CONSUMER-DRIVEN AGRICULTURE

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INTRODUCTION

Consumer-driven agriculture can be the nexus for new applications of advancement in agricultural systems to the changing and growing array of societal needs and concerns. The relationship between the consumer and agriculture is neither simple nor direct. On the contrary, it incorporates a myriad of dynamic, overlapping, and interaction factors that both influence – and are influenced by – the consumer. The multidisciplinary nature and complexity of the issues involved have limited the understanding of them; yet this understanding holds the key to effective planning for the future.

Currently, one of the most fundamental knowledge gaps in research and intervention is an understanding of the determinants of consumer choice and how to use this information to improve food and agricultural systems, the environment, and the health of Americans. Limited focus on the implications of research has justifiably inflamed the negative reaction consumers have had to new technologies. The CSREES system of partners is trying to address criticism that scientific pursuit of technology, without the concomitant reflection on long-term effects of technologies, has been a liability and vulnerability of new technologies with consumers.

New ideas, new technologies, and new products are discussed under the umbrella of consumer-driven agriculture. Specific topic areas include:

- **Accountability** to the consumer spans all topics.
- **Food** is the ultimate currency between the consumer and the world of agriculture.
- **Non-food** biobased industrial products relate to consumer audiences that include business, industry, and governmental agencies seeking innovative ways to conduct business that is competitive and environmentally sound.
- **New technologies** address consumers' desires for new and improved qualities in food and agricultural production systems, and these technologies include functional genomics/proteomics, bioinformatics, and nanotechnology.

ACCOUNTABILITY

Need/Current Activities

Technology has radically altered the marketplace, including its agricultural dimensions. As change occurs throughout the agricultural system – from production through consumption – and with consumer response to the same, there is a concomitant need for the Agency to develop a strategy for a more coherent approach to the accountability issues associated with user/consumer-relevant research and development issues. Marketplace acceptance of genetically modified food remains uncertain. Recent consumer response to genetically altered corn is one example that has created a greater demand for accountability at the research-development-consumer information interface. This misunderstanding was based in part on incomplete information and in part on a lack of vision in exploring the long-term impacts of technological applications on ecological systems. Basic comparative research is needed on an array of innovations in agriculture, recent and historical, to document the social, economic, cultural, geographic, and political factors affecting their adoption.

A case in point is "hobby farms" – family-based economies on small land holdings that are the primary source of family income, often managed by a restive but well-educated sector grown weary of the traditional workplace, or retrained traditional small farmers – are increasing in popularity and profitability. A re-conceptualization of "hobby farms" as "hobby agro-ecosystems" embodies accountability from production to distribution to waste management decisions. Stewardship of the environment-as-ecosystem, safety of the products being produced, and use of technology in management are inextricably related to these enterprises. This strategy holds much hope for the return of vitality to rural areas, a reduction in the "mass sameness" of suburban areas, more efficient approaches to small farming, and sustained responses to consumer demand for safe locally developed food systems.

Strategies

- Building stronger bridges between research and practice: As individuals are trained to conduct path-finding research in new areas such as genomics, they should also be trained to think through the potential consequences of their research for consumer use and well-being as well as ecological system impacts. Research and extension professionals should also be trained to communicate clearly and frankly with a more educated – but less-trusting – public about the importance of the research and its impact on society. Increased recognition of consumer-driven agriculture would suggest the need for professionals who appreciate the need to facilitate the links between research and consumer needs.
- Reporting the results of agricultural research and practice: As a federal agency with close ties to the consumer, CSREES must devise more effective means to regularly inform the citizenry and elected officials about the advancements derived from effective accountability for the public funds devoted to the land-grant enterprise. And, as well, our information feedback system should be in tune with consumer angst about biotechnology as it relates to the food and fiber system.

Outcomes

- Greater consumer confidence in the agricultural system via more accurate and timely information flowing to the public about research findings associated with research and development efforts that expand the traditional agricultural markets.
- The scientific exploration of new ideas, including new applications for existing products and practices.
- Less fragmentation in Agency-sponsored multi-purpose/integrated research centers.

FOOD

Consumers vote with their dollars in the grocery store every day. It is evident that interest in cost and taste has yielded to quality and higher ideals toward production standards in some discerning consumers creating niche markets (Food Marketing Institute, 2001). Consumers can and do "drive" local agriculture/food programs that can improve a community's way of life economically as well as through health. Key to understanding how consumers would "drive agriculture" is to understand issues around food.

