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Considerations for Exploring Livestock as a Nutrition Intervention in the Rural United States

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Residents of rural communities in the United States typically have poor access to high-quality protein. Internationally, livestock nutrition intervention programs have been successful at increasing access to high-quality dietary protein in rural areas; however, these programs have not been largely explored in the rural United States. Given its lack of support facilities, availability of land, lack of zoning restrictions, and economic struggles, the rural United States is an ideal setting to pursue a livestock nutrition intervention project. What, then, would it take to establish an intervention? A number of community and livestock-related considerations need to be addressed in preparation for a livestock nutrition intervention in a rural community in the United States. Four examples of livestock are discussed.

KEYWORDS *rural communities, food security, nutrition intervention, livestock, rural United States, sustainable agriculture*

INTRODUCTION

Communities in rural America typically face higher food prices and poorer access to food than communities in metro areas.^{1,2} Approximately 15% of rural America, more than 7.5 million rural Americans, are food insecure.

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A large proportion of the 803 food desert counties in the United States are in rural areas.^{2,3} Some suggest that food assistance has been relatively ineffective at reducing hunger and may even be a factor contributing to obesity.^{4–6} Community gardening and other food self-reliance projects related to fresh fruit and vegetable access have been explored in urban and rural areas in the United States and Canada.^{7–9} The purpose of this article is 2-fold: to (1) substantiate the need to explore livestock nutrition interventions in the rural United States and (2) offer considerations for embarking on a livestock nutrition intervention project.

Multiple factors are contributing to high levels of food insecurity, obesity, and diet-related chronic illness in rural America. Researchers have shown that the rural food environment does impact food security and suggest that food insecurity in rural communities needs to be addressed at the community level rather than on the household level.¹⁰ Interventions therefore may need to be broader in scope and focus on the local system rather than on individual diets. In terms of the food environment, affordable foods that are most available in the rural United States are minimally nutritious and more healthful foods tend to be more expensive than they are in average urban supermarkets.^{1,11} In both metro and nonmetro communities, food stamp usage and hunger are associated with obesity and nutrition-related health problems.^{4,5} Furthermore, due to logistical challenges such as lack of transportation and other community infrastructure, rural America also has a lack of support resources and facilities to address hunger and food insecurity.^{1,2,12}

Given the persistence and complexity of the chronic food and nutrition-related issues facing rural America, there has been a call for multifaceted and innovative nutrition interventions to address rural food deserts.^{2,13} Home gardening and community gardening have been innovative methods of increasing fruit and vegetable access in a variety of communities domestically and internationally with mixed results.^{7–9,14} Domestically, little time has been devoted to increasing access to high-quality dietary protein. Incorporating more quality animal protein into the diet may alleviate risk of micronutrient deficiency more efficiently than a diet without animal products.¹⁵ For example, vitamin B-12, riboflavin, calcium, iron, and zinc can be low in vegetarian diets.¹⁵

Though fast food and convenience store protein sources are typically complete, they are highly processed and contain excessive amounts of sodium, saturated fat, and preservatives.^{16,17} Contrary to popular opinion, it is processed meat rather than red meat per se that is associated with higher incidence of coronary heart disease and type 2 diabetes and stomach cancer.^{18–20} Ironically, the majority of manufacturing jobs accessible to rural Americans are in meat processing facilities.²¹ Given that the primary affordable protein source at most food access points for rural communities is processed meat and that most innovative nutrition interventions have

primarily addressed fruit and vegetable consumption, avenues to improve dietary protein quality in rural America should be explored.

