequences", November 2005, A Report by Yale University Schools of Public Health and Medicine with the Institute for Alternative Futures, available online at:http://www.oxha.org/knowledge/publications/changing_diabetes.pdf
[44] Tom Hester.. "Corzine open to 'sin tax' to aid hospitals." *Associated Press.* April 30, 2008
[45] Thomas Goetz. "The Thin Pill" *Wired.* October 2006.