Individuals as Consumers

The determinants of food choice include a host of critical factors. Some examples are:

- Physiological factors (age, genetic background)
- Psychosocial factors (lifestyle, cognitive ability)
- Economic factors (resources including disposable income, federal and local assistance programs)

- Community-related factors (community viability, availability, accessibility)
- Environment-related factors (food safety, biosecurity, good stewardship values)
- Production-related factors (organic standards, agricultural consolidation, globalization and vertical marketing, labeling, advertising)

Communities as Consumers
At the community level of analysis of the determinants of consumer choice, there is a confluence of social, economic, cultural, geographic, and political factors. Public investment is needed on research into human factors affecting the production, dissemination, and adoption of new ideas, new technologies, and new products in food and agriculture. Research should especially focus on the role played by local networks, community leaders, and other communal features.

A. OBESITY

Need/Current Activities
In the simplest terms, "consumer driven agriculture" refers to the consumer being a major determinant of agricultural production. Health is an important consumer value, one which President Bush highlighted in his June 2002 announcement of an Initiative on Healthy Lifestyles and Fitness. However, the national epidemic of overweight and obesity is a major obstacle to health and fitness. Since obesity is the result of an imbalance of food intake and energy expenditure under the influence of heredity, concerns about obesity will have a significant effect on food, agriculture, and community systems. In 1999, an estimated 61% of U.S. adults were overweight, along with 13% of children and adolescents. Notable disparities exist among racial, ethnic, and economic subgroups.

The total direct and indirect costs attributed to overweight and obesity were estimated at $117 billion in the year 2000 alone. Despite CSREES-supported research in several critical areas and outreach to consumers, especially low-income and minority groups, through the Cooperative Extension System (CES) and the Expanded Food and Nutrition Education Program (EFNEP), the effort is insufficient and uncoordinated. A sense of the big picture is missing, and the roles of USDA and the Land-Grant System are disjointed and undocumented – resulting in the danger of redundancy, diminished synergy, uninformed planning, and the likelihood that the problem of obesity will grow worse.

Strategies
CSREES and the Land-Grant System are uniquely suited to take a multidimensional, coordinated approach to the problem of obesity. CSREES can provide leadership to establish a national initiative that:

- provides additional funding for critical research through the National Research Initiative (NRI), for a competitive grants program for CES, and for expansion of EFNEP and higher education programs that prepare scientists to address the multidimensional issues involved;
- evaluates the success of the initiative; and
- establishes a mechanism for documenting and sharing information about research findings, related academic programs, and effective intervention strategies.

Outcomes
Establishing a national initiative in the Land-Grant System takes advantage of the power of its tripartite mission in research, education, and extension – bringing a holistic approach to the problem of obesity. Coordination and documentation of ongoing work will improve needs assessments, resource utilization, and strategic planning for research, food production, educational efforts, and federal and community programs. The work directly serves the President s Initiative on Healthy Lifestyles and Fitness and USDA s goal to "Promote Health by Providing Access to Safe, Affordable,

and Nutritious Food." However, in today s new era of consumer-driven agriculture, the interconnectedness of the consumer with agricultural, food, and community systems becomes clearer, as does the synergy among all five of USDA s goals.

B. COMMUNITY-BASED FOOD SYSTEMS: A NEW DIMENSION FOR AGRICULTURE

Need/Current Activities

Community-based food systems have advantages as alternative food sources for a variety of reasons. The distance from field to table reduces use of fossil fuels as well as the possibility of bioterrorism. The production and marketing of food can become a stimulant to general community development; community isolation is broken down, growing social capital, reducing violence, and bringing economic growth. Rural and urban areas can breed a political strength of mutual need through food systems. New American immigrant populations have gained economic footholds in the U.S. through food enterprises. While restaurant and grocery enterprise creations are frequent, land is less often made available for production of special foods familiar to immigrant populations. Nutritional value of immigrant (as well as all American) diets can be enhanced through production of new fruits and vegetables through immigrant interest in agrarian enterprises.

