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Perspectives

Linking Sustainable Agriculture and Public Health: Opportunities for Realizing Multiple Goals

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ABSTRACT

The realms of nutrition, public health, and sustainable agriculture have historically functioned as distinct, nonoverlapping disciplines. A simple analysis of farm production policy and dietary guidelines quickly illustrates this reality. However, it is increasingly clear that public health dietary guidelines around diet cannot be met without a simultaneous focus on sustainable agriculture and food production. This article explores the degree of disconnect between public health dietary guidelines and agricultural production. Building on this discordance, it presents a strategy for using a food system, rather than food supply, strategy for approaching public health nutritional goals for the American population and thus enhance our ability to develop sustainable food systems. This strategy brings other sectors of interest into the discussion—especially

partnerships in communities across the country. Two case studies—fruits/vegetables and dairy—are briefly presented to illustrate the opportunities.

KEYWORDS:

Sustainable food systems | economic development | community-based food systems | fruit and vegetable consumption

INTRODUCTION

To develop an analysis of what it means for domestic agriculture and dietary goals associated with public health to “find one another” it is necessary to view the moment both historically and globally. As we move through the 21st century, it is useful to consider our relationship to food. In the 20th century we moved from a nation of farmers to an urbanized nation, with little individual connection to the food production we rely upon on a daily basis and an ever increasing percentage of young people having no generational connection to farming. Thus, the medical and nutritional/public health fields typically focus on the product—the food supply—with little thought to the process, or food system, providing this food; neither the U.S. dietary guidelines[1] nor Healthy People 2010[2] move beyond sufficiency/excessiveness of different foods consumed by individuals. Such questions as where food comes from, sufficiency of production for all Americans, production practices, and labor treatment (either owner labor or hired labor) in producing the food are not considered.

However, several things are readily apparent if we look around the globe, consider alternative futures, and imagine the potential to significantly impact our food supply for generations to come. The first and most obvious is growth in global population. While there are currently about 6.6 billion people, it is projected this will grow to 8 billion by 2025 and 9.4 billion by 2050.[3] Over the same time span, the U.S. population will grow from our current 300 million to about 337 million. Using recommended U.S. consumption characteristics as our base of analysis, each of these people should consume about 1200 pounds of food per year,[4,5] excluding coffee, tea, soda, fats/oils, or sugars/sweeteners. Thus, every billion people added to the earth requires about 1.2

In addition, there are multiple effects of development on agricultural production and dietary standards, one typical change as a country develops and the standard of living increases is increased per capita meat consumption. The less vegetarian a person's diet, the more land required to produce their food. For example, using 1990 data and considering world grain production versus world grain requirements offers a striking picture.6 “Grain equivalent” is the grain effectively consumed by an individual that is either eaten directly or consumed by animals that are then consumed by humans. If the world ate like the average person in China, consuming about 300 kg per year of grain equivalents, we would have been awash in grain in 1990. If this continued with current production levels and projected population growth to 2030 we would still have plenty to feed everyone. However, if the world consumed like Americans (800 kg of grain equivalent per person per year), we would be well short of our needs by 2030 (assuming constant production). While the potential for a second green revolution with biotechnology producing a great abundance is possible, it seems less than prudent to develop a single strategy for producing a sufficient, healthy food supply for the future world's population.

In addition, these raw number needs do not account for the stress on water supplies from increased population, increased development, and increased need for agricultural production. The United Nations estimates that 48 countries are currently either water stressed or water scarce, with 6 additional countries added to this list by 2050.7 Thus, at the global level we are experiencing a marked increase in population and an increase in food dependence coupled with increasing scarcity of fresh water. While the United States as a nation is water sufficient, there are areas, for example, the Southwest, that are water stressed or water scarce. Some of these areas currently have high levels of agricultural production fundamentally based on massive importation of irrigation water.