The model that Heifer Project International (HPI) has created for addressing food insecurity in communities internationally seems to be worth greater domestic consideration. HPI has regularly demonstrated in developing countries throughout the world that adding livestock to rural communities can sustainably improve nutrition and economic viability.²² In regards to HPI, Pelant et al²² stated that more than 20 different kinds of food and income-producing animals have been provided for communities and families in over 110 countries worldwide. Annually, HPI has projects in approximately 40 countries. Intensive training in animal husbandry, environmentally sound animal agriculture practices, and community development are all part of HPI's program. HPI has had a long history with using small ruminants, from sheep and goats to llamas and alpacas, around the world.²² Though livestock have played a major role in enhancing nutrition and quality of life in developing nations, few attempts have been made to explore livestock as a nutrition intervention in the United States.²³ If managed properly, ruminants such as cattle, sheep, and goats can enhance an ecosystem while also converting inedible forage to high-quality complete protein for human consumption.²⁴ In addition to ecological benefits, Pelant et al suggested that there are also unquantifiable societal benefits created through responsible animal husbandry and the resulting relationship between livestock human nutrition, health, and development.²²

CHARACTERISTICS OF A LIVESTOCK NUTRITION INTERVENTION IN THE RURAL UNITED STATES

For this article we examined a variety of literature on 14 different agricultural aspects of establishing a livestock nutrition intervention in order to provide a starting point for organizations that might be interested in mobilizing community resources to address rural hunger in this way. We look at what is needed for interventions that might involve rabbits, meat chickens, dairy goats, or hogs in terms of land, infrastructure, labor, and resources and questions that would need to be addressed such as differences in feed needs, harvest characteristics, and animal care. We leave for another paper a discussion of the community organizing or household grants that would be needed to implement such an intervention. But we envision interventions that could facilitate household-level animal husbandry (with training as needed) such as those implemented successfully with the HPI model. In this model, HPI provides gifts of livestock and training, allowing families and communities to improve their nutrition and generate sustainable income. Families who receive livestock agree to give one offspring of a gift animal to another family in need.²⁵ HPI has implemented numerous projects in a sustainable manner overseas

for over half a century and funded similar projects in the United States, though not on a large scale.^{25,26}

Funding a Livestock Nutrition Intervention in the United States

Annual food stamp expenditures have increased every year since 2000 and reached an all-time high of nearly \$25 billion in fiscal year 2007.²⁷ Using these figures, just one tenth of 1% of annual food stamp expenditures could fund approximately 100 livestock nutrition self-reliance projects in the United States, assuming an approximate startup cost of \$250 000. Initial startup funds for a livestock nutrition intervention can be obtained through a combination of sources including public funding, nonprofits, area businesses, and national foundations. Grants for food security projects have commonly been provided through the National Institute of Food and Agriculture's (NIFA) Community Food Projects Competitive Grants Program (CFPCGP). CFPCGP grants annually provide one-time awards of up to \$300 000 funding 1- to 3-year projects. CFPCGP grants aim to promote self-sufficiency and food security in low-income communities through community food projects (CFP) and training and technical assistance projects. CFPCGP grants do require dollar for dollar matching with the exception of training and technical assistance projects.²⁸ 4-H Youth Development is also funded through NIFA and provides small grants for youth development and training while fostering civic engagement in young people.²⁹ The Sustainable Agriculture and Research Education (SARE) program of the US Department of Agriculture (USDA) funds projects that involve research and education of sustainable agriculture-related issues. Three livestock nutrition intervention issues that SARE funds could address include pastured livestock/rotational grazing; marketing; and building sustainable communities.³⁰

Livestock-Related Considerations

The underlying concept of a livestock nutrition project would be to match a particular animal or animals to a particular community with the intention of improving nutrition while enhancing the ecosystem in an economically viable manner that builds social capital and strengthens civic structure in rural communities in the United States. Ideally, a project would be designed to enable a community to enhance its natural resource base through good animal husbandry practices while improving the overall well-being of its population. Ikerd suggested that for a rural community's development process to be sustainable, it must fully realize the value of geographically fixed resources. These resources represent the link between developmental purpose and place.³¹ Therefore, when choosing appropriate livestock for a community, a thorough understanding of geography and natural resources

is necessary to achieve sustainability for a project. [Tables 1–9](#) provide information about the variety of geographic and natural resource considerations that are necessary for planning projects around representative livestock.