CSREES has been the agency where federal agriculture programs clearly link with the consumer through the Cooperative Extension Service, which links every county in every state with research-based knowledge through research, education, and extension. Similarly, the county extension system has given CSREES the benefit of being grassroots/consumer driven and a main source of stakeholder input on what counties believe the federal partner's roles and responsibilities to them should be. This is a role unique to CSREES, and one that is invaluable when consumer-driven agriculture is so important.

CSREES is involved in creating alternative food systems through research, education, and extension across the country, including programming for small farms, alternative farming, organic and sustainable agriculture, value-added products, food marketing, horticulture, community development, food and nutrition education, youth development, and the community food projects program. Immigrant populations have been the focus of new farmer education programs, as in Massachusetts, Minnesota, California, and Wisconsin. Diets of vulnerable populations (both for health promotion and chronic disease prevention) have been improved by having local food systems programs.

Horticulture is a good example of an activity that offers commodity farmers with a profitable alternative, allowing them to diversify their operations and provide favorable cash flow. At the same time, urbanization puts many farmers close enough to demand centers to make distribution of perishable products realistic, thus offering marketing advantages to local farmers.

Strategies

- Create an undergraduate major in community food systems. Community colleges and land-grant universities (LGUs) develop 2-2 programs that would give practical education at the associates level, to be augmented at an LGU in year 3 and 4 to complete a bachelor's degree.
- Mentor farmers build cooperative growing and marketing systems with new immigrant farmers.
- Farmers contract with community citizens to provide produce through community-supported agriculture programs.
- Communities form cooperative grocery stores.
- Low-income and small communities create urban gardens and value-added processing facilities.

- Urban and rural communities in partnership help shape policies to increase access to good foods.
- Immigrant populations with agrarian experience are mentored and given opportunities to farm.

Outcomes

- CSREES would be an agency linked to efforts in improving the diet of low-income consumers, redeveloping those communities, creating a viable alternative to improve diets, and reducing chronic diseases (especially obesity and diabetes).
- New community-based food systems will improve the fruit and vegetable intake of consumers, resulting in improved health.
- New farms will produce food requested by consumers within their locale/region.
- Family farmers will be supported by local markets to produce a variety of fresh products with value-added to stay economically viable.
- Rural areas and urban areas will create a balance of interaction to maintain local food systems through policies and economic viability.
- Institutions will seek out local growers for food needs, creating vital markets for local growers.
- Immigrant populations may maintain good eating practices and spread good practices into the American diet (e.g., salsa, hummus, Asian greens).

NONFOOD: BIOBASED INDUSTRIAL PRODUCTS

Need/Current Activities

Consumers can be defined not only as individuals and communities, but also as businesses, industry, and government agencies, and they are seeking innovative ways to conduct business that is competitive and environmentally sound. Biobased products are defined as nonfood industrial products, including bioenergy, manufactured from agricultural raw materials or wastes. Because they are environmentally preferable products, they directly address environmental management issues. The federal government spends about $200 billion a year on products and services (White House Task Force on Recycling, 2001). Because of the magnitude of this purchasing power, purchasing decisions have a significant impact on the use of resources and on the environment. A federal agency can demonstrate its environmental stewardship through the products and technologies it uses. An appropriate role for the federal government is to take leadership in promoting environmentally preferable purchasing and in creating market pull for the emerging biobased industry.

A new concept of managing a business from an environmental or ecological perspective is proving to be an effective strategy to remain competitive in a global marketplace. An international standard (ISO 14001 titled Environmental Management Systems [EMS]) requires that environmental impacts in all three phases of a productive enterprise – inputs, production processes, and outputs – be considered. This system is gaining the attention of farmers, processors, and manufacturers, as well as government agencies, and is considered to be a practical way to save money and to demonstrate social responsibility to the communities they serve. For individual consumers, many biobased products are relatively new in the marketplace and must overcome market obstacles and cost competitiveness. The American public has a positive perception of the family farm and of environmental conservation and appears to be willing to support both. Taking advantage of these attitudes, identity preservation or product labeling has proven to be a value-added feature for both food and nonfood products. Labels such as “locally grown,” “organic,” “biodegradable,” and “biobased” are perceived by consumers to have health, social, and environmental values, and are used as increasingly effective marketing tools.

