

Healthy Food Systems, Healthy People

AN INITIATIVE OF THE ASSOCIATION OF PUBLIC AND LAND-GRANT UNIVERSITIES



Association of Public and Land-grant Universities

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EXECUTIVE SUMMARY

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The Association of Public and Land-grant Universities' Board on Agriculture Assembly and Board on Human Sciences launched the Healthy Food Systems, Healthy People initiative on July 23, 2014, to build on work previously submitted by the Extension Committee on Organization and Policy's Health Task Force. This report identifies research and education/outreach priorities, as well as the need to integrate these efforts across agriculture, food, nutrition, and health care systems to make a positive difference on human health and chronic disease. America's land-grant universities' colleges of agriculture and human sciences have the capacity to advance research, education and engagement as it relates to human health. Many institutions and professionals understand how agriculture, food and nutrition can independently affect a person's health, yet little work has been done that integrates these systems with health care to understand impacts on overall human health and incidence of chronic disease.

This unique initiative calls for collaborations and integration among agriculture, food, nutrition, and health care systems that have never before been explored or optimized. Working across these systems and developing solutions that combine multidisciplinary research and education efforts is a new and essential way to approach the issues facing human health and chronic disease prevention.

PROGRAMMATIC PRIORITIES

In order to understand the depth and breadth of challenges and opportunities surrounding human health, input was solicited from experts representing agriculture, food, nutrition, and human health. Five programmatic priorities were identified that could successfully connect agriculture, food, and nutrition systems together with health care systems to improve human health and minimize the impact of chronic disease. Critical public and private partners were also identified to help achieve those priorities.

Integration Across Systems

Research and education priorities will require expertise in systems implementation science, identifying how to measure system variables, and implementing evidence-based strategies to change food systems and health care systems to impact human health and chronic disease. A greater understanding of the differences and challenges that have kept these systems separate could provide a means of building more sustainable and enduring relationships across systems.

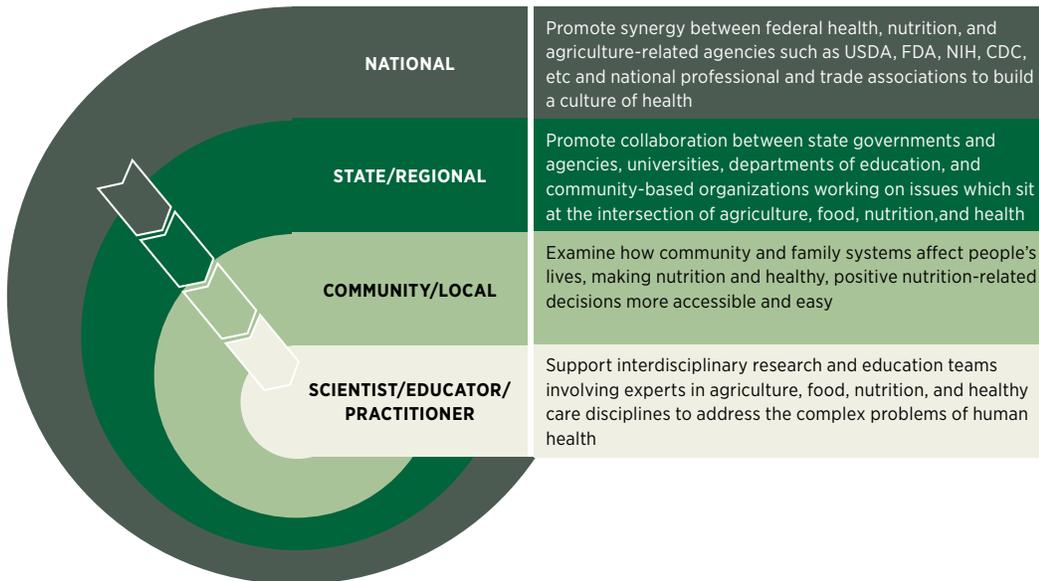


Figure 1. Integration must occur at many societal levels, including national, state/regional, community/local, and scientist/educator/practitioner.

Goal

Realign the research and education approaches using a “systems thinking” model to remove barriers, incentivize the formation of interdisciplinary partnerships among various entities (i.e., academia, industry, federal and state governments and health care), resulting in responsive systems approaches for positive health outcomes of individuals across communities, states, the nation and the world.

Drivers of Food Choices and Consumer Behavior

Obesity is a complex issue influenced by consumer behavior, including food consumption choices. The role of policy, systems, and environmental drivers of consumer behavior is not well understood. There is a need to examine the complex interrelationships between various factors that could affect obesity. Research on determinants of food consumption/purchase behavior studies is extensive; however, additional behavioral research is needed in order to understand how consumers make choices.

Goal

Identify the main policy, systems, and environmental drivers of consumer behavior in relation to chronic diseases; and understand the drivers’ inter-connectedness in terms of food consumption decisions and how that information can be used to influence better decisions.

Impact of Food on Consumer Health

Effectiveness of bioactive food components in promoting human health and well-being is the result of complex interactions of food composition, human genetic predisposition/lifestyle factors, and the gut microbiome. To most effectively utilize food or food bioactive compounds to promote human health and reduce chronic disease requires a clear understanding of these interactions. Acquisition of this knowledge, which requires a systems biology approach, could allow us to tailor optimal nutrition programs for each individual for maximum effect in promoting human health and reducing chronic disease.

Goal

Better understand the complex interrelationships of the food-human-gut microbiome ecosystem and its roles in promoting human health.

Definition and Accessibility of Quality Food

Food quality encompasses the characteristics of food that make it both safe and acceptable to a consumer. Considering the well-established relationship between diet and health, a broader definition of food quality is needed that can account for the diversity of factors that may impact human health. Consumers, producers and health professionals need a definition of food quality that incorporates the interaction of food constituents with human therapeutic targets to prevent chronic disease or improve metabolic function.