METHODS AND BACKGROUND

The research for this article sought first to identify the agricultural considerations that an effective livestock nutrition intervention would need to address and then to review a variety of literature in order to provide guidance for the requirements of each of the 4 animal protein sources under investigation: meat rabbits,^{33–40} broiler chickens,^{41–47} dairy goats,^{48–52} and hogs.^{52–66} Fourteen livestock considerations were identified through a total of 12 unstructured interviews with farmers, ranchers, farm educators, nutritionists, public health professionals, animal and range scientists, and Extension specialists. Cooperative Extension publications from varying states provided key information, as did Appropriate Technology Transfer for Rural Areas (ATTRA) and National Center for Appropriate Technology (NCAT) and the USDA. This limited number of interviews served to frame a much more extensive examination of current literature. Other information was obtained from various agriculture-focused nonprofit agencies, journal articles, conference proceedings, and book resources on small-scale or subsistence agriculture. The resulting tables represent a synthesis of the most

TABLE 1 Land Use Considerations for a Livestock Nutrition Intervention^a

Meat rabbit	Broiler chicken	Dairy goat	Hog
Stocking density: 2.4 ft ² /rabbit in pasture pen Management: MIG Rotation: Daily Ideal rest ^a : Varies depending on annual distribution of precipitation Beginning numbers: 20 does, 3 bucks	Stocking density: 1.5 ft ² /bird in pasture pen; up to 1000 birds (in smaller flocks) on 1 acre Management: MIG Rotation: Daily depending on annual distribution of precipitation Beginning numbers: 250–500 birds	Stocking density: ^b Dependent on several variables Management: MIG Rotation: When forage is below 4 inches Ideal rest: Varies depending on annual distribution of precipitation Beginning numbers: 20 or fewer producing does	Stocking density: Pasture Feeder pigs: 1/4 acre paddock/30–50 pigs Sows: 8–11 farrowing pens/acre Indoor Piglet to weaners: 16 ft ² /pig Weaners to finished: 40 ft ² /pig Farrowing sow: 40 ft ² /pig Management: MIG Rotation: 2–3 days (1/4 acre paddocks) Ideal rest: Varies depending on annual distribution of precipitation Beginning numbers: 10–15 acres/100 pigs

^aMIG indicates management intensive grazing, a labor-intensive method of managing livestock systems that has been shown to be beneficial to animal health and land fertility.

^bStocking density for dairy goats and ideal rest for all livestock require consideration of many site-dependent variables. For more specific guidance.³²

TABLE 2 Infrastructure Considerations for a Livestock Nutrition Intervention

Meat rabbit	Broiler chicken	Dairy goat	Hog
Housing: Pasture pens; hutches; breeding cages or pens Cost: Low; recycled materials Construction: Can build one pen in half-day Feeders: Metal top-load feeders Water: Nipple waterers most sanitary; automatic waterers reduce labor Fencing: Electric netting surrounding pens may mitigate predation Other: Tattoo gun; winter lighting; isolation area for sick rabbits; guard dog(s)	Housing: Pasture pens; pasture hoophouse; brooder house (heating and lighting) Cost: Low–moderate; recycled materials Construction: Can build one pen in half-day; brooder house should be well ventilated and insulated—size/difficulty dependent on flock size and available housing Feeders: Metal top-load feeders Water: Automatic waterers reduce labor Fencing: Electric netting for pastured hoophouses Other: Guard dog(s)	Housing: Milking parlor (herds greater than 50); winter barn Cost: Moderate–high, pending herd size; recycled materials for barn Construction: Several-month building project for barn and parlor—size/difficulty dependent on herd size and available housing Feeders: Bin for grain and minerals Water: Automatic waterers reduce labor and protect water supply Fencing: Four-foot barbed wire most effective for permanent; electric netting for paddock division Other: ID system; guard dog(s)	Housing: Portable hog huts; farrowing huts/pens; winter barn Cost: Low-moderate; recycled materials for barn Construction: Hog huts typically purchased but can be built in half-day; barn is 1- to 2-month building project—size and difficulty dependent on herd size and available housing. Barn should be well ventilated and dry Feeders: Feeding troughs Water: Automatic waterers reduce labor Fencing: Four-foot barbed wire with high-tensile, charged line 1–2 ft above ground; electric netting for paddock division Other: Holding pens for hogs ready for harvest