This continuing increase in global demand accompanied by reasonable questions concerning global productivity gains can be placed in a U.S. domestic context. It is clear that at a time when we are concerned with our diet and its relationship to obesity and chronic disease, we are becoming more dependent on global supplies for our food. A study of vegetable sourcing indicates that we currently import over twice as many vegetables as we export—a balance of trade that continues to widen.8 This does not imply that we should close our borders to trade or that we should reduce our focus on developing fair food trade as a vehicle for development and livelihood enhancement in the developing world. It does imply that in many of these countries people still need

begs the question: Are we short-changing, future domestic food security through growing dependence on a distant food supply? Additionally, the American Farmland Trust[9] estimates currently that 86% of our fruit and vegetable production occurs on land that is under threat of development. Similarly, 63% of our dairy, 39% of our meat, and 35% of our grain is produced on lands under threat of development. In the 5-year period from 1992 to 1997, states like Illinois, Alabama, New York, Mississippi, and Arizona saw in excess of a 100% increase in their loss rate of prime agricultural land.[10] In other words, this phenomenon of productive land capacity loss is widespread across the country—it requires a national dialogue as well as a great deal of local action. We also have a declining base of farmers with a 17% farm number decline from 1974 to 1997 and an additional 4% loss between 1997 and 2002.[11] Should we continuously reduce our natural resource assets and human skill base for food production? Rather, does it make sense to ensure that we maintain the productive capacity of our landscape across the country for future generations?

From a dietary standpoint, this should be of great concern. It is clear that, excepting tobacco use, poor diet and physical inactivity are the leading causes of death in United States.[12] This implies that agriculture and public health are intimately connected. However, a recent report from USDA's Economic Research Service finds[13] that we would need to increase our fruit and vegetable production by approximately 13 million acres (based upon 2005 population) to produce sufficient quantities that would allow for full adoption of the Dietary Guidelines for Americans by the entire population. Therefore, from a food supply standpoint, our agricultural production is currently incapable of providing sufficient levels of fruits and vegetables for all to consume a healthy diet. We cannot have good public health without a good, healthy food supply; and, simply put, we cannot have a good, healthy food supply now and into the future without a sustainable food system that links preservation of our natural resources base and human skill base to provisioning a healthy diet for all Americans. As a corollary to this, we also know that we cannot have healthy people without a healthy economy or environment. The economy, the Earth's environment, and the food supply are all part of the biological and social environment in which American's exist.

CONCEPTUAL FRAME

Considering functional principles for health and sustainability now and into the future is a useful beginning:

1. The preservation and enhancement of our natural resources for future generations.
2. A healthy population with each person able to realize their potential, maintaining a quality standard of life as they mature and age.
3. A vibrant, sustainable economy that fits the 21st century.

This suggests a strategy—a strategy that links agricultural production, diet/public health, and economic development. This can be succinctly framed from the standpoint of community-based food systems. Community-based food systems can be thought of as collaborative efforts to build more locally based food systems and economies. They prioritize local resources and local markets, emphasize social equity and environmental sustainability, and rely on relationships among growers and eaters, retailers and distributors, processors and preparers of food within the community.[14] "When local agriculture and food production are integrated in community, food becomes part of a community's problem-solving capacity rather than just a commodity that's bought and sold."[14]

Focusing on relationships in communities is a good starting point for considering a sustainable food system. Framing the concept for healthy, livable communities around the 4 dimensions (see Figure 1) of health, environment, farming, and economics allows development of (1) health outcomes such as people maintaining a quality standard of life as they mature and age rather than focusing solely on disease treatment; (2) farming outcomes such as maintaining a diversity of viable farms across our landscape rather than accepting consolidation and loss as the accepted norm; (3) environmental outcomes that enhance our natural resource base for future generations, rather than degradation and the resultant need for restoration; and (4) economic outcomes that allows for vibrant urban and rural linked communities aided through networks of small business owners rather than deteriorating rural communities across our landscape.

FIGURE 1. Four Dimensions of Healthy, Livable Communities.