Goal

Broaden the definition of food quality in a manner that considers the true functionality of food and translation of human health promoting attributes to consumer food products and dietary supplements.

Education, Outreach and Engagement

Many sources of misinformation about nutrition and lifestyle interventions have emerged in the last several decades. The best means of countering this is to provide research-based information, through credible sources to patients and clients throughout the communities. Improving the lab-to-community pipeline of information by providing education through Cooperative Extension regarding the impact of food and nutrition on health to health care providers will provide improved patient interventions, and to the general public will enable more informed health decision-making.

Goal

Improve the lab-to-community pipeline so that medical, public health, education, and Cooperative Extension professionals are well-prepared to use state-of-the-science food and nutrition recommendations to help their patients, clients, and the public improve their health and lessen the burden of chronic disease.

CONCLUSION

All over our nation and across the world, people are suffering from a variety of chronic diseases and diminished health. With public and private partnerships in academia, industry, and government, the expertise is available to move this initiative forward. Strategic partnerships, coupled with appropriate funding opportunities, will revolutionize the way we approach integration of agriculture, food, nutrition, and health care systems when identifying solutions for challenging human health issues. A strategic investment is needed to create partnerships and to integrate food and health systems which will ultimately improve the lives of Americans.



INTRODUCTION

The Association of Public and Land-grant Universities' (APLU) Board on Agriculture Assembly (BAA) Policy Board of Directors, together with the Board on Human Sciences (BoHS), took action on July 23, 2014, to establish an integrated committee known as the Healthy Food Systems, Healthy People (HFSHP) steering committee. This action was taken to build on initial work by the Extension Committee on Organization and Policy's (ECOP) Health Task Force.

The ECOP Health Task Force created a robust document (*Cooperative Extension's National Framework for Health and Wellness*, http://www.aplu.org/members/commissions/food-environment-and-renewable-resources/CFERR_Library/national-framework-for-health-and-wellness/file) that identified the overwhelming need for both changes and advances in current healthcare systems. The task force offered several recommendations as to how Cooperative Extension could create and execute education and outreach programs to help address this need.

The HFSHP steering committee focused their efforts on identifying knowledge gaps and research needs that could support future education and community engagement activities related to human health.

These research priorities were then integrated with Cooperative Extension programming needs identified by the ECOP task force to develop this report. Ultimately, the HFSHP steering committee expects this effort will create opportunities to make a positive impact on human health and chronic disease.

COMMITTEE CHARGE

The HFSHP steering committee was tasked with creating a broad-based initiative that would seek funding in the 2018 fiscal year. The committee adopted the following charge for the given task:

“Help secure funding to improve human health and reduce chronic disease by integrating food, environment and agricultural systems through alignment of science, education, community engagement, and strategic partnerships.”

JUSTIFICATION

“Lifestyle choices we are making in this new century threaten to undo all the medical advances of the last one.” — U. S. Surgeon General David Satcher

We have long known that the primary determinants of an individual’s health status are lifestyle, environment, and genetics. Health care is only responsible for 10 percent of an individual’s overall health. Yet, approximately 90 percent of the national health budget is dedicated to healthcare.

Individuals and families looking to embark on the road to a healthier life face a myriad of social, economic, and environmental factors that reinforce their current behaviors. As a result, the United States continues to spend more on health care (\$8,600 per person) than any other nation but has among the worst health outcomes of any developed nation.

There are several trends in public health that indicate a need for additional research, education and outreach. Changes in public policy, increased chronic disease, health disparities, economic factors, population change, technology advances and health literacy all contribute to the way consumers select and receive care.

There are certainly more options available when seeking health care compared to years prior but that does not necessarily mean human health has improved. There is a somewhat

recent shift from acute and infectious disease to chronic and non-communicable diseases. When examining what led to the shift in disease types, social and economic status is proven to have significant impact. Individuals, families and communities that have systematically experienced social and economic disadvantages face greater obstacles to optimal health. For example, food insecurity is one factor that is directly correlated with health, and unfortunately the number of those facing very low food security is on the rise.

Furthermore, matters of food, nutrition and diet-related chronic disease are an extremely high priority for many minority and high-risk populations, such as tribal nations and urban indigenous communities; unfortunately, dietetics programs on university campuses usually have very little representation from within these communities.

America's land-grant universities' colleges of agriculture and human sciences have the ability to advance research, education and outreach as it relates to human health. However, resources and existing boundaries between agriculture and food systems and health care systems often restrict exploration into such possibilities. Many institutions and professionals understand how agriculture, food and nutrition can independently affect a person's health, yet little research has been done that integrates across these multiple systems to understand the impact on overall health. There is a well-established causal link between food consumed, long term health and many chronic diseases. Scientists have identified several food components that have a positive or negative impact on health, as well as the interaction of those food components with the human gut and overall metabolism. Genetic manipulation of food crops and animals have improved composition of certain health-promoting food components, and farming practices, such as harvest timing and postharvest handling, have improved food quality.

However, numerous factors along the continuum, from the farmer's choice of crop variety or livestock breed to the consumer's choice of what to eat and lifestyle, determine how what is consumed affects health.

All of these variables impact health in some way, and there is certainly an opportunity to work together with strategic partners to combine what is known about agriculture, food, and nutrition systems together with health care systems to reduce chronic disease and improve human health. This unique initiative calls for collaborations and integration across agriculture, food, nutrition, and health care systems that have never before been explored. Working across these systems and developing solutions that combine multidisciplinary research and education efforts is a new and essential way to approach the issues facing human health and chronic disease prevention.