TABLE 3 Time/Labor Considerations for a Livestock Nutrition Intervention

Meat rabbit	Broiler chicken	Dairy goat	Hog
Labor: Very intensive Type: Daily pasture rotation Feed/water 1–2 times per day Extensive recordkeeping; breeding; harvest/processing Time: 200 hours per year for 20 does	Labor: Intensive Type: Daily pasture rotation; feed/water 1–2 times daily; harvest/processing Time: N/A	Labor: Very intensive Type: Herd/pasture management; milking 2 times/day; breeding Time: 1.5 FTE per 100 does	Labor: Intensive Type: Herd/pasture management; farrowing management; feed 2 times daily; harvest/processing (when applicable); sanitation/barn management (when applicable) Time: N/A Other: Producer labor is more physically demanding than with smaller livestock

TABLE 4 Breeding Considerations for a Livestock Nutrition Intervention^a

Meat rabbit	Broiler chicken	Dairy goat	Hog
Starting: Visit breeder, start with good stock Breeding age: 4–6 months Estrous cycle: N/A Gestation: 31 days Offspring: 8 kits/litter Productive life: 2 years Breeding cycle: Yearround; 6–9 litters/year; every 14–21 days Mating: 1 buck: 8–10 does Other: Breeding is crucial for food production and profit	Starting: Purchase chicks from hatchery Breeding age: N/A Estrous cycle: N/A Gestation: N/A Offspring: N/A Productive life: N/A Breeding cycle: Purchase every 4–5 weeks to stagger production Mating: Most common to purchase baby chicks from hatchery Other: Seasonal operation; warmer months	Starting: Visit breeder, start with good stock Breeding age: Yearlings Estrous cycle: 18–22 days Gestation: 21 weeks Offspring: 1–3 kids/birth Productive life: 7–8 years Breeding cycle: Fall breeding; spring breeding possible but with decreased productivity Mating: 1 buck: 50 does; A.I. more common Other: Production, milk composition, disease/parasite risk differs greatly among breeds	Starting: Visit breeder, start with good stock Breeding age: 5–8 months Estrous cycle: 21 days Gestation: 16 Weeks Offspring: 9 piglets/litter Productive life: 8–9 years Breeding cycle: Yearround; 2 litters/year Mating: A.I. more common Other: Farrowing management very labor intensive

^aA.I. indicates artificial insemination, a common breeding practice among livestock producers.

TABLE 5 Feed and Nutrition Considerations for a Livestock Nutrition Intervention^a