How can agriculture address evolving consumer demands for environmentally friendly products? Biological sciences are interweaving more tightly than ever with other branches of science and engineering, fostering many innovative ideas and numerous economic possibilities to meet the public's growing interest in health and environmental stewardship. The challenge is to streamline research, development, and production systems and to resolve technical bottlenecks to bring products still in the R&D pipeline to commercialization, thus stimulating more research to meet the growing need for new products and innovative technologies.

Land-grant universities have tremendous human resources, infrastructure, and interests to contribute to the formation of a biobased economy. ESCOP recently published "A Science Roadmap for Agriculture," identifying seven challenges that directly address stakeholder interests in a number of agricultural issues. One of the seven is to find new uses for agricultural materials and wastes and to develop and market more products that are cost competitive and can replace petroleum-based products. Products and technologies are emerging from a number of successful programs in academia that encompass basic molecular biology to process engineering to applied economics. Agricultural raw materials and wastes are being converted into products such as fuels, energy, industrial lubricants, and polymers. Forest resources and wood processing waste are sources for a number of products, including pharmaceuticals and composites.

Strategy

To accelerate the entry of biobased industrial products into the marketplace, there should be increased support for the portfolio of CSREES programs, including targeted foundational/early applied research, applied/developmental integrated research, education, extension, and the special grants authority for forest products programs. In addition, establishing new or enhancing existing centers will exploit the breakthroughs of advanced agricultural science and engineering research. To focus efforts towards the common goals of developing commercially successful products and production systems, the centers should be vertically integrated multidisciplinary teams ("dream teams") with adequate resources to resolve technical, economic, and environmental obstacles. Incorporating the concept of industrial ecology into the centers is critical. Industrial ecology is defined as an integration of an entire industrial process (from the farm to the consumer) to determine maximal beneficial use of resources, with minimal waste generation during the entire process (Forsch, R. A., 1992). The centers should demonstrate their strong commitment to the mission of – and facilitate timely dissemination of – new discoveries and technology transfer through interaction with external supporters and stakeholders.

Outcomes

- From a consumer perspective, new products and technologies that have a reduced negative impact on human health and the environment will become commercially available and cost competitive more quickly.
- From the farm community perspective, nonfood uses of agricultural materials offer tremendous opportunities to expand agricultural markets beyond traditional food and fiber markets.
- From a national security perspective, agriculture will play a significantly larger role in providing raw materials and products to support the U.S. industrial base
- From the CSREES perspective, the land-grant system can support research, engage extension to demonstrate and accomplish technology transfer of this research, and educate a future workforce with not only technical expertise but also with the ability to apply that expertise in a comprehensive and integrated framework that meets consumer demand for quality, low cost, and pollution prevention.

NEW TECHNOLOGIES

New agricultural technologies facilitate the development of products that meet societal needs for sustainable environment-friendly farming practices, sensitive detection devices, food safety, and consumer preferences for quality, variety, nutrition, and health enhancement.

A. FUNCTIONAL GENOMICS/PROTEOMICS, BIOINFORMATICS

Need/Current Activities

Genomics is defined as the mapping and sequencing of all the genes of an organism. A recent explosion of information about crop, animal, and pest genomes will have a major impact in developing novel strategies to feed the world in the 21st century. The crucial question now in genomics research is: What are the functions of the proteins encoded by genomic sequences? This question can be addressed by using functional genomics, the study of the relationship between the structure and organization of the genome and the function of the genome as it directs growth, development, physiological activities, and other life processes of an organism.

Computational biology such as bioinformatics plays a critical role in data management for both structural and functional genomics. The amount of data released into publicly accessible databases is rapidly increasing, and expanding large-scale database management and algorithms for whole genomic comparisons across different species (bioinformatics) is needed. Genomic mapping studies in several agriculturally important organisms such as rice, corn, wheat, cotton, soybean, cattle, swine, poultry, tilapia, tobacco budworm, and many species of microbes are a wealth of genomic and gene sequence information. This genomic research identifies important traits such as disease and stress resistance, and yield-enabling improvements in agricultural productivity and environmental quality.