COMMITTEE PROCESS

In order for the committee to understand the depth and breadth of challenges and opportunities surrounding human health, the committee sought input from experts across agriculture, food, nutrition, and human health. Over 60 experts were identified in these areas and then asked to complete a survey focused primarily on the following two questions:

- What do you consider to be the three most important research priorities that could successfully connect agriculture, food, and nutrition systems together with health care systems to improve human health and minimize the impact of chronic disease?
- Undoubtedly, important partnerships (academia, industry, government, consumer, other) will need to be formed to better connect research priorities in agriculture, food, and nutrition systems together with the goal of improving human health. What critical partnerships would help evolve this research?

Twenty-nine responses were collected from the survey with an extensive, diverse array of research priority statements and potential partners. The responses were evaluated by an ad hoc Research Priorities Subcommittee and five priority areas identified. Each priority area was expanded to include background information, a goal statement, objectives, outcomes, impacts, and key public/private partnerships, all of which were adopted by the steering committee for this report.

PROGRAMMATIC PRIORITIES

Integration Across Systems

Background

In order to build on the social-ecological model and the systems in play which support research, translation, and implementation through many sectors, the conversations need to be framed among and between the spheres of influence at the national, state/regional, community, and principal investigator levels. Research and education priorities will require expertise in systems implementation science, identifying how to measure system variables, and implementing evidence-based strategies to change food systems and health care systems to impact human health and chronic disease. A greater understanding of the differences and challenges that have kept these systems separate could provide us means of building more sustainable and enduring relationships across systems.

For purposes of establishing recommendations and action steps, this section describes opportunities for improved integrated approaches at the national, state/regional, local/

community, and individual scientist/educator/practitioner levels in support of research and education which will result in more effective and comprehensive systems approaches (refer to Fig 1).

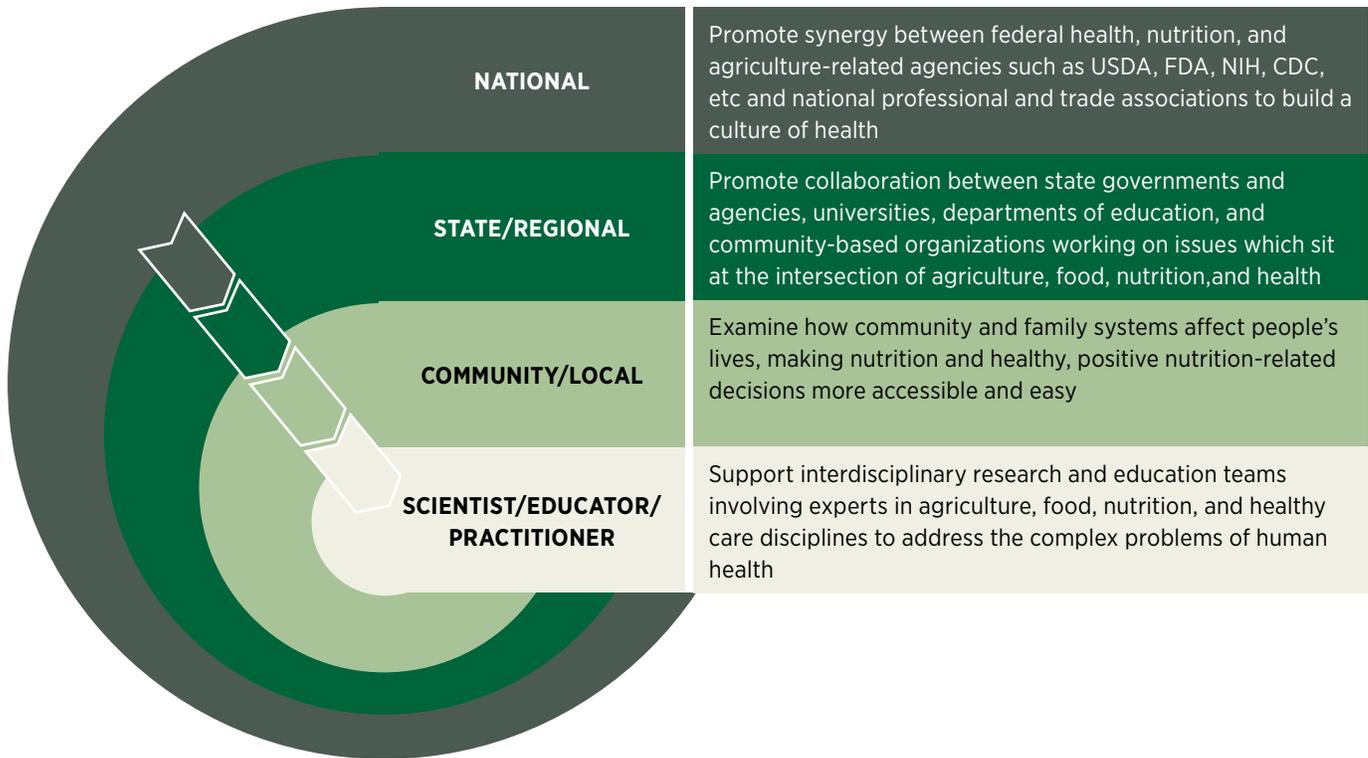


Figure 1. Integration must occur at many societal levels, including national, state/regional, community/local, and scientist/educator/practitioner.

Discerning how to best prevent chronic diseases and promote health will most efficiently be achieved by engaging partners at national, state, community, and individual expert levels and by working within levels across disciplines and domains to achieve measurable progress in improving outcomes. For instance, recognizing the agricultural food-production-to-human-health continuum and integrating the disciplines along that continuum more intentionally may lead to better interventions on poor health.

This integration should also result in feedback from health practitioners to better inform research in this area, similar to the way producer feedback helps direct agricultural production research. Land-grant universities have a unique capacity to support projects that span the boundaries of what some have viewed as closed and separate systems. Facilitating intentional work across systems that yield higher-order wins for all parties is critical.