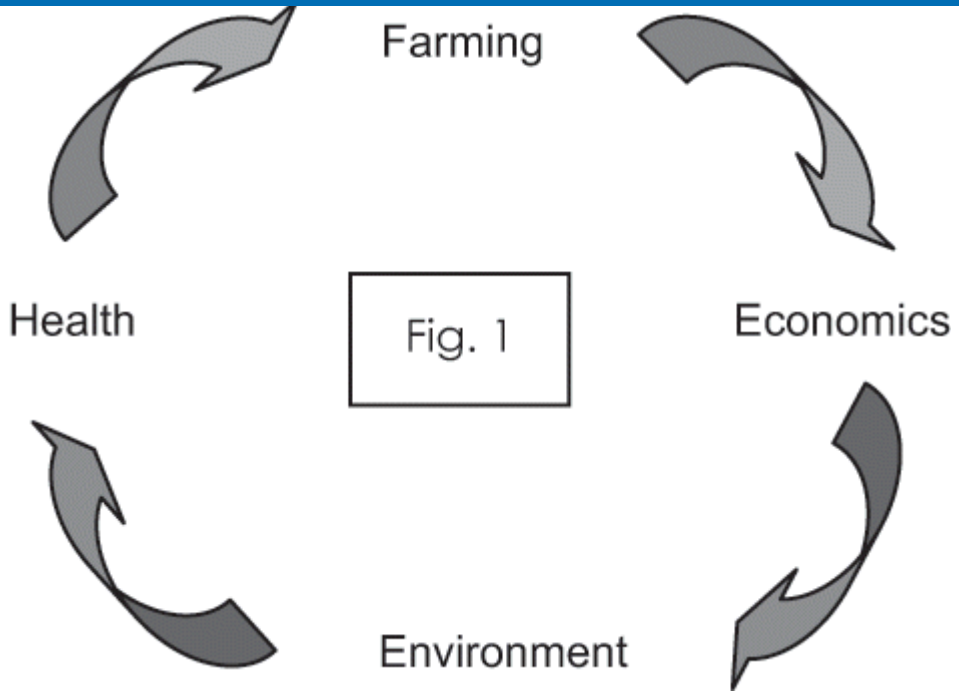

Fig. 1

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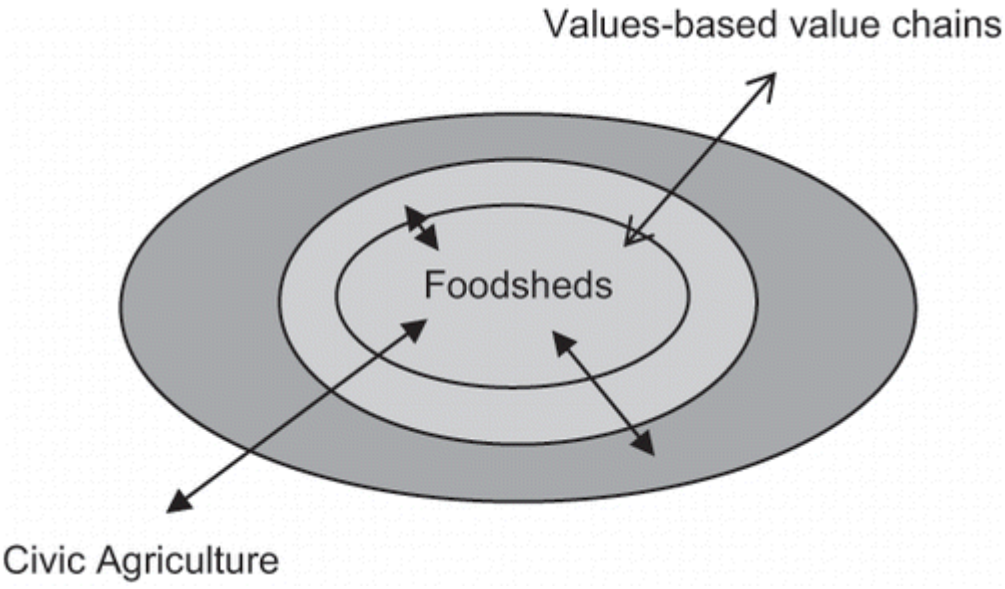
How would we incorporate the idea and practice of sustainability into this framing of healthy, livable communities? As we move toward greater sustainability in health, farming, economics, and the environment, we will continually identify shortfalls to our practices. Our precise notions of what sustainability is and is not continually evolves and develops and becomes more find-tuned. Ten years from now we will have more advanced precision to our concept of sustainability than we do today and 20 years from now it will further evolve. Sustainability is a process of improvement as well as a product of practices. As one farmer said in response to a question concerning their role in preserving the environment (paraphrasing), “Well, I think that I do a better job than my dad did 20 years ago. I use fewer pesticides, partly because it's more expensive now, and it costs me money to do it, but I do a better job and hopefully my kids will farm and they'll do a better job than I do” (M. W. Hamm and J. Bingen, unpublished data, 2004).