Meat rabbit	Broiler chicken	Dairy goat	Hog
Diet: Nonruminant herbivore Primary nutrition: Alfalfa/cereal mix or commercial rabbit pellets Alternative nutrition: Root vegetables; leafy greens; legumes Average daily requirement: $\frac{1}{4}$ – $\frac{3}{4}$ lbs Forage: Up to 40% of diet Protein requirement: 16%–17% of diet Minerals: Cobalt, copper, iodine, iron, manganese, salt, zinc FCR (lbs): 3:1 Economics: Can reduce pellet use by 50% by incorporating root vegetables, greens, legumes Other: Can enhance meat flavor by feeding herbs (ie, rosemary) one week before harvest	Diet: Omnivore Primary nutrition: Corn, wheat, oats, barley, soybeans, fishmeal Alternative nutrition: Leafy greens; insects; food scraps Average daily requirement: $\frac{1}{4}$ – $\frac{1}{3}$ lbs Forage: Up to 10% of diet Protein requirement: 20% of diet Minerals: Cobalt, copper, iodine, iron, manganese, zinc FCR (lbs): 2.92:1 (Rainbow broiler) 2.45:1 (Cornish X) Economics: Most expensive aspect of raising broilers Other: Rainbow broilers have less efficient FCR but lower mortality rates and are more efficient foragers	Diet: Ruminant herbivore Primary nutrition: High-quality forage, oats, corn, wheat, barley, buckwheat Alternative nutrition: Can be fed 100% forage and browse plants if high quality (production will slightly decrease); vegetable scraps Average daily requirement: 6–8 lbs Forage: 70% from forage and browsing; prefer woody plants to forage (30% from grain) Protein req.: 10%–12% of diet Minerals: Calcium, phosphorus, salt, selenium FCR (lbs): 1.26:1 Economics: High-quality forage essential to optimal production Other: FCR changes significantly with age, lactation cycles, season, breed; general guideline for FCR is 1/3 lb of grain for each pound of milk over 3.3 lbs/day	Diet: Omnivore Primary nutrition: Corn, alfalfa, soy Alternative nutrition: Food scraps; root vegetables; “hogging off” field crops Average daily requirement: 5 lbs Forage: Up to 25% of diet Protein requirement: 14%–18% of diet Minerals: Calcium, copper, iodine, iron, magnesium, manganese, phosphorus, potassium, salt, selenium, zinc FCR (lbs): 3.28:1 Economics: Up to 60%–70% of production cost Other: Many opportunities for feed innovation

^aFCR indicates feed conversion ratio, an animal’s efficiency at converting feed mass into live body mass.

TABLE 6 Harvest/Slaughter and Processing Considerations for a Livestock Nutrition Intervention^a

Meat rabbit	Broiler chicken	Dairy goat	Hog
Equipment: Low–moderate cost (scale dependent) Skill: Moderate Labor: 2 people can slaughter/process 10–12 rabbits per hour with right equipment Amount required for processing: Minimal; consumed and sold whole Other: Slaughter equipment largely influenced by end use of carcass—consumption or market? If intending for market, research should be conducted on local regulations	Equipment: Low–moderate cost (scale dependent) Skill: Moderate Labor: 2 people can slaughter/process 15 birds per hour with right equipment Amount required for processing: Minimal; consumed and sold whole Other: Slaughter equipment largely influenced by end use of carcass—consumption or market? Some areas have mobile slaughter/processing units that are USDA-approved	Equipment: Low–high cost (scale dependent); milking machine more economical with herds of 20+ goats Skill: Moderate–high Labor: Milk 2 times/day, 7 days a week, 8–10 months/year; gerding goats in and out for very milking; hand-milking is about 7–15 minutes per goat with several variables Amount required for processing: Minimal if consuming raw; extensive if selling or converting to cheese/yogurt Other: Teat sanitation is crucial step for safety; pasteurization and processing required for market milk; self-processing is equipment and labor intensive and may be more economical to sell to processor; raw milk and value-added other niche market possibilities	Equipment: Low–high cost (scale dependent) Skill: High Labor: 2–3 experienced people; time varies Amount required for processing: Extensive; influenced by carcass use Other: Slaughter equipment largely influenced by end use of carcass—consumption or market? Hog meat is very versatile; market meat should be slaughtered/processed at USDA facility

^aUSDA indicates US Department of Agriculture.

consistent information. It should be noted that certain numbers such as feed conversion ratio (FCR) can have a range of results because they are influenced by numerous independent variables.

RESULTS

In interviews, community considerations came to light that we do not address here beyond recognizing their importance to the design of a livestock nutrition intervention: land available for public use, climate, geography, natural resources/features, cultural preferences, population demographic, population density, diet-related health problems, and desire/ability to learn.