Goal

Realign the research and education approaches using a “systems thinking” model to remove barriers, incentivize the formation of interdisciplinary partnerships among various entities (i.e., academia, industry, federal and state governments and health care), resulting in responsive systems approaches for positive health outcomes of individuals across communities, states, the nation and the world.

Objective 1

Encourage collaborations among government agencies as well as non-profit organizations to develop joint grant request for proposals (RFP) models that encourage integration in research, education, and outreach, as well as foster critical public/private partnerships.

- **Outcome:** Adequate resources secured to support the enhanced infrastructure and capacity necessary to expand existing research and Cooperative Extension outreach health programming.
- **Outcome:** The Land-grant Universities (LGUs) and existing Cooperative Extension infrastructure, found in nearly every county in every state that is utilized by the US Department of Agriculture’s (USDA) National Institute for Food and Agriculture (NIFA), is also accessed for outreach and education by Center for Disease Control and Prevention

(CDC), National Institutes of Health (NIH), National Science Foundation (NSF), Food and Drug Administration (FDA), Non-governmental Organizations (NGOs) and others.

- **Impact:** LGUs in partnership with a wide variety of agencies and NGOs address the major health issues in our country through implementation and evaluation of national health interventions, enabling all partners to be more effective and efficient in keeping people healthy.
- **Impact:** Synergy among many builds a culture of health for all.

Objective 2

Incentivize the formation of partnerships among the various entities (academia, industry, government, non-profit organizations, health care providers and consumers) to establish sustainable approaches that benefit research, education, and outreach.

- **Outcome:** Support is enhanced for interdisciplinary teams and responsive reward systems leading to long-standing sustainable partnerships among social science professionals, plant and animal scientists, nutritionists, food scientists, engineers, and public health and medical professionals.
- **Outcome:** Partnerships are formed leading to strategies and funding that support pilot projects which are designed and new models tested for the greatest benefit.
- **Impact:** Patient- and community-centered models for healthcare are created and thrive in our country through innovation and redesign of delivery of education and health care.
- **Impact:** A health literate population and a delivery system which takes a longer term view raises and sustains the wellness of the American population.

Objective 3

Expand and/or reallocate some existing USDA NIFA competitive and/or capacity funds to support integrated approaches to human health priorities. Require that RFPs include participation across colleges of agriculture and human sciences in collaboration with to colleges of medicine and public health.

- **Outcome:** Clear health program goals and/or new health-focused guidance documents and structures enhanced in USDA NIFA result in a strong, deliberate, and visible human health agenda in the agency.
- **Outcome:** Enhanced leadership and professional development increase knowledge and content experts and build skills in health and evaluation of health interventions.
- **Impact:** A nationally strong and responsive infrastructure for health thrives due to the adoption of a sustainable model of integrated research, education, and outreach by USDA, NIFA, Cooperative Extension System (CES), and Agriculture Experiment Station (AES).

Objective 4

Engage land-grant and non-land-grant public and private universities in a dialogue to maximize academia's collective efforts from different disciplines to address the human health issues at all levels of the social-ecological model.

- **Outcome:** Cross-disciplinary and collaborations inclusive of many units in higher education results in the development of novel approaches and broadens collective thinking and understanding to solve the complex problems in human health.
- **Impact:** Combining what is known about agriculture, food, and nutrition systems impact on health with what is known through public health and health care systems results in innovative models for community-integrated care, better coordinated care, better health for individuals and populations, and lower cost, particularly to those with the greatest health care needs.

Objective 5

Implement systems research for a greater understanding of the barriers, differences, and challenges that inhibit the agriculture, food, nutrition, and healthcare systems from effectively changing health outcomes.

- **Outcome:** System variables are identified to measure changes in food production and food systems which lead to positive impacts on health of the people and populations across the country.
- **Outcome:** Innovative models for community-integrated health programs are implemented and evaluated.
- **Outcome:** Funding provided for natural experiments in communities to study systems expands the current body of knowledge about health, which was previously based on randomized controlled trials or program evaluation rather than generalizable systems science.
- **Impact:** Through examination of how community and family systems affect people's lives, individuals achieve positive gains as health- and nutrition-related decisions become the easy choice.
- **Impact:** Through enhanced food systems approach, rather than food supply strategies, farm production policy and dietary guidelines around diet and health are coordinated and enhanced to benefit human health.

Drivers of Food Choices and Consumer Behavior

Background

Obesity, and related chronic diseases, i.e. heart disease, diabetes, hypertension, etc., is a complex issue influenced by consumer behavior, including food consumption choices. The role of policy, systems and environmental drivers of consumer behavior is not well understood. There is a need to examine the complex interrelationships between various factors that could affect obesity. An example of an important area that needs more work is how the food environment (e.g., food retail environment) can affect weight outcomes of individuals, particularly children and adolescents. Again, an assessment of not only the relationship but also the causal impact of the food environment on obesity outcomes is essential for food and health policy and for the agriculture/food industry. Also needed is education on food choices and behavior change at an early age in both schools and informal settings, i.e. a life-span approach.

Research on determinants of food consumption/purchase behavior studies is extensive; however, additional behavioral research is needed in order to understand why consumers make choices that are not part of current economic models. There is a need to understand which factors truly are causal and not just correlated with food consumption behavior. Causal factors may include childhood experiences (i.e., no experience with food preparation or cooking, or family meals together) and neighborhood attributes (i.e., food deserts or food swamps), but more examination is needed to determine the specific factors to study. Another initial step would be identifying the best methodology to study the causal factors and the inter-correlations. Questions emerge such as, “Are randomized controlled trials feasible or are some natural experiments a better a way to evaluate causality?” Behavioral science, integrated with human and food sciences, is needed to understand this complex question.