With this in mind, we can think of developing sustainable food systems as a matter of shifting, continually improving strategies—more/less not either/or: it is more localized rather than less, there is greater environmental sustainability rather than less, shorter food miles rather than longer, more control by individuals and communities rather than less, more knowledge among consumers rather than less, and more relationships among people in the food system rather than less. This does not mean that people get everything from a local place but it does mean that we triage our food supply in the

sourced locally? (2) If not, can a local substitute suffice? (3) If not, can a more distant source be used that incorporates the same environmental, social, and economic traits desired in the local?

How do we put this in a food system context and maintain a perspective regarding the volume of food required to feed a national population of 300 million people—about 360 billion pounds of food? There are 3 schools of thought in the literature that can be integrated to help conceptualize a vibrant, sustainable network of community-based food systems. Kloppenburg et al[15] have developed the “foodshed” concept (see Figure 2). While there are a number of facets to the concept, the spatial aspect is most critical to this analysis. Similar to the drainage area of a watershed, a foodshed is the area from which a people's food “drains.” In its simplest terms, it is a spatial relationship to our food system. In the context outlined above, a community would seek to reduce the drainage area of its food system.

FIGURE 2. Foodshed Concept.



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Layered upon this foodshed concept, Lyson[16] has introduced the concept of “civic agriculture,” with subsequent expansion of the concept by DeLind.[17] Again, simplifying for the sake of brevity, it is a concept that stresses food-focused relationship development between producers and consumers. That is, communities would seek to increase the amount of food secured through direct farmer–consumer relationships. A focus on decommodifying food through these relationships secures the potential of food

becoming a vehicle for problem-solving as a community; allowing the emergence of linkages among health, economic development, community development, and natural resource preservation for mutual resolution.

However, most consumers currently prefer to source most of their at-home food from grocery stores and supermarkets. Also, nearly 50% of consumer food dollars are spent on food consumed outside the home.[18] Extending the supply chain beyond the direct consumer–producer can utilize the concept of values-based value chains.[19] The conceptual intention is to maintain transparency in the supply chain in which values desired by consumers begin with the producer and are identity-preserved as they move to the consumer. In addition, the concept implies a greater degree of price-making by producers (for example, cost plus pricing), insuring a viable farm given sufficient markets. It is intended as a way to build more distant relationships between producers, consumers, and intermediaries involved in moving food from field to fork over the course of a year.

Linking the concepts of foodsheds, civic agriculture, and values-based value chains implies a dynamic relationship between self-provisioning (i.e., home and community gardens), direct market relationships (i.e., farmers' markets, farm stands, and CSAs), and indirect market relationships (i.e., retail markets, institutional food meals, restaurants) in a manner that maintains a consistent set of values. Also, it allows for reframing the food system in a community such that it does truly become part of the problem solving toolkit and reinforces diet-related public health efforts. However, if consumer demand does not exist or develop, then this is all an exercise in wishful thinking.

Several studies have investigated the desire and willingness of consumers in the marketplace. In addition, a number of companies and supply chains have emerged to provide selected food attributes to consumers. Although food from local sources need not necessarily be more expensive, consumers have indicated a willingness to pay a premium for a variety of preserved attributes in food, including place, organic, scale, environmental attributes, animal friendly/animal welfare, heritage breeds/varieties, and labor standards. It is useful to consider where consumers may be moving in the near future as an indicator of strategies to link with public health needs. A number of groups have surveyed consumer attitudes toward a host of food/environment related themes; for example, attitudes toward local and family farm support.[20,21] While there is

and often find it difficult to do another—surveys are consistent on a significant cohort of consumers willing to pay more for food with desired attributes. In one survey,[20] 71% of consumers indicated a willingness to pay more for food grown locally, 71% indicated a willingness to pay more for food if it could be produced in ways that protected the environment, 77% thought government policy should be oriented toward helping family owned or operated farms, and 59% thought the family farms should be supported even if it meant higher food prices.

The preceding frames a strategy of linking food-related public health goals and agricultural production within community-based food systems and serves to lay the basis for two case studies derived from Michigan. These identify opportunities to link agricultural production opportunities directly to dietary guidance and public health issues while also incorporating notions of community and economic development and environmental sustainability. The first of these concern fresh fruit and vegetable production and consumption.