TABLE 7 Average Daily Protein Yield and Harvest Age Considerations for a Livestock Nutrition Intervention^a

Meat rabbit	Broiler chicken	Dairy goat	Hog
Daily protein yield: Per animal: 61 g; Per AU: 610 g	Daily protein yield: Per animal: 3.6 g; Per AU: 514 g	Daily protein yield: Per animal: 97 g; Per AU: 571 g	Daily protein yield: Per animal: 47 g; Per AU: 191 g
Harvest age: Confined: 8 weeks; Pasture: 10–12 weeks	Harvest age: Confined: 6–8 weeks; Pasture: 8–11 weeks	Harvest age: Confined: 20–24 months; Pasture: 20–24 months	Harvest age: Confined: 22–26 weeks; Pasture: 28–32 weeks
		*Dairy goats bred as spring yearlings will begin lactation at 20–24 months	

^aAU indicates animal unit, approximately 1000 lbs of a livestock species. Average daily protein yield refers to how much protein an animal or AU can provide on a daily basis. An approximate AU value was obtained by dividing an animal's adult weight by 1000. Nutrition information was obtained using the US Department of Agriculture's Nutrient Database.⁶⁷ For meat rabbits, this number seems disproportionately high when compared to other species' protein yields for 3 reasons: (1) the rabbit's small AU factor results in a high multiplier (100) to achieve one AU; (2) the breeding doe is, in essence, multiplying itself 49 times per year; (3) the breeding doe's offspring were not counted toward the AU factor for the purpose of this specific calculation because they are seen as the dairy goat's milk yield—protein. This formula was derived strictly for the purpose of calculating protein yielding potential and in no way reflects the extra cost or effort associated with an additional 49 rabbits, nor is it intended to minimize the life of the 49 offspring. For a full explanation of the calculations for average daily protein yield per animal and per AU, readers are encouraged to contact the authors.

The agricultural considerations we chose for further investigation were the following:

1. Land use, which refers to animal stocking density or space necessary per animal, the most sustainable land management style, pasture rotation frequency, ideal rest periods for a piece of land and reasonable starting numbers for a small-scale project (Table 1).
2. Infrastructure, which includes housing required for daily use and breeding, housing cost, housing construction, feeding and watering equipment, and fencing (Table 2).
3. Time and labor, which refers to the time commitment required to raise each type of animal, the intensity of the labor involved, and typical activities (Table 3).
4. Breeding, which addresses startup stock, breeding age, estrous cycle, gestation periods, number of offspring per birth, productive life of a breeding animal, breeding cycle, mating procedures, and other general considerations (Table 4).
5. Feed and nutrition, which refers to the animal's diet type (ie, omnivore, herbivore), primary nutrition sources, alternative nutrition sources, average daily feed requirements, percentage forage in diet, crude protein

TABLE 8 Climate, Predator, and Disease and Parasites Considerations for a Livestock Nutrition Intervention^a

Meat rabbit	Broiler chicken	Dairy goat	Hog
<p>Climate: Perform poorly in hot, humid climates; rarely require additional heat in winter due to thick coats</p> <p>Predators: Risk: High; Type: Small rodents; dogs; foxes; raccoons; birds of prey;</p> <p>Prevention: Roofing, electric barriers, and guard dogs</p> <p>Most common diseases and parasites: Pasteurellosis and intestinal coccidiosis</p> <p>Other: Flies; conjunctivitis; enteritis complex; mastitis; heat prostration; ear mites</p> <p>Prevention: MIG; polycultures; pen/feed sanitation</p>	<p>Climate: Seasonal; pastured poultry works best in warmer climates but sensitive to extreme heat</p> <p>Predators: Risk: High; Type: Small rodents; dogs; foxes; raccoons; skunks; birds of prey; Prevention: Roofing, electric barriers, and guard dogs</p> <p>Most common diseases and parasites: Heart attack and joint failure (Cornish X); coccidiosis; Other: Respiratory disease; Prevention: MIG; polycultures; vaccination at birth; pen/feed sanitation</p>	<p>Climate: Prefer arid conditions; can tolerate cold</p> <p>Predators: Risk: Moderate; Type: Coyotes; wolves; cougars; dogs; bears; Prevention: Herd management; guard dogs; lighting; protective housing; proximity to occupied residence</p> <p>Most common diseases and parasites: Contagious ecthyma; caprine arthritis-encephalitis; mastitis; scrapie;</p> <p>Other: Abortion; footrot; Johne's Disease; ketosis; Prevention: MIG; polycultures; breed selection</p>	<p>Climate: Poor heat regulation in hot climates</p> <p>Predators: Risk: Low; Type: Bears; cougars; wolves;</p> <p>Prevention: Herd management</p> <p>Most common diseases and parasites: Transmissible gastroenteritis; trichina worm; Other: N/A; Prevention: MIG; polycultures; dewormed in first 3 months; pen/feed sanitation</p>