Greater understanding of the impact of government programs on both over-nutrition and under-nutrition is needed. Current USDA nutrition programs would benefit from an enhanced knowledge base and additional staff expertise in physical activity, public health intervention, and health systems. Current USDA funding supports research programs that integrate research and Cooperative Extension, but this funding does not include health systems. Current researchers and Cooperative Extension staff lack the research expertise in public health interventions to advance science. There is a need for a greater understanding of the differences and challenges that have kept these systems separate; the current systems have little in common. The use of proper program evaluation techniques that can definitively estimate the “true” effects of the programs is essential. This will allow for the assessment of specific benefits

(including government-funded programs) relative to the costs of program development and implementation.

There is a need to engage and learn from food industries about the influences on consumer food choices. This work would allow for potential tailoring of food traits to make foods either more or less appealing, thus helping to understand causes of appetite, obesity, and chronic diseases. Currently the interplay of what consumers are actually consuming is not being evaluated – there is a need to stop looking at food from a science perspective and start looking at food the way a consumer does. What is it that makes a consumer ingest different types of foods?

Goal

Identify the main policy, systems, and environmental drivers of consumer behavior in relation to chronic diseases; and understand the drivers' interconnectedness in terms of food consumption decisions and how that information can be used to influence better decisions.

Objective 1

Identify what cultural, policy, systems, and environmental changes can positively affect consumers to make healthy choices.

- **Outcome:** Understanding of what cultural, policy, systems, and environmental factors affect consumers' ability to make healthy choices increases.
- **Impact:** Through examination of how cultural, policy, systems, and environmental factors affect individual choices, healthy choices become the easy choice.

Objective 2

Understand how the food environment (e.g., food retail environment, food deserts) affects consumer behavior and weight outcomes of individuals, particularly children and adolescents.

- **Outcome:** Knowledge of the ways in which proximity to food and food placement may impact food purchasing decisions and weight outcomes among children and adolescents is increased.
- **Impact:** Percent of children and adolescents who maintain a healthy weight increases.

Objective 3

Determine how U.S. government food program and policies (e.g., Supplemental Nutrition Assistance Program (SNAP), school meal programs, and Older Americans Act programs such as congregate meals and Meals on Wheels) affect consumer behavior and weight outcomes of people served by these programs.



- **Outcome:** If and how government-funded and subsidized food programs affect consumer behaviors and weight outcomes of clients is determined and evaluated.
- **Impact:** Weight outcomes of government food program clients improve as a result of changes to programs based on findings from the observational analyses.

Objective 4

Describe the extent that U.S. governmental and/or agricultural policies and practices influence the U.S. food supply in positive and negative ways (e.g., levying taxes on unhealthy foods, understanding how farm subsidies and practices have altered the food supply) and what changes could have a positive outcome.

- **Outcome:** Improved policies and practices have positive effects on healthy food availability, cost, and composition.
- **Impact:** Positive consumer health benefits are realized as food production and food systems policy transparency improves.

Objective 5

Translate science on consumer behavior into viable marketing interventions that influence consumer behavior.

- **Outcome:** Identified consumer behavior science to support consumers' behavior in the marketplace.
- **Impact:** Improved understanding of processes consumers employ when making food decisions in the marketplace.

Objective 6

Determine the impacts of interactions of nutrition/food intake, physical activity, and educational interventions on chronic disease prevention and treatment.

- **Outcome:** Better understanding of the impacts of education, diet, and physical activity on prevention and treatment of various chronic diseases.
- **Impact:** Increased proportion of healthy lives at every age using education, recommended diet, and appropriate physical activity.

Impact of Food on Consumer Health

Background

The effectiveness of bioactive food components in promoting human health and well-being is the result of complex interactions of food composition, human genetic predisposition/lifestyle factors, and the gut microbiome. All three are subject to genetic and environmental variation. To most effectively utilize food or food bioactive compounds to promote human health and reduce chronic disease requires a clear understanding of these interactions.

Food nutritive value can readily be altered through genetic and environmental manipulation; however, each consumer has a unique genetic predisposition toward foods and bioactive food compounds which affects their ability to absorb and utilize particular nutrients. Each individual also has a unique gut microbiome which plays a vital role in nutrient absorption and utilization. While research has been done on each of these three components, little is understood about their complex interactions and their role in promoting human health.

Acquisition of this knowledge, which requires a systems biology approach, could allow us to tailor optimal nutrition programs for each individual for maximum effect in promoting human health and reducing chronic disease.

Goal

Better understand the complex interrelationships of the food-human-gut microbiome ecosystem and its roles in promoting human health.

Objective 1

Identify the role of the gut microbiome in modulation of inflammatory and antioxidant responses to foods and the absorption and utilization of nutrients.

- **Outcome:** Better understanding of the gut microbiome's role in absorption and utilization of nutrients, and in modulating positive and negative metabolic reactions.
- **Impact:** Improved biodiversity and health of the human gut microbiota resulting in improved ability to process food, extract key nutrients and combat detrimental gut microbiota.

Objective 2

Understand the interaction of the human gut microbiome with the human genome and food nutritive value and its effect on nutrient absorption and utilization by the human body.

- **Outcome:** Identification of genetic markers in human gut microbiota, boosting our ability to identify strains which enhance or inhibit food utilization by humans.
- **Outcome:** Identification of genetic markers for functionally active compounds in plant and animal food products.
- **Outcome:** Identification of human biomarkers that predict reaction to functionally active compounds in food products.
- **Impact:** Better understanding of the food-gut microbiome-human genome interface thus enabling medical professionals and dieticians to better customize health-promoting diets for individuals.

Objective 3

Develop new biomarkers to better predict chronic disease predisposition, which can in turn help to tailor individual nutrition programs to better address these diseases.

- **Outcome:** Identification of human biomarkers that predict chronic disease predisposition.
- **Impact:** Individual nutrient programs are adjusted based on presence of biomarkers for people who are predisposed to certain chronic diseases.