Case Study—Fruits and Vegetables

Consider two views of the apple. First, an apple is an apple is an apple; second, an apple is different depending on where it was grown relative to its consumption point, how it was grown, and/or who grew it. From the standpoint of a sufficient food supply, at the current moment in history, the first consideration of an apple will probably suffice. The overall goal of public health campaigns is typically conceived of, for example, as the consumption of recommended levels of fruits and vegetables. However, consumption patterns fall far short of this.[22] People consuming an average 2000-calorie diet need to increase their fruit consumption 132% and vegetable consumption overall by 31%. Subgroups of vegetables are more disparate from recommended levels: legumes would need to be increased by 431%, orange vegetables by 183%; dark green vegetables by 175%; and starchy vegetables would be decreased by 35%.

This is coupled with the fact that we increasingly rely on imports for both our fresh fruits and fresh vegetables. In 2003, the ratio of fresh vegetables imported to those exported was about 2.25. As cited earlier, recent data indicate over 13 million more acres of required production to meet public health goals for fruits and vegetables from domestic sources,[13] equivalent to the current production of 3 California's. Thus, two

a healthy diet and, second, those we do consume are increasingly from nondomestic sources.

In addition, we are just beginning to develop an understanding of the potential to modify dietary attributes in individual foods through production strategies and varietal selection. If we linked agricultural production with dietary guidance, we could begin to target both the quality and quantity of consumption. Asami et al[23] reported a 10% to 40% increase in total plant polyphenols in organically and sustainably produced crops relative to those conventionally produced. An even greater potential for impacting the nutritional quality of crops may be through variety selection. Genotypic variation within particular crops has been identified as a feasible tool for improving levels of beneficial phytochemicals.[24] One study[25] reported up to an 8-fold difference in glucosinolate concentrations (an abundant phytochemical in broccoli connected to reducing risk of certain cancers in humans) across 32 varieties of broccoli. Indications are that we can link increased levels of beneficial phytochemicals through production and selection strategies.

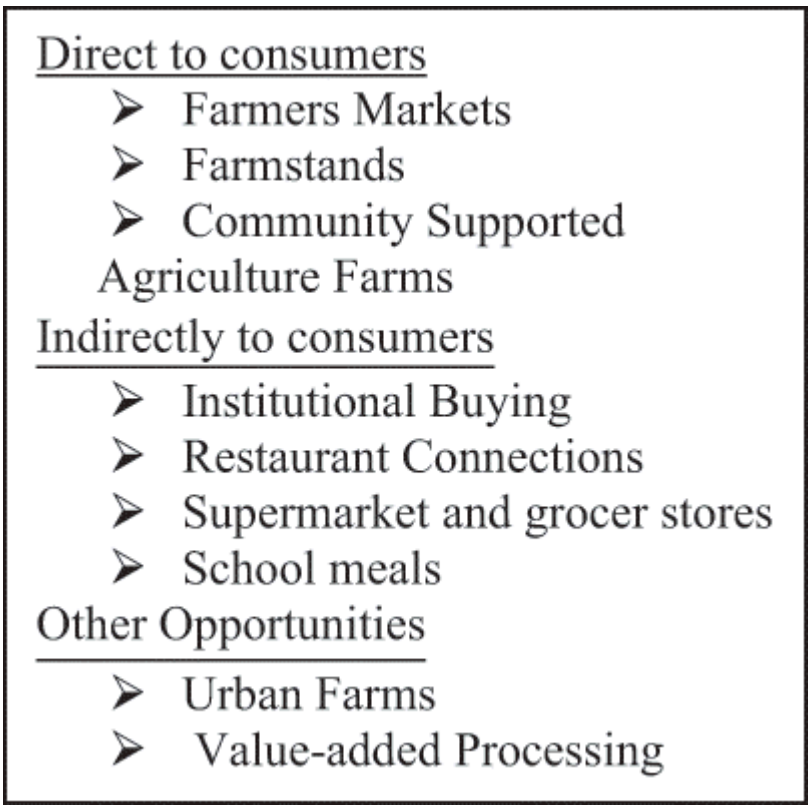
We are also beginning to develop an understanding of strategies to enhance agriculture's utility as an economic development tool for place-based development in communities across the country. We can approach such concepts by asking scenario questions such as “What would it mean to small business and job creation across the country if production and consumption were linked locally to achieve dietary guidance public health goals?” Cantrell et al[26] investigated Michigan fruit and vegetable production. Historically, Michigan fruits and vegetables have been marketed predominately to the processing sector with 74% of fruits and 44% of vegetables grown sold for processing. Making some assumptions about market changes, we identified that a shift to fresh direct and wholesale markets would increase farmer net income by up to $164 million, resulting in an additional 1900 new jobs in Michigan's economy simply due to the fact that farmers have more money in their pockets to spend in their communities.