Proteomics is a relatively new tool of functional genomics that is used for the large-scale identification of the complete sets of proteins in a living cell, which determine how a living organism interacts with its environment. Proteomics provides the way to determine the patterns in which proteins are expressed in various states of growth, development, health, stress, disease, and natural decline. It can have significant implications for agricultural research. Proteomic approaches are being used to identify species-specific molecular targets for effective pesticides against ticks, termites, ants, mosquitoes, and crop pests. Agricultural proteomics can provide new ways to understand the function of proteins at higher levels of organization such as biological signal transduction, metabolic pathways, and cellular organelles. This integrative aspect of agricultural proteomics will provide excellent research and training opportunities, in addition to facilitating the development of improved food and biobased and agricultural systems.

Strategy

Increase funding for competitive basic research programs to make more significant impacts in functional genomics, proteomics, and bioinformatics.

Outcomes

Targeted outcomes include:

- Development of crop species that better tolerate cold or drought, allowing increased yield and economic prosperity under less than ideal environmental conditions.
- Improved plants that will serve as energy and industrial product feed-stocks.
- Plants and microbes that can clean contaminated soils.

- Decreased use of antibiotics in livestock by identifying genes that enhance resistance to infectious diseases.
- Improved diagnostics and vaccines for farm animals.
- Safer and more effective pesticides that have reduced negative environmental impacts.
- Plants with improved or enhanced nutritional characteristics.

B. NANOTECHNOLOGY

Need/Current Activities

Nanotechnology is the study and manufacturing of structures and devices with at least one dimension ranging in size from 1 to 100 nanometers (10^{-9} meters or one billionth of a meter), e.g., a film or membrane with a thickness of less than one thousandth the width of a human hair. Applications of this technology to address agricultural issues are boundless. This technology is new, but it can have a significant impact on agriculture and food production systems, such as detecting pathogenic bacteria and hazardous biological and chemical substances. Detection devices are sensitive, fast, low cost, and capable of processing a large number of samples simultaneously. Prototypes are close to commercialization.

Strategy

Initiate a new program or modify an existing competitive program that identifies nanotechnology as a topic. Focused research areas would include, but not be limited to, development of novel composite materials and improvement of material properties, development of biosensors and sensing systems for detecting toxic chemicals and pathogens, fabrication of self-assembling nanobiostructures, and fundamental investigation of biological phenomena using tagging and labeling.

Impacts

Nanotechnology can lead to the development of the smallest and precise sensors and instrumentation to characterize complex and dynamic processes in living organisms, provide targeted delivery systems, and rapidly detect harmful substances. Innovative nanoporous catalysts can be used to enhance the efficiency of conversion processes for food and nonfood products. This technology can also lead directly to the development of the strongest and lightest novel materials with superior functional properties that have a wide range of applications in agriculture and human health.

SUMMARY

The desired outcome of an initiative in consumer-driven agriculture is a greater understanding of critical factors that affect consumer behavior related to agricultural products and the application of this understanding to the development and evaluation of effective programs to stabilize or improve American food systems, communities, health, and the environment. To achieve this outcome, science must be accountable to the public it serves. Science is being challenged by consumers to allow them to be participants in the decision-making process. This white paper defines who the consumer is and suggests a number of directions that agricultural programs can take to address consumer demand for healthy food, healthy communities, and a healthy environment.

Two recurrent themes are found across the major topics of food, nonfood, and new technologies described in this paper.

The first is homeland security. Identity preservation will allow efficient tracking of materials, and new technologies will allow detection of harmful contaminants in food and distribution systems. When food production is addressed with community involvement, the result is local, decentralized

food systems that are less susceptible to potentially catastrophic tampering than would occur with a centralized process facility. Decentralized local energy production is also a strategy that can protect a community from sabotage. Products and processes that replace petroleum counterparts or reduce energy inputs support the industrial base and reduce dependence on oil imports.

The second theme is the systems management or "holistic" approach to agricultural production systems. Local food production that encompasses the entire system results in consumers that are better informed about food choices and health, and the involvement of all stakeholders in food production activities enhances the vitality of the rural community. For nonfood biobased products to be considered environmentally preferable, the total production system (i.e., the concept of industrial ecology) must be taken into account. The use of agricultural materials in the manufacture and use of biobased products is envisioned to be a stimulus for rural development and a practical way to address natural resource conservation and pollution prevention. Environmental considerations are inherent in the holistic approach for both food and nonfood systems, and new technologies can reduce chemical input and make production systems more efficient. Integration of scientific disciplines and the functions of research, education, and extension are necessary to implement a systems management strategy.

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