Definition and Accessibility of Quality Food

Background

Food quality is a term used to encompass the characteristics of food that make it both safe and acceptable to a consumer. This can include broad aspects of taste/ flavor, appearance/ texture, nutritional content and absence of chemical or biological safety hazards. More often than not, this definition is connected throughout the value chain from breeding for quality traits (flavor, color, yield, macronutrient profile and content) through post-harvest and packaged food processing to yield products that consumers demand. While fitting, this view is centered on defining food quality as “what food is” with only a subtle association to the broader question of “what food does” in regard to consumer health. Considering the well-established relationship between diet and health, a broader definition of food quality is needed that can account for the diversity of factors that may impact human health. This notion would include aspects of current food quality definitions including presence and absence of chemical and biological hazards, flavor, appearance, and compositional aspects of food, including content of macro and micronutrients. However, to better associate with health endpoints, the definition of food quality must be extended to include previously underappreciated factors, such as:

1. Measures of health promoting components and their biomarkers of exposure in humans, including bioactive food components not currently classified as nutrients (e.g., phytochemicals) or typically categorized broadly with macronutrient classes (e.g., omega-3-fatty acids or prebiotic fibers)
2. Specific markers of bioactive food component health functionality in the context of complex foods and dietary patterns, including their bioavailability and interactions impacting their functionality
3. Identification of genetic and agronomic/production factors driving their presence and function in foods
4. Better definition of the intersection of plant genome and phenotypes with impact at the level of the biomarkers of human health through influence at the genome/epigenome/microbiome level

Consumers, producers and health professionals need to have a better definition of food quality that incorporates the interaction of food constituents with human therapeutic targets to prevent chronic disease or improve metabolic function. Likewise, a move to establish the true health functionality of food and how that functionality is altered through the full agricultural value chain is also critical. This



shift will also require the development and application of technology to monitor and define essential factors relative to food quality and safety. However, ultimate impact will require that these concepts can be translated into consumer products that can both enhance overall diet quality and be made broadly accessible to consumers. This includes alignment of traditional agricultural, food science, biomedical, and consumer science disciplines with both government and private industry in synergistic efforts to define not only optimal quality traits and their responses in humans, but factors that drive preference, cost and ultimate accessibility of improved food products.

Goal

Broaden the definition of food quality in a manner that considers the true functionality of food and translation of human health promoting attributes to consumer food products and bioactive compounds.

Objective 1

Develop a portfolio of reliable, robust phenotypic traits that correlates to health-protective value of agricultural products and finished foods that can be used to expand both breeding programs and the definition of food quality.

- **Outcome:** Food quality defined to include broader aspects of food composition and functionality in regard to human health promotion.
- **Impact:** Consumers are more knowledgeable about food quality attributes beyond traditional metrics and consumption behavior is modified using that knowledge.

Objective 2

Better understanding of the impact of post-harvest handling and food processing on the health functionality and overall quality of foods.

- **Outcome:** Additional measurable phenotypic attributes identified in raw agricultural commodities as they are transformed through the value chain, including processing, which are directly connected with human health outcomes.
- **Impact:** Food value chain is enhanced by commercialization of products with validated health benefits.

Objective 3

Identify biomarkers of intake for bioactive food components (e.g., phytochemicals, bioactive lipids or probiotics) that can be monitored in human fluids to establish diet patterns and quality, and correlate these with disease risk or progression.

- **Outcome:** Reliable biomarkers characterized for long term diet patterns rich in bioactive food components.
- **Impact:** Health care professionals use biomarker assays of body fluids to determine patients' dietary patterns and future guidance.

Objective 4

Determine the role of underlying factors (e.g., food composition, overall diet, lifestyles, and disease risk/status) in modulating the bioavailability and efficacy of dietary bioactive compounds from foods.

- **Outcome:** Knowledge is improved regarding associated factors' effects on functionality of bioactive food compounds.
- **Impact:** Impacts of associated factors are considered by food processors and health care professionals when determining new product formulations and patients' dietary recommendations.

Objective 5

Establish translational and commercial paths for improved crop and animal products, and other raw materials that generate products of enhanced health quality.

- **Outcome:** Plant and animal breeders and producers are more informed about reliable and robust phenotypic attributes linked to consumer health.
- **Impact:** Improved agricultural commodities are produced with enhanced nutrient and phytonutrient density.
- **Impact:** Food products that meet the broader definition of quality are more widely accessible to consumers across the socioeconomic spectrum.

Education, Outreach and Engagement

Background

Different domains of science (including agricultural science, basic biological and chemical science, medical science, and other fields) and practice (including medicine, nutrition, public health, education, and Cooperative Extension) often operate within their own fields with limited exposure to other disciplines. Cross-collaboration is necessary if progress is to be made towards improving the health outcomes of people worldwide. Many sources of misinformation about nutrition and lifestyle interventions (e.g., media personalities, popular publications, retailers, etc.) have emerged in the last several decades, and the best means of countering this is to provide evidence-based/informed information via credible sources to patients and clients in communities. Advances in technology continue to shape the way we record, distribute and seek information. Electronic records are becoming the norm, a wealth of credible, as well as not-so-credible, information is available via a variety of news sources, and a surge in the use of social media and crowdsourcing sites has left both professionals and consumers with many options. The focus of this priority area is to improve the lab-to-community pipeline of information by providing research-based education through Cooperative Extension regarding the impact of food and nutrition on health to health care providers for counseling their patients, thus providing improved interventions, and to the general public for more informed health decision-making.

For the purpose of this report, education relates to academic programs designed to prepare scientists, academicians, practitioners, and other professionals. Outreach and engagement are functions of all public universities. In the Land-grant University system, Cooperative Extension provides one critical segment of this work. In general terms, outreach is a one-way approach taking knowledge from science to targeted audiences. In contrast, engagement is largely a convening function where educators bring together targeted audiences in communities to understand and apply science-based solutions to vexing local problems.