Investigators at Iowa State University[27] looked at the potential for creating jobs in Iowa through increased production and consumption of fruits and vegetables. They developed scenarios in which changes in local production and consumption of 37 fruits and vegetables were modeled. In this scenario, 25% of current consumption of these 37 fruits and vegetables were shifted to being grown in Iowa and direct marketed,

wholesale marketed, net job production drops to about 1200. These two scenarios reflected a shift in current consumption from distant sourcing to local sourcing. If consumption were increased and all Iowans consumed 5 servings of fruits and vegetables a day, with all the other assumptions kept constant, new job development would increase to 4000; an increase to 7 servings per day would result in approximately 5600 new jobs. A reasonable conclusion from these studies is not the absolute number of new jobs but rather the suggested link between job creation, the development of agriculture as a viable business for individuals and families, and the provisioning of a diet that meets current dietary guidelines.

Then we might ask ourselves the question: What are ways to develop linkages between producers and consumers such that agricultural production was linked to a healthy diet. Figure 3 indicates a number of strategies for these linkages. Farmers markets and other direct market strategies receive a great deal of emphasis but probably have limitations in their ultimate ability to deliver a large percentage of a family's dietary needs. Also, consumers appear to largely prefer accessing their at-home food from grocery stores and supermarkets.[21] Thus, indirect market strategies, with imbedded value chains, are an important component in the full mix of opportunities.

FIGURE 3. Strategies for Linking Producers to Consumers.



One strategy gaining credibility and credence across the country is working with K-12 school meal programs to develop farm to school linkages. Farm-to-school is thought of as any program that promotes and encourages the utilization of locally produced foods in school cafeterias while providing farmers with market opportunities. In essence, the concept is to forge closer linkages between schools and farms and between our nation's youth and our nation's farmers. We have investigated the interest of food service directors in such sourcing within Michigan.[28] Three hundred of 684 school food service directors indicated that they would be interested in purchasing food directly from a local producer if pricing and quality were competitive and a source was available (73% of those responding). If their vendor or the state warehouse distributor offered it as part of the contract services, the positive response rate increased to 83% of respondents. Food service directors indicated an interest in purchasing fruits and vegetables as well as animal products. A survey of Oklahoma food service directors[29] indicated similar response rates to these types of questions.

It is thus clear that there is potential to link the provisioning of sufficient levels of fruits and vegetables for all of America's population with the production of those crops as an economic development tool for communities across the country; an additional 13–14 million acres of fruit and vegetables spread across 50 states provides a lot of opportunity. This has the simultaneous capacity to help increase the economic vitality of both rural and urban communities while providing economic and public health incentives for preserving the productive capacity (land and water as well as human skills) for future generations. Fruit and vegetables are only one component of our diet. While analyzing all components is beyond the scope of this article, one additional case study with animal products may be useful.

Case Study—Dairy Production

Dairy production is an interesting consideration because, like fruits and vegetables, the general population consumption is well short of recommended levels; there have also been significant shifts in production strategies over the last several decades. Since the mid-1970s the average person has consumed more gallons of carbonated soft drinks per year than beverage milk.[30] Given that the average American consumes about 45% of their dietary calcium from fluid milk and another 17% from cheese, this is of concern.[31] It's estimated that we consume approximately 46% less from the dairy group than required for an optimal diet.[32]