^aMIG indicates management intensive grazing, a labor-intensive method of managing livestock systems that has been shown to be beneficial to animal health and land fertility.

TABLE 9 Products/Services and Cost-Effectiveness Considerations for a Livestock Nutrition Intervention

Meat rabbit	Broiler chicken	Dairy goat	Hog
Products/services: Breeding; manure; meat; pelts; vermiculture	Products/services: Insect control; manure; meat; microtillage; weed control	Products/services: Breeding; grazing; manure; meat; milk; value-added products (ie, yogurt, cheese)	Products/services: Breeding; food waste conver- sion;manure;meat; tillage
Average net profit: \$34/doe (annual; 100-doe rabbitry)	Average net profit: \$2–3/bird	Average net profit: \$104/doe (annual; 100-doe herd)	Average net profit: \$484/sow (annual)
Highest input cost: Feed	Highest input cost: Feed and labor	Highest input cost: Labor	Highest input cost: Feed

requirements, important minerals, FCR, feed-related economic issues, and other general considerations (Table 5).

6. Harvest and slaughter, which refers to level of equipment needs, skill level and labor required, and other factors that should be considered when addressing protein harvest (Table 6).
7. Processing, which refers to the amount of processing required and related considerations (Table 6).
8. Average daily protein yield,^{36,39,45,48,62–64,68} which refers to how much protein an animal or animal unit (AU) can provide on a daily basis. An approximate AU was obtained by dividing an animal’s adult weight by 1000.⁶⁸ Nutrition information was obtained using the USDA Nutrient Database⁶⁹ (Table 7).
9. Harvest age, which refers to the earliest that an animal could provide protein, equipment needs, skill level, and labor required. Note that several variables can impact harvest weight and age, including weather, climate, feed, stress, and disease (Table 7).
10. Disease and parasite challenges, which refers to common diseases and parasites in a given species and prevention methods (Table 8).
11. Climate issues, which includes climate-related impact on the animals and production (Table 8).
12. Predation, which addresses how much a particular species is at risk to predators, list of common predators, and common techniques for reducing predation (Table 8).
13. Products and environmental services, such as products that a livestock species is capable of efficiently producing or beneficial services a species can offer to livestock producers of any scale (Table 9).
14. Cost effectiveness, which addresses average net profit per animal and highest input cost(s). Note that net profits can vary greatly based on scale, market demand, and skill and experience of producers (Table 9).

DISCUSSION

The preceding comparisons of livestock options shows that each species of livestock has a unique set of characteristics that will impact the animals' welfare and productivity, pending the surrounding environment. The recommended considerations are based on a limited number of structured interviews followed by an extensive review of existing literature on the highlighted livestock. The data in [Tables 1–9](#) are not intended to be an authoritative guide but rather a set of general considerations that would serve as a resource to grant writers pursuing a livestock nutrition intervention, policymakers interested in publicly funding a project, nonprofit organizations that conduct nutrition interventions, or civic leaders and public health professionals seeking alternatives in their communities. In some cases, a range of guidelines is given from the diverse set of references used. Variations should be expected in all of the data when applied in an actual situation. No 2 animals function exactly alike, even animals within the same gender of the same species of the same breed on the same piece of land managed by the same person. Beyond the 4 that were addressed in this article, numerous other species of livestock would also be viable options in a livestock nutrition intervention. For example, Tilapia, ducks, laying hens, sheep (milk and meat), meat goats, and cattle (milk and meat) have proven to be reliable food-providing livestock in a variety of settings. Soy and quinoa are complete plant proteins that may be more culturally appropriate than animal products in some communities and so can also be considered.