Goal

Improve the lab-to-community pipeline so that medical, public health, education, and Cooperative Extension professionals are well-prepared to use state-of-the-science food and nutrition recommendations to help their patients, clients, and the public improve their health and lessen the burden of chronic disease.

Objective 1

Forge partnerships with health care and public health professionals to enhance understanding of the role of nutrition and lifestyle strategies in improving health and lowering the risk of chronic disease.

- a. These groups may be accessed during their pre-licensure/pre-professional training and post-licensure for continuing education opportunities.
 - b. The focus of this education should be directed to 1) basic nutritional and lifestyle education and 2) strategies for distinguishing between ‘factual’ vs. ‘popular’ nutritional recommendations.
- **Outcome:** Health care professionals’ and policy makers’ knowledge of nutrition and lifestyle strategies, and how to integrate them into their work with clientele and policy development, respectively, is increased.
 - **Impact:** Health care professionals and policy makers understand nutrition and lifestyle strategies; they consistently seek opportunities to integrate the two when working with clients and developing policy.

Objective 2

Enhance the work of *Cooperative Extension’s National Framework for Health and Wellness* to further refine the role of Cooperative Extension in the following areas.

- a. Improve health literacy and the ability to obtain, understand, and act on health information and services.
 - **Outcome:** Health literacy among audiences engaged in education programs increases.
 - **Impact:** Audiences engaged in education programs make better health-related decisions.
- b. Improve health insurance literacy and individuals’ knowledge, ability, and confidence to find and evaluate information about health plans, select the best plan for their circumstances, and use the plan once enrolled.
 - **Outcome:** Health insurance literacy among audiences engaged in education programs increases.
 - **Impact:** Audiences engaged in education programs make better health insurance-related decisions.

d. Promote positive youth development toward a successful transition to adulthood marked by health and well-being, economic stability, social success, and civic engagement.

- **Outcome:** Positive youth development programs increase their emphasis on nutrition and lifestyle strategies; program participants have improved knowledge in these areas.
- **Impact:** Participants in positive youth development programs adopt healthier nutrition and lifestyle strategies.
 - e. Provide health policy issues education to inform and assist individuals and groups as they make decisions about the health issues that affect them and their communities.
- **Outcome:** Health policy education programs incorporate healthy nutrition and lifestyle strategies in a holistic approach to health policy development and implementation.
- **Impact:** Health policy developers and decision makers have a better understanding of healthy nutrition and lifestyle strategies and integrate them into policy development.

Objective 3

Build teams that link agricultural and health scientists across schools of medicine, nursing, public health, and human sciences to Cooperative Extension professionals to improve translation of science for the general public using culturally appropriate methods for rural and urban audiences.

- **Outcome:** Cooperative Extension education programs increase their engagement with faculty and academic staff in schools of medicine, nursing, public health, and human sciences.
- **Impact:** Educational programs delivered by Cooperative Extension integrate content from schools of medicine, nursing, public health, and human sciences.

Objective 4

Collaborate across academic colleges of agriculture, human sciences, medicine, nursing, and public health to develop curricula and other learning experiences that enhance workforce understanding of, and scientific skills related to, food and nutrition impacts on human health and chronic disease.

- **Outcome:** The number of college graduates with enhanced knowledge and scientific skills related to the impact of food systems on human health and chronic disease increases.
- **Impact:** Trained agricultural, human science, and health care leaders utilize food and nutrition to improve human health and reduce chronic disease.



Objective 5

Collaborate with veterinary medicine colleagues to improve understanding of the animal-human-environment health continuum through the ONE Health initiative.

- **Outcome:** Project teams collaborate with veterinary college colleagues to improve understanding of the animal-human-environment health continuum through the One Health initiative.
- **Impact:** Project teams include veterinary college colleagues and integrate concepts of the animal-human-environment health continuum through the One Health initiative for better care of humans and animals and reduction of zoonotic disease transmission.

IMPACT METRICS

Land-grant Universities, via their Cooperative Extension system, are capable of translating integrated research recommendations into community-based action along specific lines to achieve measurable outcomes. An example of this is provided by the North Central Cooperative Extension Association, with its annual report on community development impacts, registered in terms of policy-relevant variables such as jobs, dollars leveraged, and efficiencies gained. (For example reports, see http://ncrcrd.msu.edu/ncrcrd/state_extension_leader_section1). A parallel set of metrics should be established for this initiative's priorities related to human health and reduction of chronic disease.

FUNDING CONSIDERATIONS

The initiative outlined in this report requires development of new multidisciplinary and cross functional research, Cooperative Extension, and education programs that integrate efforts across agricultural, food, nutrition, and health care systems. Although a significant amount of work is currently being funded in the areas of agriculture, food, nutrition, and health care; little is being done to integrate these systems and explore their overall impact on human health and chronic disease. New investments of resources from federal, state, and local government agencies, as well as private industry, will be required to support and sustain this type of effort, particularly federal agencies that commonly fund work in these systems.

It is very important to the success of this initiative that multiple federal agencies invest in funding programs that encourage integration across agricultural, food, nutrition, and health care systems, and that congressional appropriations make this possible. Agencies such as USDA/National Institute for Food and Agriculture, USDA/Food and Nutrition Service, USDA/Agricultural Research Service, HHS/CDC/Chronic Disease Prevention and Health Promotion, HHS/NIH (multiple institutes), HHS/Food and Drug Administration, NSF/Directorate for Biological Sciences, and NSF/Directorate for Social, Behavioral, and Economic Sciences are potential funders. The majority of funds should be distributed competitively; however, a portion of formula driven funding will also be important to support long-term research, Cooperative Extension, and education programs. In addition, joint funding programs from multiple agencies, as well as those that require collaborations across agriculture, food, nutrition, and health care systems would facilitate integration.