Recognizing that, on average, 62% of the population's dietary calcium comes from dairy products, we can explore the potential for new farm development and potential benefits of certain types of new farming operations by linking dietary public health goals with dairy agriculture. Assuming that existing milk production in Michigan continues to be distributed as it currently is, Michigan's 10 million people would require 2.1 billion pounds of additional milk if 100% of our unmet calcium needs came from dairy products or 1.3 billion pounds to meet 62% of the unmet needs. This would require the production from an extra 94,000 cows at 22,000 pounds annual production per cow[33] (58,000 for meeting 62% of unmet need) or 137,000 cows at 15,000 pounds annual production per cow[34] (85,000 for meeting 62% of unmet need). A typical grain-based dairy cow produces about 22,000 pounds of milk and a typical pasture-based cow produces about 15,000 pounds of milk annually. In 2002 the average Michigan dairy farm size was about 90 cows.[35] Thus, if developed as grain-based dairies, this would require from 650 to 1050 more average-sized dairy farms across Michigan. If they were pasture-based dairies, this would required 950–1520 average size farms across Michigan. This represents an opportunity to consciously consider catalyzing new farms to improve the health of America's population.

Why might this be important? What might different production strategies mean to maximize environmental attributes in our production systems while preserving future landscape production potential? The dominant form of dairy production today is grain based. That is, the primary feed is a balanced formulation heavily based on corn and soybeans. Michigan had approximately 8 million acres of cropland; 2.1 million acres of soybeans, and 2 million acres of corn for grain in 2002.[33] (This is prior to the current focus on corn-based ethanol production.) An analysis of pesticide usage indicates that approximately 3 pounds of total pesticides were used per acre of corn produced (1997 Michigan data);[36] the comparable figure for pasture is 0.078 (Michigan data) or approximately 2.7% as much. Therefore, linking enhanced dairy consumption to pasture-based dairy production could result in both an increased dietary quality for consumers and a strategy for reducing total pesticide inputs on our landscapes.

Consider soil erosion. A study of the lower Minnesota River watershed[37] investigated the effect of rain events on erosion in grass pastures and conventional cornfields; a single severe rain event resulted in 52 pounds of sediment per acre erosion from grazed pasture dairy lands, while adjacent lands producing corn and soybeans showed erosion rates of 20,000 pounds per acre (384 times as much), and those under

much). In other words, grass-based production dairy has the potential both to markedly reduce erosion on certain landscapes as well as reduce pesticide load in the environment. This implies that coupling food-related public health needs to production agriculture can also be seen as a tool for encouraging a greater mix of production strategies that can help preserve our natural resource assets for future generations.

Finally, several studies have investigated the startup and production costs of grass-based relative to grain-based dairies. The bulk of the data indicates that pasture-based dairies are less expensive to capitalize and operate, with greater returns per cow and per hundredweight of milk. In one study, investigators compared a 250-cow grass-based dairy and a 1,000-cow grain-based dairy.[35–40] They reported facilities, equipment, and machinery costs of about $670 per cow with total investment of about $4,000 per cow in the pasture-based system; the grain-based dairy had facilities, equipment, and machinery costs of $1,895 per cow and total investment of $5,500 per cow. Investigators also estimated lower ownership costs both per cow ($241 versus $429) and per hundredweight of milk produced ($1.61 versus $1.95, at 15,000 and 22,000 pounds of milk sold, respectively). Another study of dairies in 4 states demonstrated increased profit per cow and per hundredweight of milk in the pasture-based dairies.[41] A literature review of the economic, social, and environmental differences between grain-based and pasture-based dairies is available.[42]

There is great potential to link dairy needs from a public health perspective with production opportunities to the benefit of both while also enabling new business formation across the country. Furthermore, it is clear that this could be utilized as a strategy, in part, to strengthen diversity of production strategies and further strengthen our ability to preserve natural resources for our children's children.

SUMMARY

It is reasonable to argue that achieving either national public health goals or preservation of our natural resources is increasingly difficult as isolated goals. There is, however, ample evidence to indicate the potential for synergistic benefits through linkage of these goals. In addition, there is evidence for community economic development potential embedded in this beneficial linkage. In other words, shifting from a focus on the food supply to a focus on enhancing sustainability of the food

linking the realms of public health, sustainable agriculture, environmental stewardship, and economic development. The issue does not really seem to be one of “if” there is potential but rather what degree of creativity can be brought to the task of maximizing the opportunity.

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