Other livestock-related considerations not addressed in our study include water consumption and needs, micro- and macronutrient profile, and scale of livestock enterprise. Water and its availability is an increasingly relevant topic as our population grows and the natural resource base shrinks. Though micronutrient and macronutrient profiles for each animal would differ based on numerous factors, it is nevertheless important information that would be beneficial in a livestock nutrition intervention. Optimal production scale would be best addressed alongside an assessment of a community's natural resource base. Cost effectiveness will vary according to scale. For example, raising and harvesting 250 broiler birds takes only slightly more land availability, labor, and inputs than raising 25 broiler birds, yet 250 birds would yield significantly greater nutrition and economic benefit to a community.

It should be duly noted that economies are dependent on ecosystems, yet our economy has regularly rewarded natural resource extraction.⁷⁰ The ability to pursue any nutrition intervention comprehensively requires an understanding that soil is where nourishment begins and all life springs. Soil building and enhancement should be the common goal of every nutrition professional and land manager.⁷¹ Food systems are complex entities that are influenced first and foremost by the natural resource base.^{72,73}

SUMMARY AND CONCLUSION

New approaches to address food insecurity and diet-related illness are needed. Current innovations in food security and nutrition initiatives domestically and internationally have utilized community and home gardening to increase access to fresh fruits and vegetables—a model that can be mimicked to improve high-quality protein access. Though very few Americans are at risk for protein-energy malnutrition, the quality of dietary protein available to many Americans is poor and ultimately can be harmful to health. A number of food security advocates have focused on improving food access and nutrition in urban areas in the United States or developing nations internationally; however, little attention has been directed toward the rural United States. Citizens of rural communities have a far greater distance to travel to access food support facilities and major food retailers than citizens of urban communities.¹² Though some kinds of support facilities such as food banks and assistance offices may not be feasible in rural communities due to population density, other measures can be taken. Livestock nutrition interventions have been largely successful in international models but have yet to be thoroughly explored in varied settings in the United States. The combination of bountiful reservoirs of land and a lack of zoning restrictions often found in urban areas makes the rural United States an ideal setting to pursue livestock nutrition interventions. A livestock nutrition intervention pilot project is a realistic approach to potentially reversing the increase of food insecurity throughout the United States. The benefits of such a project have the potential to expand far beyond nutrition—economic growth, increased social capital, and natural resource enhancement are all possible outcomes associated with a project of this nature.

Implications for the Public Health Professional

Pursuing a livestock nutrition intervention project requires a community that is aware of its food and nutrition needs while also being collectively willing to work together to find solutions to meet these needs. Public health professionals and nutritionists from inside or nearby a community must also be willing to participate in working with the community to build food security in a manner that assesses a community's resources and capabilities comprehensively.⁷⁴ This concept is embodied by the term *civic dietetics*, introduced in 2004 by Jennifer Wilkins as a way for nutrition professionals to be engaged with the food system at all levels to address food and nutrition-related problems.⁷⁵ When civic dietitians, organizations, and agencies work together to address food security,⁷⁶ they can build the social capital that ultimately establishes a stronger resource base to sustain community-based projects.⁷⁷

Sustainability of livestock nutrition intervention projects requires a comprehensive understanding of a community's needs, resources, and environment, as well as a community's willingness to be civically engaged. Given the need for interventions to improve nutrition and increase food access in rural communities, using livestock to build food security is an approach that should be pursued, ideally through the collaborative engagement of agricultural specialists, social scientists, and public health and nutrition professionals.

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