PARTNERSHIPS

Partnerships in academia, industry, and government will all be critical to meet the goals and objectives listed above, as well as partnerships with public and private entities in public health, nutrition, physical activity, and the health care industry. Some examples of specific partners that may be beneficial to helping advance this initiative are listed below. This list is a compilation of suggestions from across agricultural systems, food, nutrition, and human health experts. This list is not all inclusive; additional partners should be considered as they are identified.

POTENTIAL PARTNER
INDUSTRY
<ul style="list-style-type: none">American Beverage Association Archer Daniels MidlandFood products companies (ex. Kellogg, PepsiCo, Nestle, Cargill) Food retailers (ex. Walmart, Kroger)Food service companies (ex. McDonalds, Subway) Medical/nutritional companies (ex. Abbott Labs) National Restaurant AssociationSnack Food Association

GOVERNMENT

- Agency for Healthcare Research and Quality
- Centers for Disease Control and Prevention
- Commonwealth Scientific and Industrial Research Organization (CSIRO) in Australia
- Crown Research Institute in New Zealand
- Department of Education Food and Drug Administration
- National Institutes of Health
- National Science Foundation Plant & Food Research Ltd
- State Departments of Public Health
- U.S. Department of Agriculture
- U.S. Department of Health and Human Services

ACADEMIA

- Alaskan Native Tribal Health Consortium
- Colleges of Agriculture, Human Sciences, Medicine, Nursing, Veterinary Medicine, etc.
- Institute of Nutrition and Functional Foods (INAF) in Quebec
- K-12 school systems
- Tribal Universities and Colleges

CONSUMER/NON-PROFIT ORGANIZATIONS

- Annie E. Casey Foundation
- Bill and Melinda Gates Foundation
- Center for Science in the Public Interest
- Consumer Federation of America
- Food and Agriculture Organization of the United Nations
- International Union of Nutrition and Health
- Medicines for Malaria
- National Childhood Obesity Foundation
- National Obesity Foundation
- Obesity Prevention Foundation
- Oldways Health through Heritage Program
- Robert Wood Johnson Foundation
- The Pew Charitable Trusts Venture
- W. K. Kellogg Foundation
- Wild Blueberry Association of North America
- World Bank
- World Health Organization

PROFESSIONAL ASSOCIATIONS

- Academy of Nutrition and Dietetics
- American Society of Animal Science
- American Academy of Nursing
- American Association of Behavioral and Social Sciences American
- Association of Cereal Chemists
- American Association of Horticultural Science
- American Heart Association
- American Medical Association
- American Public Health Association
- American Society for Nutrition
- American Veterinary Medical Association
- Crop Science Society of America
- Institute of Food Technologists International Life Science Institute
- International Social Marketing Association
- National Extension Association for Family and Consumer Sciences
- State Medical Associations

OTHER

- Cherokee Health Systems
- Community-based medical centers and hospitals
- Food Trust
- International Food Policy Research Institute

CONCLUSION

All over our nation and across the world people are suffering from a variety of chronic diseases and diminished health. Consumers face conflicting ideas on the best approach to healthy living when searching for ideal food and nutrition, as well as a myriad of choices when it comes to health care options. Experts in the agriculture, food, nutrition, and health care systems face similar conflicts when trying to design research, education and outreach programs to help improve human health. There is clearly a need for integrating across these diverse systems to address chronic diseases and improve human health.

With the involvement of academia, industry and government, professional associations, and non-profit organizations, the expertise is available to move this initiative forward. Bringing

public and private resources to bear, along with a commitment among these sectors to work as partners across the agriculture, food, nutrition, and health care systems, will assure the public that the United States is dedicated to improving human health and reducing chronic disease. Strategic partnerships coupled with appropriate funding opportunities will revolutionize the way we approach integration of agriculture, food, nutrition, and health care systems when looking for ways to solve human health issues.

GLOSSARY

Agricultural System – the integrated components and operations of producing food, feed and fiber raw materials from domesticated plants and animals.

Food System – the integrated components and operations of producing consumable food from plant and animal agricultural products for sustenance to satisfy biological and sociological needs and provide nutrients for maintaining human health.

Nutrition System – the integrated components and operations of providing essential nutrients; i.e. protein, carbohydrates, fat, fibers, vitamins and minerals; and other bioactive compounds, required to maintain human health and prevent chronic diseases.

Health Care System – all organizations, institutions and resources that are devoted to producing health actions. A health action is any effort, whether in personal health care, public health services or through inter-sectoral initiatives, whose primary purpose is to improve human health.

Bioactive Compounds – a consumed substance that has an effect on a living organism, tissue or cell distinguishable from essential nutrients.

Gut Microbiome – the collective genomes of the microbes (composed of bacteria, bacteriophage, fungi, protozoa and viruses) that live inside the human digestive system.

Biomarkers – a characteristic that is objectively measured and evaluated as an indicator of normal biological processes, pathogenic processes or pharmacological responses to a therapeutic intervention.

Food Accessibility – physical and economic access to sufficient, safe and nutritious food that meets dietary needs to maintain human health.

ONE Health Initiative – a movement to forge co-equal, all-inclusive collaborations between physicians, osteopathic physicians, veterinarians, dentists, nurses and other scientific-health and environmentally related disciplines, including the American Medical Association,

American Veterinary Medical Association, American Academy of Pediatrics, American Nurses Association, American Association of Public Health Physicians, American Society of Tropical Medicine and Hygiene, Centers for Disease Control and Prevention, Department of Agriculture, and National Environmental Health Association.

Systems Implementation Science – the study of methods to promote the integration of research findings and evidence into healthcare policy and practice at the system level. The intent of implementation science and related research is to investigate and address major bottlenecks (e.g. social, behavioral, economic, management) that impede effective implementation, test new approaches to improve health programming, as well as determine a causal relationship between the intervention and its impact.

Health – a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

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